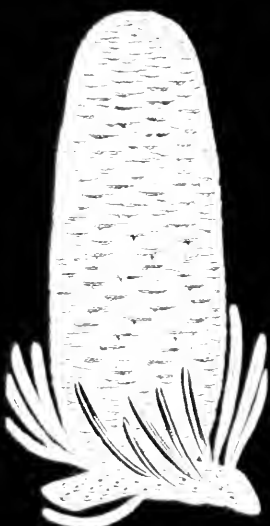

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VEITCH'S MANUAL OF THE CONIFERÆ.

William C. Appleby.
Baltimore.

VEITCH'S MANUAL

OF

THE CONIFERÆ,

CONTAINING

A GENERAL REVIEW OF THE ORDER; A SYNOPSIS OF THE SPECIES CULTIVATED IN GREAT BRITAIN; THEIR BOTANICAL HISTORY, ECONOMIC PROPERTIES, PLACE AND USE IN ARBORICULTURE, ETC., ETC.

A NEW AND GREATLY ENLARGED EDITION

BY

ADOLPHUS H. KENT.

"Science has its own peculiar terms and, so to speak, its idioms of language; and these it would be unwise, were it even possible, to relinquish; but everything that tends to clothe it in a strange and repulsive garb, and especially everything that assumes an unnecessary guise of profundity and obscurity should be sacrificed without mercy."—*Sir John Herschel.*

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PREFACE.

In this revised edition of Veitch's Manual of Coniferæ I have endeavoured to collect from the best available sources every item of information that should prove useful and interesting to amateurs of this remarkable family of trees and shrubs and also to foresters and horticulturists. The descriptions of the species have been drawn up from fresh materials and from an inspection of the subjects themselves wherever practicable, and trees of the same species growing in different and distant parts of Great Britain have been visited with this object. In the comparatively few instances in which this has not been done, the descriptions are those of the authorities quoted. With the view of conveying an idea as accurate as can be obtained of the condition and aspect of the most important coniferous trees as seen in their native forests, the accounts of them given by those who have explored the forests are transcribed wholly or in part in preference to any studied paraphrasing of their statements. Especial attention has been given to the geographical distribution of the species and the climatic conditions under which they grow in their native homes, on the conviction that correct information on these points affords material aid to the successful cultivation of them in Great Britain.

My obligations to those who have assisted in the compilation of the work either by their writings or by supplying materials for critical examination and description are very great: to Dr. Maxwell T. Masters my best thanks are due for permission to use the valuable papers on the subject contributed by him to the "Journal of the Linnean Society" and "The Gardeners' Chronicle;" to the Director and Curator of the Royal Gardens at Kew and the staff for their kindly help during frequent inspections of the extensive collection of Coniferæ in the Royal Gardens; to the Keepers of the Herbariums at Kew and the Natural History Museum for the facilities they afforded for examining original herbarium types under their charge; and to many correspondents for their untiring kindness in supplying specimens of foliage and flowers of rare and valuable species which are duly acknowledged in their respective places.

THE AUTHOR.

Royal Exotic Nursery, Chelsea.

GENERAL REVIEW

OF

THE CONIFERÆ.

CONIFERÆ, or Cone-bearing, is the name given to a Natural Order of Plants consisting of trees and shrubs, chiefly evergreen, of almost cosmopolitan distribution, and distinguished from every other Order of Plants by certain characters or properties, by the presence of any of which the coniferous plants may generally be recognised. The most noteworthy of these characters are to be found in the minute structure of their wood or stems, the resinous nature of their secretions, the form and structure of their leaves, the extreme simplicity of their flowers, and their fruit. The foliage and fruit, together with the physical aspect of the plant or tree, or its general appearance as presented to the eye, are the most easily observed; they are, therefore, except by the Botanist, almost the only characters by which Horticulturists and others recognise coniferous plants.

The fruit of nearly all the species included in the Fir and Pine tribe (Abietineæ) which greatly resembles a cone in shape, doubtless suggested the name Coniferæ as a suitable designation for the Order, and this name has been generally accepted ever since it was applied by Linnæus to the group of Gymnospermous plants known to him.* The most prominent exception is Lindley, who, in conformity with the rule almost universally observed in designating the Natural Orders—the selecting of one of the contained genera as a type around which the others may be grouped—adopted the name PINACEÆ (excluding the Taxads) in his excellent work, "The Vegetable Kingdom."† It may, however, be observed, that if the name Coniferæ as applied to the Order on account of the form of the fruit borne by a large number of the most important species belonging to it is not a sufficiently comprehensive one to be applicable to the whole, the mode of growth of a far greater number of species, especially in their young state, is strictly that of a cone in outline.

Many authors include in the Coniferæ the group of trees and shrubs known as Taxads, of which the Yew is the type, assigning

* Philosophia Botanica. p. 28 (1751). † Edition III. p. 226 (1853).

to the group tribal rank in contradistinction to the other groups constituting the Order Coniferæ as circumscribed by them.* But the fruit of the Taxads which has usually a succulent covering enclosing a single seed, and which greatly resembles a *drupe*, *e.g.*, a cherry or damson,† is very different from the ligneous scales and numerous seeds that make up the fruit of the true Coniferæ.‡ This structural difference, together with other characters that will be noted in the sequel, separate the Taxads from the true Coniferæ in a manner more marked than is usually indicated by tribal characters, and therefore a higher place in the series of groupings forming the systematic arrangement of the Vegetable Kingdom seems to be a more natural one for them. This view of their systematic place was taken by Dr. Lindley very many years ago, and is adopted by Dr. Maxwell Masters in his recently published notes on the Genera of Taxaceæ and Coniferæ.§ The Taxaceæ are thence here recognised as a Natural Order distinct from, but closely associated with the Coniferæ. The two Orders thus associated are of the highest importance to Man in many respects: they supply a larger amount of the most valuable timber for constructive purposes than is at present obtained from any other Natural Order; their resinous products are important articles of commerce that are largely used in many of the arts; in no other family of trees and shrubs are found so many subjects suitable for the decoration of the garden, park and landscape, or more valuable for forestry and other purposes in rural economy: and there is no existing race of plants that can awaken a deeper interest in their relation to the distant Past than Taxads and Conifers, vestiges of whose ancestry can be traced through a long series of geological ages till the primeval forms become as mere shadows that finally vanish in the unfathomable antiquity of palaeozoic aeons.

MORPHOLOGY.

THE SEEDLING PLANT.

THE seedling is the development of the embryo or rudimentary plant enclosed in the resting seed. The embryo of Taxads and Conifers, like that of most flowering plants, consists of two distinguishable parts, viz., the rudimentary cotyledons or seed-leaves, and the short axis or

* *Taxineæ*, Parlatore, D. C. Prodr. XVI. p. 367 (1868). *Taxeæ et Podocarpeæ*, Bentham and Hooker, Gen. Plant. III. pp. 422, 423 (1881). And others.

† The fruit of Taxads is drupe—or berry-like in appearance only; the drupe and berry in their botanical signification are developments of the ovary and contain the seed or seeds; but in Taxads the seeds are always solitary and enclosed in a fleshy aril originating from the ovule.

‡ The so-called berries (galbuli) of the Juniper have a superficial resemblance to the fruits of Taxads, but structurally they conform to the strobiles or fruits of the Coniferæ, the confluent scales being fleshy or succulent, instead of ligneous.

§ Journal of the Linnean Society, XXX. p. 1.

stem-like portion from which the cotyledon rudiments originate, and which from its position with respect to them is called the hypocotyl. The process of germination of the seeds of Conifers and Taxads is the same in all essential points as that of flowering plants generally. When the seed is placed on damp soil of a temperature sufficient to induce growth,* the endosperm or fleshy part that surrounds the embryo swells and bursts the husk (testa) that encloses it, splitting the testa into two parts, but which usually cohere at one end. From the opposite open end the radicle or first formed root protrudes and pushes its way downwards into the soil, while the rudimentary stem (the tigellum or caudicle of the older botanists, the hypocotyl of recent authors) lengthens in the opposite or upward direction, bearing at its summit the cotyledons still partially enclosed in the husk till it is thrown off by their further lengthening and consequent tension. The seedling plant then presents the appearance of a rather long slender axis, from the lower part of which a minute rootlet has been here and there given off, and terminating above in a tuft of narrow leaf-like bodies, the cotyledons, which vary greatly in number in different genera, and in a small degree, even in the same species. From the centre of this tuft originates the rudiment of the future stem. No trace of an epicotyl is to be seen in the embryo state of Taxads and Conifers, and it is not till after the development of the cotyledons into the leaf-like bodies already mentioned that it appears as a prolongation of the hypocotyl.

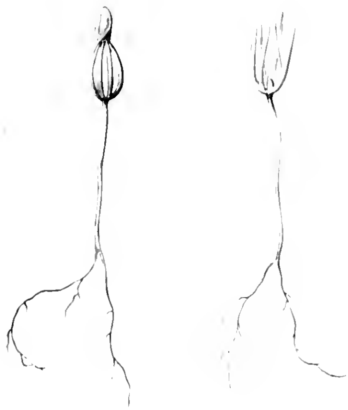


Fig. 1. Seedling plant of *Picea Glehnii*.

THE COTYLEDONS. The number of cotyledons varies considerably, but in this respect the species readily fall into two groups, one having

* The temperature necessary for the germination of the seeds of Taxads and Conifers has not been accurately ascertained. It is, however, known that it varies in the different species more or less according to the latitude of their habitat and their vertical range on the mountains they inhabit. Thus, the seeds of the Siberian Larch; the common, black and white Spruces; the Banksian, Mountain and Cembra Pines; the alpine and common Junipers, and others spreading into high latitudes or ascending to a high vertical elevation, will germinate freely in a temperature ranging from 1°–5° C. (34°–41° F.); whilst the seeds of those species inhabiting the warmer parts of the temperate zone require a higher temperature, and those of sub-tropical species still higher. It is scarcely possible to discover from the ordinary nursery practice a constant temperature for the germination of the seeds of the species commonly cultivated in Great Britain, and which are usually sown in the open ground where the temperature may vary from day to day. The question is still further complicated by the impossibility of estimating the amount of heat given out by the seeds themselves during germination, which, it is known, they must do in conformity with the universal law of Conservation of Force.

dicotyledonous and the other polycotyledonous embryos. The first group includes the whole of the Taxads, the greater part of the Cupressineæ and Taxodineæ and some of the Araucarineæ; the second group includes the Abietineæ, the section Eutassa of Araucaria, the Sequoias, Callitris and probably a few others. In the Journal of the Linnean Society* Dr. Masters gives a comprehensive list of the number of cotyledons in seedlings examined by himself and others, from which we select a few well-known species. In *Abies pectinata* and *A. sibirica* the number is 3—7, *Abies nobilis* 6—8, *Cedrus Libani* 6—11, *Larix europaea* and *L. Griffithii* 5—7, *L. sibirica* and *L. americana* 4—5, *Pinus Laricio* 4—8, *P. Pinaster* 5—8, *P. radiata* 6—9, *P. ponderosa* 6—11, *P. Cembra* 8—14, *P. excelsa* 8—12, *P. Coulteri* 10—14, *P. Sabiniana* 12—18, the last named being the highest observed number. A few instances are added selected from about forty species observed by the author and not contained in Dr. Masters' list. *Abies amabilis* and *A. magnifica* 6—7, *Picea sitchensis* 4—5, *P. Glehnii* 5—6, *P. obovata* 6—7, *Tsuga caroliniana* 3, *T. Albertiana* 3—4, *T. Mertensiana* 3, *Pinus mitis* 6—7, *P. muricata* 4—6. From the two series of observations it may be assumed that the number 3—4 of cotyledons in Tsuga is fairly constant, also the number 9—11 in Cedrus is fairly constant, while in Larix the number varies from 4—7, in Abies from 5—8, in Picea from 3—11, and in Pinus from 5—18.

Fig. 2. Seedling plant of *Pinus muricata*.

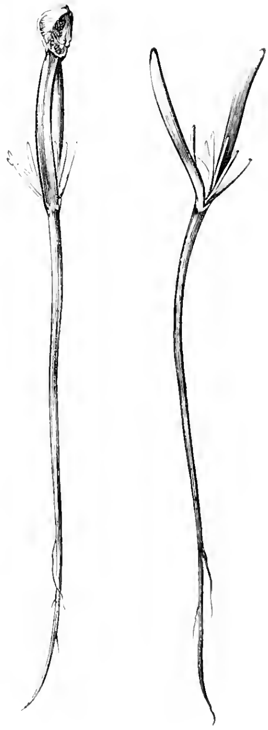


Fig. 3. Seedling plant of *Cupressus semperrirens*.

The size of the cotyledons also varies in different genera and in species of the same genus. In *Pinus pinea* they are two inches long and somewhat stout, in *P. canariensis* they are as long but more slender, in *P. Coulteri* 1·5 inch long, *P. muricata* and *P. Cembra* 1 inch, *Abies grandis* 1 inch, *Thuia gigantea* 1·5 inch, *Cupressus semperrirens* 0·75 inch, *Picea Glehnii* 0·5 inch.

The form of the cotyledons is nearly always linear or linear-oblong, the most notable exception being Ginkgo. In the Cupressineæ they are flat or with rounded surfaces, frequently with a median line on the upper side. In Abies and Picea they are flattened with rounded surfaces and with a distinct midrib in most of the species of the former; either obtuse, emarginate or acute

* Vol. XXVII. p. 235.

at the apex in Picea. In the three- and five-leaved species of Pinus the cotyledons, like the foliage leaves, are three-sided and terminate in a sharp point, the outer side rounded and green, and the inner sides flat and glaucous. In Ginkgo they are thick, fleshy, oblong, contracted at the base into a short stalk, leaving the endosperm enclosed within the shell.

THE ROOTS.

THE radicle, or primary root of the seedling plant, is slender and descends straight downwards into the soil, and, as it lengthens, gives off fibraline rootlets that are often arranged in two ranks: but in many cases they are scattered or given off at irregular intervals. As the growth of the axis proceeds, the changes that take place in the size and direction both of the primary root and its branches are greatly influenced by the circumstances of soil and other conditions under which the plant is growing. In species of the Fir and Pine tribe that have their home on the slopes of lofty mountains and on hill-sides that are constantly undergoing denudation by the weather, or where the soil is very shallow or only accumulates in hollows or crevices of the rocks, the downward course of the primary root is soon arrested: but the secondary roots increase in diameter and lengthen greatly, creeping over the surface of the ground to a great distance, sometimes to such an extent as to excite the surprise of the beholder.* But in the plains where the soil is deeper and the sub-soil more or less penetrable, a decided tap-root is often developed from the primary radicle which descends vertically to a considerable distance or till it meets with some obstacle to its progress. Instances of this are seen in several of the Pines planted for purposes of utility, as *Pinus Pinaster* on the sand-dunes in the south-west of France: *P. Laricio* nearly always, whence this Pine is sometimes difficult to transplant: *Taxodium distichum* likewise sends

Fig. 4. Seedling plant of *Ginkgo biloba*. c, cotyledon; p, primordial leaf.

* Among some remarkable recorded instances may be noted the Araucarias on the rocky slopes of the Andes of Southern Chile, the roots of which have been compared to gigantic serpents; *Abies bracteata* on the summits of the Santa Lucia in South California; the Larch and Mountain Pine on the Tyrolese Alps; the red and white Pines of Japan which escape destruction by growing on inaccessible rocks on the central mountain chain, where their roots are said to spread to a prodigious distance.

down a long tap-root deep into the mud of its native swamps. *Abies grandis*, *Thuia gigantea*, *Sequoia sempervirens* and other species which inhabit the alluvial plains of Oregon and the low-lying maritime districts of California are deep-rooted, both in their native country and when transplanted in Great Britain; but in all these, as well as in the other species that attain the dimensions of large trees, strong secondary roots branch off from the primary or main axis, and with their ramifications spread horizontally through the soil near the surface or with a slight obliquity downwards. Generally—the roots of coniferous trees and shrubs are produced freely from the seedling plant; at first but slender thread-like organs ramifying at short intervals, and sub-dividing repeatedly as they increase in size, they form a network spread over an area which in all the kinds cultivated in this country is never less than the spread of the branches of the stem, whence the newly-formed rootlets are brought within reach of the rain dripping from the foliage. In the adult trees the spread of the roots very often exceeds the spread of the branches: they thence not only form a broad base for the support of the superincumbent mass of stem and branches, but they are also exceedingly tough in texture, and cling tenaciously to the soil through which they penetrate and to the rocks over which they creep. Hence it is that many coniferous trees are so well enabled to withstand the force of high winds without being blown down. The rootlets are exceedingly numerous, and must therefore possess in the aggregate an enormous absorbent power—a

Fig. 5. Seedling plant of *Cephalotaxus drupacea*.
c, cotyledon; p, primordial leaf.

power evidently necessary to the well-being of the tree on account of the great height and distance the absorbed fluid has to travel in order to reach the extremities of large and lofty trees, especially during the season of active growth.

Like other Exogenous trees inhabiting temperate climates, the roots of Coniferae have a period of comparative if not absolute repose, during which, except in frosty weather, the plant may be taken out of the ground and removed to another spot, even after it has attained a considerable size.* The vitality of the roots of coniferous plants is remarkable, especially in the Fir and Pine tribe. Many instances have been observed in which the roots not only live but continue to grow for many years after the trunk has been cut down: this is especially the case with *Abies pectinata*.

The foregoing characters are, generally speaking, common throughout the Taxaceae and Coniferae, but a few peculiarities that are met with in the different tribes require separate notice.

In the Yew the plexus of fibrous rootlets is always very great even at an advanced age of the tree, so that the absorbent power of the roots of a large Yew must be enormous. There can be no doubt that this is one of the causes that contributes to the longevity of the Yew; and it is probable, too, that these rootlets have a limited power of selection in the substances taken up by them, since the Yew will live and thrive in soils of the most opposite description and maintain a tolerably constant habit and colour of foliage everywhere.

In the Sequoia tribe (Taxodineae), all the principal members of which are not only among the largest of Conifers, but also among the largest of trees, the roots lengthen very rapidly from early life, and spread over a large area always near the surface. A striking peculiarity is seen in the roots of the deciduous Cypress (*Taxodium distichum*) when this tree attains its maturity and is growing in swampy places, as it most commonly does in its native forests in North America, or in close proximity to water in England: they form hollow conical or beehive-shaped protuberances that rise several inches above the surface of the ground in this country, but often much higher in their native swamps, and which have never been noticed to produce buds from which shoots proceed: these protuberances are popularly called "knees." The roots of the large deciduous Cypress at Syon House, the subject of our illustration in the article on Taxodium, have spread to a distance of more than twenty yards from the bole.

In many of the species belonging to the Cypress tribe (Cupressineae), and which are mostly of fastigiate or strict habit, the primary roots lengthen but slowly, although they increase in thickness considerably during the first years of the life of the tree; but the rootlets form a dense plexus, occupying a circular area not much greater than the spread of the branches above. It is not till the tree has acquired some age, and the soil in immediate proximity to it has become quite exhausted, that the roots lengthen to any considerable extent in search of nutriment,

* It is not, however, advisable to remove large trees, especially of the Fir and Pine tribe, whose roots extend far from the trunk, and which cannot even with the greatest care be removed without destroying and injuring a large proportion of the rootlets.

which they do in conformity with a law universal throughout the Vegetable Kingdom. The fibrous rootlets then become more spreading, and those formed during the earlier life of the tree having fulfilled their functions, die.

Roots are occasionally emitted from the lowermost branches resting on the ground at or near their extremities, especially when the soil is kept moist by the shade of the branches above, or from other causes. A very remarkable instance is described and figured by Loudon.—At The Whim, situated on the northern slopes of the Romano Hills in north Peeblesshire at about 1,000 feet elevation, the lower branches of a Norway Spruce growing in the centre of a piece of mossy ground had taken root wherever they had come in contact with the soil, and had formed a double series of young trees in two concentric circles around the parent tree. At the date of the publication of Loudon's "Arboretum" there were upwards of thirty rooted stems surrounding the mother tree.* One of the lowermost branches of a *Pinus excelsa*, in the gardens of Eastnor Castle, resting on the ground has rooted in a similar manner; the extremity of the branch has ascended and developed into a stem with branches exactly like the parent tree. At Fota, near Cork, the lowermost branches of a *Cryptomeria japonica* have emitted roots into the soil below, and have formed erect stems like the parent trunk which is now surrounded by over twenty young trees of various heights, the whole forming a dense copse of Cryptomerias. In the moist climate of Cornwall and the south and west of Ireland, the rooting of the lowermost branches of *Cryptomeria japonica*, var. *elegans*, when in contact with the ground is quite a common occurrence; and this rooting has also been observed in various places in *Thuia occidentalis*, *Cupressus Lawsoniana*, *C. macrocarpa*, in some of the Junipers, the Cedar of Lebanon and in the common Yew.

The power of forming roots by pieces detached from the parent plant or from "cuttings" is very considerable, but differs much in the different tribes. It appears to exist nearly in the same ratio as that of producing leaf buds; thus in the Cypress tribe, in which the branchlets ramify repeatedly from the axils of the scale-like leaves, and produce lateral shoots very freely when the leaders are, in garden phraseology, "headed back," cuttings take root very readily when placed in circumstances favourable for their development. In the Sequoia and Yew tribes the power of rooting from cuttings is almost as great as in the Cypress and its allies. It is much weaker in the Fir and Pine tribe; some of the Araucarias and the Cunninghamia possess it in a high degree; the Spruce and Hemlock Firs less so; it is feeble in the Silver Firs, and wanting, or nearly so, altogether in the true Pines.

* Arboretum et Fruticetum Britannicum, Vol. IV. p. 2,298. The tree with its progeny here figured and described has since disappeared, but in a plantation about 200 yards south-west from the mansion may be seen many Norway Spruces whose lowermost branches have taken root in the soft damp earth, some with three, four and even more series of young trees around them. To my late excellent correspondent, Mr. Malcolm Dunn, of Dalkeith, who visited The Whim for the express purpose of inspecting these trees, I am indebted for the following particulars respecting them: "The soil in which the Norway Spruces are growing is a deep peat bog, the surface of which is covered with sphagnum moss, heath, bilberry, etc. The branches of the Spruces become loaded with moss and lichen, and when bent to the ground by their weight, the sphagnum soon covering them, they root freely into the soft bog earth. There are two fairly distinct varieties of the Norway Spruce at The Whim, one with short crowded leaves, and the other with looser, longer ones; trees with the first named foliage most readily root from the lower branches, while those with the other kind rarely do so."

THE STEM.

THE stem or trunk of taxaceous and coniferous trees is the direct prolongation of the axis of the seedling plant, which is itself a development of the axis of the embryo. Usually, under cultivation and perhaps always in a wild state, if the seed germinates in spring, the axis of the seedling continues to lengthen after the development of the cotyledons during the same season; it then produces foliage leaves that are often very different from those subsequently produced on the older parts of the stems and branches. The termination of the first stage of growth is marked by a scaly winter bud in all the species included in the Fir and Pine tribe (Abietineæ), in most of the cultivated Taxads, in Sciadopitys, Taxodium, and *Sequoia sempervirens*.* From this bud the axis continues to lengthen in the following season and to produce leaves that gradually take the form characteristic of the species. In the Abietineæ, at the termination of the growth of the axis in the second, and still more conspicuously in the succeeding seasons, the apical bud is surrounded by a variable number of smaller buds from which branches are developed in the following year. In the TAXACEÆ, the apical bud is usually solitary, but other buds are distributed irregularly over that portion of the stem formed during the current season's growth from which branches are developed in the following year; it is thence evident how greatly the position and number of both terminal and lateral buds influence the habit of the tree, and how greatly the form and beauty of coniferous trees depend on the branching. Throughout the Cupressineæ, in Araucaria and Cunninghamia, and in the Taxodineæ, with the exceptions named above, no true winter buds are formed, but during the season of rest, the apex of the shoots is protected by the latest-formed leaves in different stages of development, the older ones usually arching over and enclosing the younger imperfect ones, and which for the time being perform the function of bud scales.

In all Taxads and Conifers that come under the denomination of trees, the stem or primary axis always grows more rapidly than the branches given off from it, until the upward progress is diminished by age, or arrested by physical causes, the yearly rate of increase being fairly uniform according to age, in each species, but often modified in Great Britain by the varying climatic conditions of the seasons. In this way the stems or trunks continue to ascend year after year: they are for the most part cylindric-conic, gradually tapering from the base

* In this species the bud formed at the apex of each shoot is intermediate in structure between the true winter buds of the Abietineæ and the terminal leafy envelopes of the Cupressineæ.

to the apex, perfectly erect except where thrown out of the perpendicular by the action of the wind, and attaining dimensions varying from a few inches* to more than 300 feet in height,† and with diameters generally small in proportion to the height, but in this respect the Yew, the Cedar of Lebanon and the deciduous Cypress afford occasional exceptions. The size attained by stems of the same species is far from being uniform except under like conditions, the growth being greatly influenced by soil, situation or climate, or by a combination of these causes. Some species of Pinus and Abies, for example, having the slopes of mountains for their habitat, at and near their lower limit grow from 60 to 100 feet high, or even more; but this height is found to diminish in proportion to the elevation at which they grow, so that at the highest point, often at the limits of perpetual snow, they are dwarfed to a more scrubby bush over which a man may step. A similar change is observed in species whose habitat extends over many degrees of latitude; thus, the Cembra Pine on the Swiss Alps, and under cultivation in our own country, grows from 50 to 70 feet high; at its northern limit, in the Siberian plains and Kamtschatka, it is dwarfed to a low bush the height of which ranges between 50 and 70 inches.‡ The American Tideland Spruce, *Picea sitchensis*, which in the swampy littoral tracts of Oregon grows to a height of 250 feet, is reduced to a low scrubby bush at its extreme northern limit in Alaska. *Pinus Banksiana*, which is botanically allied to the Scots Pine of our own country and often seen upwards of 100 feet high, is a straggling shrub of from three to five feet high among the rocks in the dreary wastes of Labrador.

The chief cause of the great difference just noticed is the diminished amount of solar heat which the dwarfed forms receive, and by which their growth is constantly retarded. At high elevations, this diminution is owing to the rarity of the atmosphere, which permits a rapid radiation of heat into space without affording any such checks as are present in the denser strata of lower altitudes and at the sea level where the atmosphere is always more or less surcharged with vapour. In high latitudes, the diminution of solar heat is due to the slanting direction in which the sun's rays strike the earth, owing to the convexity of its surface, and whence their power is greatly weakened: also the short period the sun is daily above the horizon during nearly half the year, owing to the obliquity of the earth's axis.

The size and height attained by the trunks or stems of coniferous trees, and more especially of the same or allied species, are also greatly influenced by the amount of moisture of the climate in which the trees are growing, or which amounts to nearly the same thing, the annual rainfall of the region or district. It is observed, in reference to the distribution of the Coniferae, that their abundance and rate of

* *Juniperus communis compressa*, native of the Pyrenees.

† *Sequoia Wellingtonia*, the Mammoth tree of California.

‡ This form is described as a distinct species under the name of *Pinus pumila* by Dr. Heinrich Mayr, in "Abietineen des Japanischen Reichs," p. 80.

growth follow pretty nearly the general laws relative to the distribution of rain:—thus (1).—In mountainous regions of the temperate zones more rain falls than in the level districts, because mountains arrest the clouds, and a condensation of vapour ensues from collision with their cold summits, and there are found the densest forests and most luxuriant growth. (2).—The precipitation of rain decreases in proceeding from the Tropic of Cancer to the Arctic Circle; in like manner it may be roughly stated that, except in maritime districts, the size attained by coniferous trees and their rate of growth diminish in a like ratio. (3.) The rainfall also decreases in passing from maritime to inland countries; it is also found that the growth of coniferous plants is influenced by the same law. The same general facts are observable in England: thus in Cornwall and Devonshire the average annual rainfall exceeds 40 inches, while in the Eastern Counties it is often below 20 inches. The numerous reports published in the horticultural journals show that the rate of growth of Coniferæ in the south-west and west of England is much greater than in the eastern counties. And so in Scotland. On the west coast and in parts of Perthshire the annual rainfall reaches 50 inches, in particular spots very much more, while on the east side of the country it is not more than 30 inches. The finest Coniferæ in Scotland are found where the temperature and rainfall are highest.

In further illustration of these laws, the following are well-attested instances. The mountain ranges in the North American continent in the neighbourhood of the Pacific Ocean, extending through California, Oregon, and British Columbia, were, and are still in places covered with the densest coating of coniferous vegetation known, and there the summer temperature is high and the annual rainfall copious. In the eastern parts of the Continent, where it is much drier and colder, the Weymouth Pine (*Pinus Strobus*) attains a height of 100 feet; in nearly the same latitude, near the Pacific Coast, its near ally, the Sugar Pine (*Pinus Lambertiana*), towers to nearly three times that height. The Balsam Firs of Canada and Carolina (*Abies balsamea* and *A. Fraseri*) are low short-lived trees, not often more than 50 feet high; their congeners, the Western Balsam Firs of California and Oregon (*A. grandis* and *A. concolor*) are giants 200 feet high, and live for centuries. In the humid climate of the Himalaya, the Deodar Cedar, Hemlock Fir (*Tsuga Brunoniana*) and some of the Junipers attain dimensions far exceeding those of their nearest allies in other parts of the eastern continent. In Europe all the principal mountain ranges abound in coniferous forests, affording valuable timber; while in the plains, where the rainfall is much less, many kinds are dwarfed, and others cannot be made to thrive even under cultivation. Under the tropical rains of Mexico the deciduous Cypress rivals in size its great Californian cousins, while further north, in the United States, it is often a moderate-sized tree 120 feet high or thereabouts.

The stems or trunks of the larger coniferous trees increase in height and diameter very rapidly after the first years of their "infancy," when the plant has become established. Thus the Wellingtonia in this country grows at the rate of from 24 to 30 inches in one year, and *Thuia gigantea* and *Cupressus macrocarpa* have been known to make an addition of nearly four feet to their height in one season. *Abies Nordmanniana* and *A. nobilis*, which commence their growth late in the season, will add to their leaders from 15 to 18 inches in the short space of six or eight weeks. *Abietia Douglasii* makes an average growth of from 21 to 27 inches annually, and *Pinus radiata** even more. The rate of growth varies in each kind according to the soil and situation; it is also influenced by the state of the season, being greater or less according as the temperature is higher or lower than the average mean. Every annual increase in height is, of course, accompanied by an increase in the diameter of the trunk indicated by one ring.

Theoretically, the trunks of coniferous trees might increase in size and height indefinitely, were there no counteracting causes at work to check and finally to arrest the progress; but such sooner or later are sure to arise, and among the principal are undoubtedly the gradual exhaustion of the soil in which the tree is growing, and the choking up of the channels of circulation by the deposition of insoluble matter taken up by the roots. The functions of the various organs become enfeebled by age, as they do in the animal frame, although the period of the life of the one is in most instances immensely prolonged compared with that of the other, so that the cause of decay is so much the slower in its action. The vigour with which coniferous trees increase in size during the earlier period of their existence is sensibly diminished in process of time, till at length the counteracting causes balance the growing power; the tree has then reached its full maturity; the period of decay sets in which is never permanently arrested till the death of the individual and the subsequent decomposition of its tissues is complete.

A cross section of the trunk of a large coniferous tree shows that the annual rings nearest the central pith are the broadest, and that their width diminishes as they recede from the centre to the bark. In trees felled in Great Britain the diminution is not symmetrical; a ring of a certain width in any part of the section is not precisely so much narrower than the one within it, or so much broader than the one immediately without it. On the contrary, the irregularity in this respect is very considerable, so that a ring is often found which is broader than the one nearer the centre. This irregularity is believed to be due to climatic changes. During a long and warm summer a coniferous tree will make much more growth than during a wet and comparatively cold one, and it is not improbable that the fluctuations of the seasons are represented by the different widths of the rings. But in regions like California and that of the Himalaya where the alternation of seasons is regular and the average annual temperature and rainfall almost constant, the diminution in breadth proceeds very symmetrically; but there are throughout the sections circular spaces of considerable breadth in which there is an appreciable uniformity in the width of these annual rings, so that the gradual diminution is not perceptible unless a series of the inner rings is compared with a series nearer the circumference. The general principle is, however, never departed from: the rings more remote from the

* The growth of *Pinus radiata* in the warm and more equable climate of New Zealand is very rapid. A correspondent in the Canterbury district informed Messrs. Veitch that he had measured shoots of the preceding year's growth nine feet long; the average growth of a number of trees in a plantation was quite six feet. Its growth is equally rapid in South Australia, Victoria, and other sub-tropical lands possessing a moderate rainfall similar to that of South California.

centre diminish in width as they approach the bark. In very aged trees the rings near the outside are so close together that they can only be counted with difficulty, upwards of one hundred of them scarcely occupying a breadth of more than from one to two inches.

The AGE attained by coniferous trees varies very much in the different families. Some members of the Cypress tribe complete their evolution in a few years; the gigantic Sequoias of California have been living during the greater part of the time that separates us from the commencement of the Christian Era. Between these extreme cases are numerous examples of greater or less longevity; thus the Yew is known to live over a thousand years, whilst the American Balsam Fir rarely attains the "appointed age of man."

The nearest approach to accuracy in estimating the age of a coniferous tree is obtained by counting the number of rings in a transverse section of the trunk near the base. Such sections have been made for the express purpose of ascertaining the age, and others preserved in National Museums for the purpose of showing the texture of the timber are useful for the same end. Thus, in the Museum of Economic Botany at Kew there is a section of *Pinus sylvestris* from Inverness-shire that was 145 years old when felled and was sound throughout; one of *Larix europaea*, 126 years old, blown down in Northumberland in 1863, and others whose ages have not been ascertained. And in the Natural History Museum at South Kensington there is a section of *Sequoia gigantea* showing 1,335 rings. (This tree must have been standing in the earlier period of the Saxon Heptarchy.) There is also a section of *Abietia (Pseudotsuga) Douglasii* with 533, and of *Abies grandis* with 317 rings.

It is evident that while such sections indicate very nearly the age of the individual trees at the date of being felled, a number of trees of the same species would have to be felled if the average age attainable by that species is to be ascertained with any approach to accuracy. Where the geographical range of the species is restricted as in the case of the Sequoias, Cryptomeria, some of the Abies, Tsugas and Pinus, the ages ascertained from sections of some of the largest trees is practically a sufficient basis for the estimate of the age attained by the species in its own habitat. On the other hand, in the case of species which have a wide geographical distribution, and thence are growing under varying conditions of climate and environment, as *Pinus sylvestris*, *P. ponderosa*, *Picea nigra*, *Juniperus virginiana*, *Taxus baccata* and others, a considerable divergence in the size and age attained in different localities and arising from different causes, undoubtedly occurs.

The following estimate, given by various authorities, of the ages attained by some of the largest coniferous trees must be accepted only with a degree of reservation corresponding to the difficulty experienced in ascertaining anything like an approximation to the truth.

The Californian Big Tree (*Sequoia Wellingtonia*)	from 1,500	to	2,000	years.
The Red Wood (*Sequoia sempervirens*)	.. 1,300	..	1,750	,,
The Yew (*Taxus baccata*)	.. 1,100	..	1,250	,,
Deciduous Cypress (*Taxodium distichum*)	.. 750	.	1,000	,,
Himalayan Cedar (*Cedrus Deodara*)	.. 750	..	900	,,
Cedar of Lebanon (*Cedrus Libani*)	.. 500	..	800	,,
Swiss Stone Pine (*Pinus Cembra*)	.. 500	..	800	,,

Douglas Fir (*Abietia Douglasii*) . .	from	450	to	750	years.
Silver Fir (*Abies pectinata*)	,,	450	,,	600	,,
Roman Cypress (*Cupressus sempervirens*) .	,,	350	,,	500	,,
Sugar Pine (*Pinus Lambertiana*) . . .	,,	350	,,	500	,,
Moreton Bay Pine (*Araucaria Bidwilli*) .	,,	300	,,	400	,,
Kauri Pine (*Agathis australis*)	,,	300	,,	500	,,
Colombian Hemlock Fir (*Tsuga Albertiana*)	,,	300	,,	500	,,
Sitka Spruce (*Picea sitchensis*)	,,	250	,,	400	,,

RAMIFICATION.

As every branch originates from a bud, and upon the arrangement of the buds and their development into branches the habit of the plant depends, it would seem that an account of the buds should naturally precede a description of the ramification. Practically the buds and the young shoots that arise from them can be better studied on trees whose branches have attained considerable development than on young plants passing out of the cotyledonary state. For this reason precedence is given to ramification.

The ramification of Taxads and Conifers is normally monopodial, that is to say—the principal axes or mother shoots continue to develop more strongly than all the lateral shoots, and the lateral shoots of each successive order behave in the same manner in respect to their mother shoots. As pointed out by Dr. Masters, the variations in the mode of growth depend primarily upon the development of the buds in particular situations, and upon their non-development in others. Development and non-development occur in rhythmic alternation as regards time, and in relatively definite positions as regards space. The unusual degree of regularity with which these phenomena do or do not occur, brings about a style of ramification characteristic of the Coniferæ.*

Throughout the Fir and Pine tribe (Abietineæ) with the exception of a few species of Pinus, and some abnormal states of *Picea excelsa*; and also in nearly all the Taxodineæ, the Araucarineæ, and in many of the Cupressineæ, the development of the trunk is often enormous compared with that of the branches. In the first named tribe, and also in the Araucarineæ, the primary branches are in whorls, or perhaps more properly, pseudo-whorls,† that is to say—they are produced from the trunk on every side, nearly in the same plane, in tiers of from three to seven each, rarely more, five being the predominant number. In Great Britain, owing to climatic causes, the intervals between the tiers of branches vary in length, but in the more constant climate of California and other parts

* Journ. Linn. Soc. XXVII. 281 (1890).

† In young plants of *Araucaria excelsa*, cultivated in Conservatories in Great Britain, the primary branches are strictly verticillate, that is, produced in a ring around the common axis in exactly the same plane. And this is apparently the case in young trees of Abies, Picea, and perhaps Pinus. In older trees one or more branches in the same whorl are often displaced from the common plane by unequal development of the stem during growth, such as is shown by longitudinal and transverse sections of trunks preserved in the National Museums, etc.

of North America the intervals are strikingly uniform. The general direction of the primary branches is horizontal, but the higher ones are often more or less ascending, while the lower ones are deflexed by the weight of their appendages. Very often single branches are produced between the whorls, but these are adventitious, and their development is generally much weaker than the others.

Of the branches comprising a single whorl, it often happens that the growth of one or two is more vigorous than that of the others; a rigorous uniformity of growth is the exception rather than the rule.* In the remaining CONIFERÆ and in the TAXACEÆ, the primary branches are produced around the trunk, usually at close irregular intervals, and their general direction is much the same as in the Abietineæ and Araucarineæ; but there are many exceptions, especially where the disproportion between the stem and primary branches is not so marked. The resulting habit from this mode of growth is, that so long as the stem or main axis continues to ascend, the branches gradually decrease in length from below upwards, and those trees that are furnished with branches from the base have the outline of an elongated cone or spire.

Among the Cupressineæ and Taxaceæ, and even among the true Pines, instances occur in which the primary branches and their ramifications take an upward direction, either parallel with the principal axis, or at a small angle to it; the spire-like habit then becomes modified into the tapering or flame-like, the fastigiate, the globose, or even the bush form. Well-known examples of the flame-like are afforded by the Roman Cypress and the erect variety of Lawson's Cypress. The fastigiate habit is seen in the Irish Yew, the Swedish Juniper, the upright form of *Cephalotaxus pedunculata*, and others: in these fastigiate forms of Taxus and Cephalotaxus correlative changes are observable in the leaves which do not become twisted at the base, and consequently not pseudo-distichous. The globose habit is represented in gardens by varieties of *Thuia orientalis*, *Cupressus obtusa*, *Juniperus communis* and others: and the bush form by Cephalotaxus, Saxe-gothæa, varieties of the common Yew, many Junipers, several varieties of *Cupressus obtusa*, *C. pisifera*, *Thuia occidentalis*, etc. When the primary branches are short and nearly of equal length from below upwards, the tree takes a columnar form, such as is often seen in *Pinus Cembra* and *Cupressus Lawsoniana*, and always in *Libocedrus decurrens* in this country. In a few Junipers, in one or two varieties of the common Yew, in a remarkable variety of *Cryptomeria japonica* which originated in Japan, in *Thuia dolabrata laetevirens* introduced from the same country, and in a few others, the principal axis fails to ascend, while the primary branches and their ramifications spread over the surface of the ground. This prostrate habit is one of the least common amongst the cultivated Taxads and Conifers, but at high altitudes and at the extreme northern limit of arborescent vegetation where the annual periods of growth are short and the temperature low, the prostrate habit is common to well nigh all the species found under those conditions.

Much variation exists in the amount of branching. In *Araucaria imbricata*, *A. Bidwillii*, *A. brasiliensis*, *A. Cookii* and probably other species, often conspicuously in the first named,† also in some of the

*It is most frequent in the Araucarias and some of the Abies during the early period of their life.

† Primary branches of *Araucaria imbricata* have been noted by the author 7—10 feet long without a single lateral shoot.

long-leaved Pines, *Pinus Coulteri*, *P. Montezumæ*, etc., the secondary branches are comparatively few. A remarkable instance of sparse ramification occurs in a variety of the common Spruce Fir, known in gardens as *Picea excelsa monstrosa*. It is a curious fact, too, that other varieties of the same species, as *P. excelsa Clanbrasiliana*, *pygmæa*, *Gregoryana*, have the very opposite tendency; the trunk and primary branches remaining short, whilst the smaller ones become excessively multiplied. Shoots from adventitious buds on the upper side of primary horizontal branches, and often on those of a lower degree, usually take an upward direction, and in that case the leaves spread from them on all sides, as on the principal axis.

In a large proportion both of Taxads and Conifers the primary branches ramify laterally only, the secondaries branch in the same way, and likewise the tertiaries and so on. In the Cupressineæ this lateral branching is continued to branchlets of the sixth, seventh and even lower degree; the primary branch with its system of ramifications has consequently a flattened or frondose form. In the Abietineæ this frondose manner of branching is common throughout Abies except in *A. Pinsapo*, also Picea, Tsuga, Cedrus, Larix, Abietia (Pseudotsuga), and Laricopsis; but in some species, as *Picea Smithiana*, *Tsuga Albertiana*, *Larix europæa pendula*, it is obscured by the pendulosity of the lateral growths. Lateral branching is also common throughout the Araucarineæ; in the Taxodineæ it occurs in Cryptomeria, Taxodium and *Sequoia sempervirens*; among Taxads it is conspicuous in Taxus, Torreya and Cephalotaxus.

In most of the genera included in the Cupressineæ as Thuia, Libocedrus, Cupressus (in part) and some of the tropical genera too tender for the open ground in Great Britain, the smaller branch systems are also flattened or frondose;* in these cases—that is, where the production of branchlets is in one plane only, the lateral leaves are regularly conduplicate and imbricate, and the branchlets arise from their axils, while the median leaves are flattened and closely appressed to the stem. The position of these frondose branchlets is either horizontal, slightly ascending or slightly descending, as in *Cupressus nutkatensis*, *C. obtusa*, *Thuia occidentalis*, or vertical as in *Thuia orientalis*, *Libocedrus decurrens* and in the fastigiate and globose forms of all the Cupressineæ except Juniperus. In *Cupressus Lawsoniana* and its varieties almost every position occurs.

"Variations further occur, arising from the degree of ramification, as in bi- tri- quadri-pinnate ramification. In some cases this pinnate mode of branching may take place regularly on both sides of the shoot or on one side only, and in the latter case generally on the distal side, or that farthest removed from the axis, often as in Thuia causing a curvature of the branchlet whose concavity is directed towards the main axis."†

It is worthy of note that these latest formed groups of branchlets or branch-systems, whether in the flattened or frondose form, or whether produced from all sides of the younger shoots as in Juniperus, fall off

* An exception occurs in *Cupressus thyoides* known in gardens as the American White Cedar, and especially in its variety *leptoclada* in which the ultimate branchlets are in corymbiform tufts.

† Masters in Journ. Linn. Soc. XXVII. 286.

as the growth of the primary branches and their principal ramifications proceed just as the individual leaves of deciduous trees and shrubs do and by a similar process.

GEMMATION (BUDS).

LEAF buds may be regarded as young undeveloped branches. When leaves arise from the formative tissues rapidly one after the other as in the Coniferæ and most Taxads, they envelop the end of the shoot, in the centre of which lies the growing point. In the autumn the growth is temporarily arrested, and "this arrest is frequently accompanied by a corresponding check in the development of the leaves which assume the form of *perulæ* or bud scales, the perulæ being dilatations of the petiolar part of the leaf. In the unexpanded bud the perulæ are free at the base, but as the shoot lengthens they are sometimes cast off, sometimes remain attached to it, in which latter case they are uplifted with the growing shoot."* When the rudimentary or imperfectly formed leaves at the end of a shoot are so enclosed by perulæ, they form what is called true winter buds. In all broad-leaved (Angiospermous) trees and shrubs, a bud is formed, not only at the apex of every shoot, but also in the axil of almost every leaf.† But in the Coniferæ, or more properly speaking, in those members of the family which form true winter buds, the circumstances are somewhat different as will be presently pointed out.

True winter buds are formed throughout the Fir and Pine tribe, Abietineæ, in some of the Taxodineæ (Taxodium, *Sequoia sempervirens*, Sciadopitys) and in many Taxads (Yew, Torreya, Cephalotaxus, Ginkgo). But throughout the Cupressineæ and Araucarineæ, and in the Taxodineæ and Taxaceæ in part, the arrest of growth is not accompanied by a corresponding arrest of development and the growing point is not protected by perulæ or scales, but by the latest formed leaves in different stages of development and which in the following season attain their normal form and size like the rest. Intermediate stages may often be found between the perulæ and the primordial leaves showing the perfect homology of the two.

The arrangement and behaviour of the buds of coniferous trees have been so lucidly discussed by Dr. Masters in the oft-quoted paper in the Journal of the Linnean Society‡ that we cannot do better than reproduce his observations in an abbreviated form.

> The very marked peculiarity of the ramification of Conifers and Taxads depends mainly on the alternate development and non-development of the buds. A very common feature in the arrangement of the buds is the

* Masters in Journ. Linn. Soc. XXVII. 271.

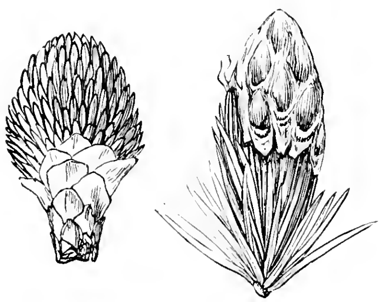
† From some of these buds the inflorescence is developed in the place of a new shoot; morphologically the one is but a modification of the other.

‡ Vol. XXVII. pp. 226—325.

development of one apical bud at the end of the shoots whether terminal or lateral, and of a circlet around it at the base. In the erect leader the circlet is complete, but in the lateral branches it usually happens as seen in the species of Abies and Picea, that the uppermost buds of the circlet, if developed at all, remain in a rudimentary condition. This is evidently connected with the horizontal position of the branches; but it is curious to note that it is the uppermost buds, those most exposed, that are not developed, but are checked in their growth to the advantage of the lower buds.

In Pines, on the other hand, the lateral buds in the first instance are erect like the terminal bud; but as they grow they assume a horizontal direction as in the species of Abies, but with this important exception, that they generally turn up at the tips as growth goes on, and thus allow of the access of light to the branches beneath. Hence in Pines we find the circlet of buds, whether on the terminal or on the lateral shoots, complete and equally developed on all sides. The relative absence of lateral buds, except near the ends of the shoots, is also a marked feature in the Abietineæ.

The bud scales are arranged spirally and are frequently compacted together by a felted arrangement of the hairs or fringed margins of the scales as in many Pines, or by an exudation of resin as in many Firs. These arrangements are evidently adapted for the protection of the young buds from cold or wet. In some Spruce Firs, additional protection is afforded by the arrangement of the leaves near the end of the shoot, and which, instead of spreading laterally, are directed parallel to the long axis of the shoot, and thus close over the buds. The form of buds and bud scales sometimes afford useful means of discrimination between certain species.



1 2

Fig. 6. 1, Tubular. 2. Calyptrate deperulation.

The bud scales, or perulæ as they are technically called, present variations in texture and duration, being coriaceous in some species, long, thin and membraneous in others; they are either entire, fringed or lacerated at their margins. As these perulæ serve a uniform and temporary purpose only, they are less liable to variation and modification during growth from the operation of external causes, than organs of longer duration and more complex function, and hence, from their relative invariability, their utility for classificatory purposes is greater than might be supposed.

The manner in which the bud scales are removed or thrust aside by the growing shoot is also worthy of attention. The variations observed depend, of course, on the relation between the nature of the scale, the amount of resistance they offer, and the degree of vigour and direction of growth in the bud beneath. In some cases the bud scales are least resistant to the pressure of the growing shoot at the apex of the bud, in which case the shoot makes its way through a ring or tube of scales which persist around the base of the branch for a long time. Illustrations of this occur in *Abies amabilis*, *A. nobilis*, *A. Fraseri*, *A. Veitchii*, *A. firma*, *Picea polita*, *P. Smithiana*, and many others. In other species the bud scales offer the least resistance at the base of the bud, and when this happens, the bud scales are pushed off in the form of a cap. This is observable in *Abies bracteata*, *A. cilicica*, *A. Pinsapo*, *Picea pungens*, *P. obovata*, and others. Instances have also been observed in which both processes have occurred, as *Picea Engelmanni*.*

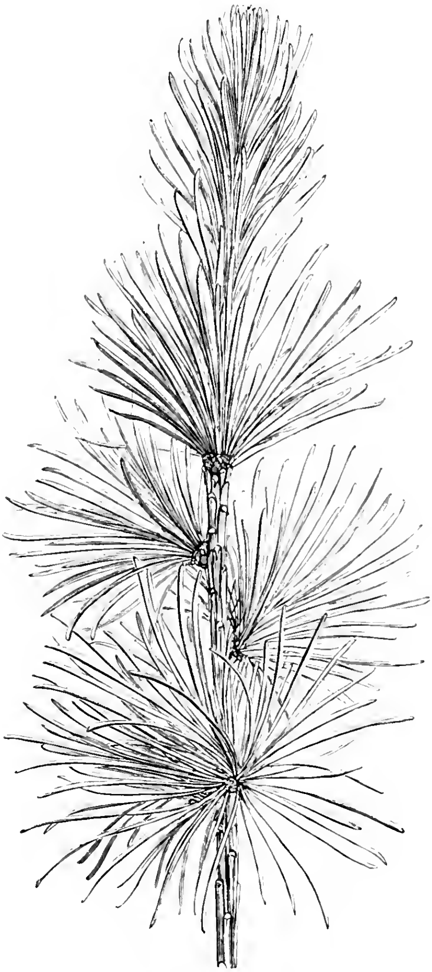


Fig. 7. Branchlet of *Larix europæa* with tufted foliage.

The order of development of the terminal and lateral buds at the end of the erect or of the horizontal shoots should also be noticed. The general but not invariable tendency in the Abietineæ is for the side buds to expand before the central or terminal one, even when that is larger than the others. In some of the Pines where the cone is apparently but not really terminal the central bud does not start into growth and develop into a shoot until the originally erect cone bends downwards; hence the shoot in question is a season behind the cone in development though formed at the same time.

In Pinus the young shoots present differences which are useful for specific distinction, in colour, degree of hairiness, form, etc., some being cylindrical, others with prominent angles with intervening furrows; but the most remarkable difference is the presence or absence of leaf fascicles at the base of the shoot. When the growth is uniform, the whole length of the shoot is covered with leaf tufts as in *Pinus pinea*, *P. Laricio*, *P. sylvestris*, *P. contorta*, *P. Cembra*, *P. rigida* and many others; but when growth is disproportionately rapid near the base, there the base of the shoot is destitute of leaves for some distance, as in *Pinus Strobus*, *P. excelsa*, *P. Sabiniana*, *P. Coulteri*, *P. ponderosa*, *P. Bungeana* and several others. This

* The process of casting off the bud scales is technically called "deperulation." Dr. Masters calls the first of the two processes described *tubular*, and the second *calyptrate*. Instances of tubular deperulation observed by the author occur in *Abies homolepis*, *A. cephalonica*, *A. balsamea*, *A. magnifica*, *Picea ajanensis*, *P. nigra*, and many others, including most of the commoner species of Pinus; and of calyptrate deperulation in *Abies sachalinensis*, *Picea pungens*, *P. Engelmanni*, *Abietia (Pseudotsuga) Douglasii*, but it is not absolute in all, if in any of these species. In Pinus generally the bud scales are carried forward with the young growth till the leaves are partially developed, when they drop off in centrifugal order.

character, however, is no more absolute than any other, for in *P. montana* while the central shoot is leafy at the base, the lateral shoots from the same cluster of buds are naked at the base.

The species of Cedrus, Larix, Laricopsis (Pseudolarix) and Ginkgo are remarkable for the production of two kinds of branches, the one long and slender with the leaves distributed at intervals, the others short and thick with the leaves in tufts at the extremities.* The former are the extension or leader shoots in which growth and development are rapid; the latter are analogous to similar growths in the Apple, Pear, Laburnum, but are in the TAXACEÆ and CONIFERÆ not necessarily connected with the production of fruit, although in Cedrus and Laricopsis (Pseudolarix) the spurs bear the staminate flowers, and in Ginkgo both the staminate flowers and the fruits are produced from the apex of the spurs. The leaves on the extension or leader shoots of Cedrus and Larix are generally longer and more glaucous than those on the spurs, and are stomatiferous on both sides.

The mode of development of the spurs may readily be traced in the Larch and Cedar, and confirm the view that the appearances are due to the more vigorous growth of the basal and peripheral parts in comparison with the central and apical portions. Thus, if a bud at the end of a shoot be examined in October, the apex will be found to be dome-shaped; the young leaves emerge in succession from the base of the dome, leaving the apex naked, so that the development of the leaves is centripetal. If one of the lateral buds be examined at the same time, the axis will be found to form, not a dome, but a cup from whose margins the leaves protrude, those at the upper edge of the cup being the oldest and corresponding to those at the base of the dome. These lateral buds are those destined to form the tufts of leaves on the spur; the greatest energy of growth is in the one case at the apex of the growing axis, in the other at the base of it.

FOLIATION.

THE term is here restricted to foliage leaves only, and to those organs that function as such, as the phylloid shoots of Sciadopitys and the cladodes of Phyllocladus. The morphology of the leaves in the cotyledonary state has been already noticed.

The cotyledonary leaves are almost always followed by leaves that differ in form and arrangement both from the cotyledons and from the adult leaves of the same species; they are known as primordial or protomorphic leaves. Except in Ginkgo, they are linear in shape, and are either spirally arranged around the axis (Pinus, Abies, Picea, etc.); scattered (Cedrus, Larix, Sequoia, Taxus, etc.); or in decussate pairs (Cupressus, Thuia, Libocedrus, etc.) Sometimes they are separated by a distinguishable interval, but there are cases in which they are so crowded as to appear tufted; there are also cases in which they are seen to pass gradually into the adult state. These primordial leaves can be readily recognised in most species; in

* In reality the leaves are arranged in a spiral as on the longer shoots, but they are so closely packed that the spiral arrangement is often very much obscured.

Ginkgo they are almost of circular form; in Sciadopitys they are alternate and not whorled like the phylloid growths that perform the functions of leaves in older plants: in Pinus they are solitary, and not in clusters of two or more.* In the Cupressineæ the primordial leaves are often produced for many years in succession, and are thence frequently seen simultaneously with the adult foliage as in Juniperus, Thuia, Cupressus (section Chamaecyparis). In these genera, and in a remarkable variety of *Cryptomeria japonica* known in gardens as *C. elegans*, there are forms in which primordial leaves only are produced during the whole life of the plant.†

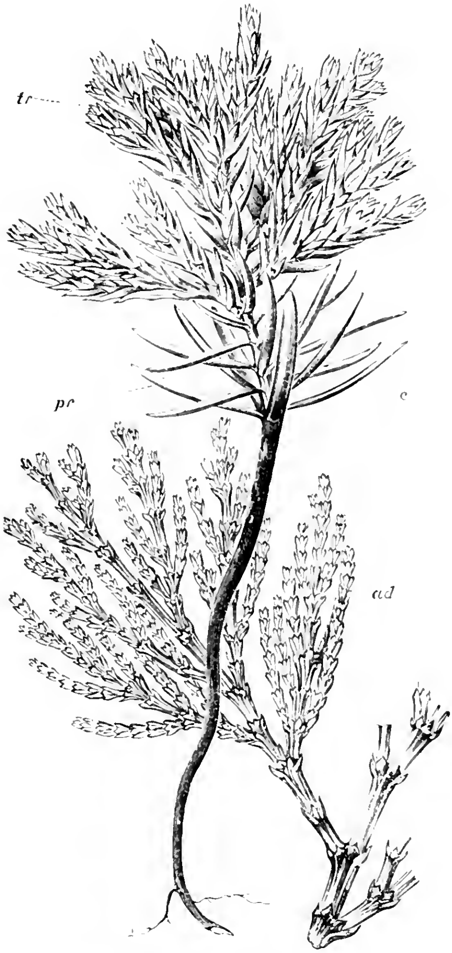


Fig. 8. Young plant of *Libocedrus decurrens*.
C, cotyledons; PR, primordial, TR, transitional leaves; AD, adult foliage.

Narrowness in comparison with length is the prevailing characteristic of the adult foliage of the majority of the species cultivated in Great Britain, the exceptions occurring chiefly in the Cupressineæ with heteromorphic foliage, of which the adult form is small, scale-like, almost as broad as long, especially on the terminal growths. A more conspicuous exception is Ginkgo, in which the leaf expands into a fan-like blade that is usually much broader than long but without any true midrib; the numerous veins of nearly equal size diverge from the top of the stalk and are unconnected by any lateral reticulations. Notwithstanding the prevailing narrowness in comparison with length, there is a considerable diversity in the shape of the leaves in the different genera, and

* The protomorphic leaves of Pinus should not be confused with the metamorphosed primordial leaves of the adult foliage, which consist of small membraneous envelopes, called for convenience of description "basal sheaths."

† These forms, often called in gardens "juvenile," can only be perpetuated from cuttings.

even in species included in the same genus. Some of the more easily observed forms may be here mentioned as they afford in many cases a simple mark for distinguishing the genera.

In Pinus the leaves are linear or filiform (thread-like); in some species of remarkable tenuity and exceeding a foot in length *(P. longifolia, P. patula, P. Sabiniana)*: in others they scarcely exceed an inch in length *(P. Parryana, P. monophylla, P. Balfouriana)*. Their form is modified according as they are in fascicles of two (geminate), three (ternate), or five (quinate); in the first named they are semi-circular in section, that is, they have one convex and one plane side; in the other two they are triquetral (three-angled) with one convex and two plane sides. Much discussion has arisen respecting the true nature of the "needles" or adult (secondary) leaves of Pines which need not be introduced here. "The evidence derived from comparative morphology including teratology, development and minute anatomy is entirely in favour of the view that the 'needles' are true leaves borne upon a shoot whose apical development is usually arrested after the formation of the verticil of leaves, two, three or five, as the case may be."*

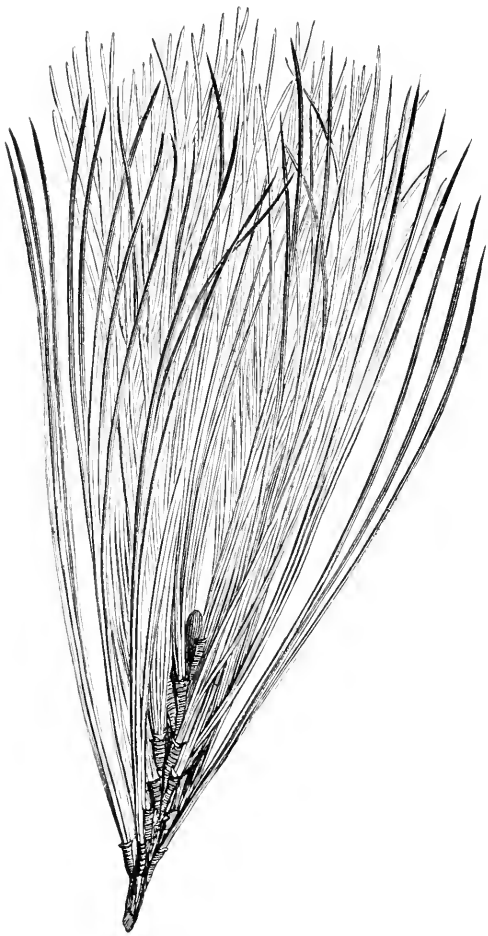


Fig. 9. Ternate leaves of *Pinus radiata*.

In the group of genera known under the common name of Firs (Abies, Picea, Tsuga, etc.) the leaves are linear or acicular (needle-shaped), flattened or tetragonal (four-angled) with their apex spine-tipped, acute, blunt or emarginate. In some species of Abies the leaves on the fertile branches are different in form, size and direction from those on the sterile (usually lowermost) branches; this difference is noticeable in *A. cephalonica* in which the leaves on the cone-bearing branches are acicular and spread equally on all sides, whilst those on the barren branches are longer, flattened, spine-tipped and pseudo-distichous. In *A. firma* the leaves on the barren branches are longer and narrower than those on the fertile ones, and they are also deeply notched. In *A. concolor*

* Masters in Journ. Linn. Soc. XXVII. 267.

var. *Lowiana* and in *A. grandis* the leaves on the barren branches spread away from either side of the axis markedly in one plane, whilst those on the cone-bearing branches are much shorter and curve inwards like those of the Colorado type (*A. concolor*). Another peculiarity observable in the leaves of Abies is that those on the latest growths of the principal axis (leader shoot) are in most species much smaller and more distant than those on the branches, and never assume the pseudo-distichous arrangement.

In Cryptomeria, *Sequoia gigantea*, the Araucarias included in the section Eutassa, and many Junipers, the adult leaves are awl-shaped

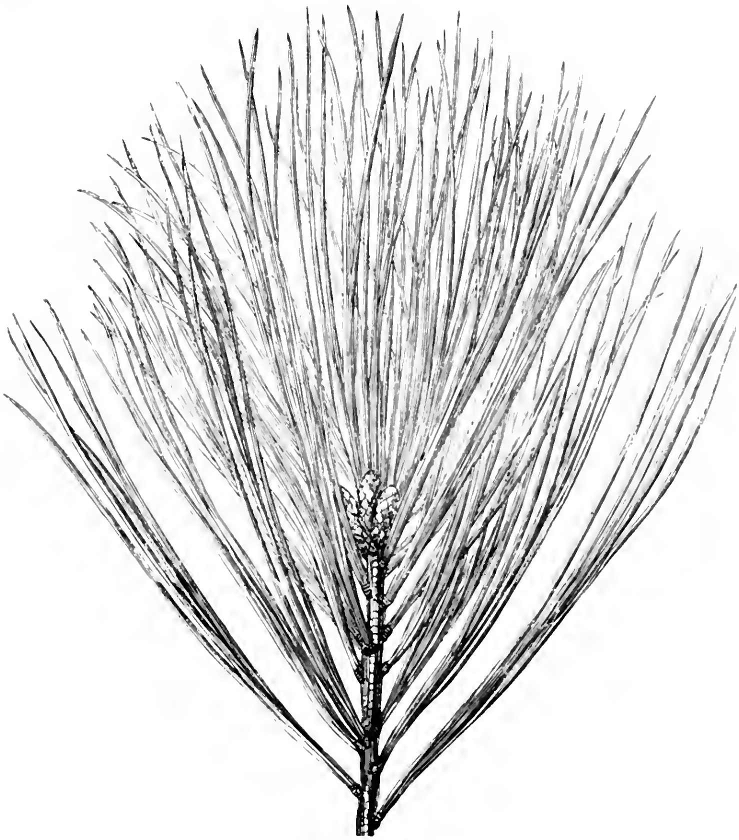


Fig. 10. Quinate leaves of *Pinus Strobus*.

(subulate) or some slight modification of that form, and often falcately curved. In Taxodium, the Redwood, the Yew and other Taxads they are linear, flattened, and pointed at the apex (in Torreya spine-tipped). In the Cypress and its allies (Cupressineæ) the leaves are often heteromorphic, that is to say, they occur in two, three or even more different forms; primordial leaves are often produced simultaneously with adult leaves, the former being always linear or acicular and more or less spreading, whilst the latter are scale-like, often in two different forms, and more or less appressed to the shoot or concrescent with it. But in species in which the branchlets are sub-terete or rounded as in *Libocedrus tetragona* and in some belonging to the Australian genera Callitris and Actinostrobus the leaves are uniform in size and shape.

The arrangement of the leaves of the adult foliage in regard to their insertion on the principal and lateral axes is either spiral, decussate, or whorled.* The spiral arrangement is usually very clearly marked, and is by far the most predominant one; it occurs throughout the

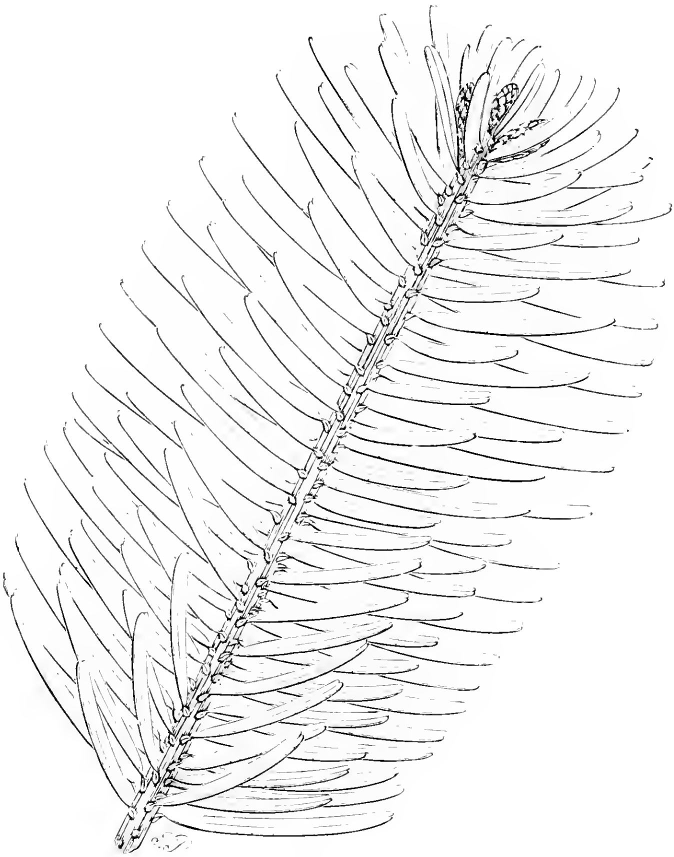


Fig. 11. Sterile branchlet of *Abies grandis* with leaves spreading in one plane.

Abietineæ (the close-set leaves on the short spurs or arrested branchlets in Cedrus, Larix and Laricopsis are apparent exceptions only), also throughout the Araucarineæ, the greater part of the Taxodineæ, and the Taxaceæ. This spiral arrangement of the leaves is

* There is no essential distinction between decussate and whorled (verticillate). The difference consists only in the number of leaves completing the circle (decussate two, whorled more than two) and in the relative position of the leaves of one circle to those of the next above or below.

due to a torsion or gyratory movement made by the shoot during its growth; in those cases where the growth is rapid, as the "leader shoot" of species of Abies and Picea, notably *Abies Nordmanniana* and *A. Veitchii*, *Picea sitchensis* and others, this gyratory movement may be detected by watching the progress of the shoot at frequent intervals. Were the gyratory movement that gives rise to the spiral arrangement absent, it is evident that the leaves would then be in straight lines, an arrangement unquestionably detrimental to the well-being of the plant since the area of leaf surface exposed to direct sunlight would be enormously reduced.

Fig. 12. Branchlet of *Tsuga Mertensiana* with leaves spreading in various directions.

The decussate arrangement—that is to say, when each pair of opposite leaves is placed at a right angle to the pair immediately above and below it—is common throughout the Cupressineæ except in those species of Juniper in which subulate (awl-shaped) adult leaves predominate (*Juniperus communis*, *J. rigida*, *J. drupacea*, *J. oxycedrus*, etc.), and these are always in whorls of three each. The whorled arrangement occurs only in Juniperus and in the phylloid growths (cladodes) of Sciadopitys.*

In all the Firs and in many Pines the leaves are inserted on outgrowths of the suberous or corky layers of the bark called pulvini (*pulvinus*, a cushion), and these pulvini are prolonged into spiral ridges

* The arrangement of leaves, whether foliage, floral or carpellary (fruit bearing), on the axial structures that produce them is described in Botany under the name of Phyllotaxis. The subject is treated of in all the best text books.

around the young shoot and always at a very small angle to its long axis; their form in connection with that of the cicatrice left by the leaves varies so much in the different genera as to afford a characteristic of each. These outgrowths have sometimes been wrongly described as the "decurrent bases of the leaves." The position taken up by the leaves with respect to the axis that bears them is subject to much variation, but in every case with the evident purpose of enabling them to perform their functions to the greatest advantage. On the principal

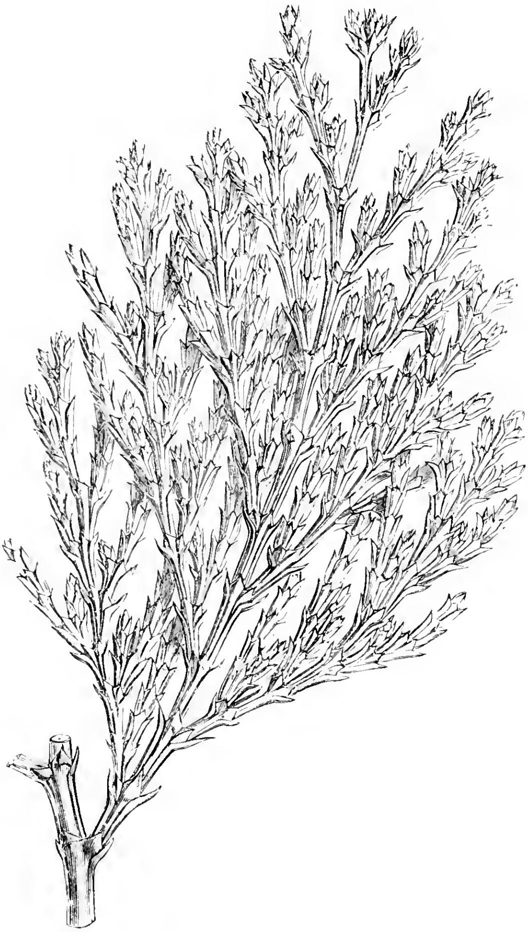
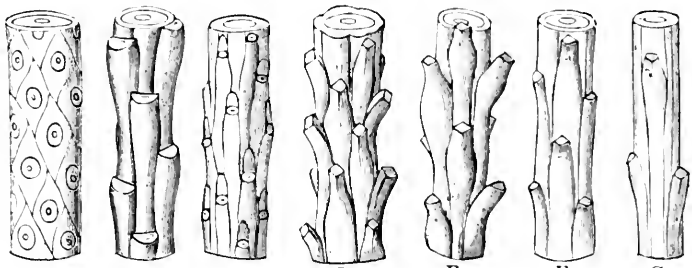


Fig. 13. Decussate foliage of *Libocedrus decurrens*.

axis or "leader shoot," not only in Abies, Picea, Tsuga, etc., but also in the Araucarias, *Sequoia sempervirens*, Taxus, Torreya and others, the leaves spread on all sides. This is also the case with side shoots which suddenly quit the horizontal direction and assume an upright position, as is frequently the case in *Picea ajanensis*, *P. sitchensis* and others, and normally so in the fastigiate varieties of the common Yew and Cephalotaxus. In *Taxodium distichum* and *Sequoia sempervirens* the leaves are distichous, that is to say, they are arranged in opposite rows on either side of the shoot, and spread in one plane. In the common Yew, Torreya and Cephalotaxus the leaves are sub-spirally arranged around the shoot but spread laterally in two directions only, except in the fastigiate forms already noticed. In Abies, Picea, (with some exceptions,) Tsuga and Abietia, the leaves on the under side of the lateral shoots are twisted at their base so as to bring them either into a horizontal position or at a small angle to it, arranged in two, three or more ranks; whilst those on the upper side are nearly parallel with the long axis of the shoot, more or less appressed to it, and are always shorter than those pointing laterally,* as in *Abies amabilis*, *A. Nordmanniana*, *Picea excelsa*, *P. nigra*, *P. ajanensis*, etc.; but in *Abies grandis*, *A. balsamea* and *A. concolor* all the leaves of the sterile branches are pseudo-distichous. It is now well known that these positions are taken by the leaves in order to bring them into the most advantageous relation to direct sunlight, and thence for the object of promoting their main functions to the greatest benefit of the tree, viz., the assimilation of food stuffs, respiration, and the exhalation of superfluous water vapour.

In connection with the same objects may be mentioned the movements of the leaves of some Conifers that have been observed during the



A *B* *C* *D* *E* *F* *G*

Fig. 14. Pulvini with their cicatrices.

A. *Abies pectinata*. B. *Tsuga canadensis*. C. *Abietia Douglasii*. D. *Picea excelsa*. E. *Cedrus Libani*. F. *Larix europaea*. G. *Larixopsis Kaempferi*.

(From Engler and Prantl's Naturlichen Pflanzenfamilien).

season of active vegetation, as *Abies Nordmanniana*, *Pinus halepensis* and other Pines, notably those with long filiform leaves as *P. excelsa*, *P. Strobus*, etc. The leaves of these Pines in winter collapse and hang in clusters that are quite pendulous; but in summer, especially under the influence of sunlight, they become divergent and even spreading. More observations covering a larger range of subjects are, however, wanting before any certain deduction can be drawn from these movements.

In many of the species included in the Cypress tribe, especially those in which the branchlets are frond-like, the decussate pairs of scale-like leaves are frequently dissimilar, markedly so in Libocedrus, the lateral pairs being larger and free at the apex, whilst the dorsi-ventral pairs, those on the upper and under side of the shoot, are smaller and

* Among the Abies, *A. Pinsapo* is a constant exception to this rule, and *A. cephalonica* in part; in these species the leaves spread equally in all directions on the branches, and on their ramifications. Among the Piceas, *P. polita* and *P. Smithiana* are exceptions so far as the trees growing in England have been observed.

concrescent with it; on the latest growths both pairs are generally similar and equal.

Mention may here be made of leaf-like structures that occur in two well-defined genera, and which are popularly called leaves but are not true foliage leaves in the scientific acceptation of the term, although they perform all the functions of such. These are the "needles" of Sciadopitys and the cladodes of Phyllocladus. The "needles" of Sciadopitys present greater resemblance to axial structures than to foliage leaves; they occupy the axils of leaves of the first order—scale-like bodies of deltoid shape which soon fall off, and thus correspond in position with the fascicles of leaves in Pinus but are not necessarily of the same morphological significance.* From the evidence derived from their anatomy and from other circumstances they are more properly regarded as phylloid shoots than as true leaves.

In Phyllocladus, a genus of Taxads occurring in New Zealand, Tasmania and Borneo, the primordial leaves are small linear organs that usually disappear before the end of the third year, and the adult leaves are minute scale-like bodies produced at the base of the shoots in the early spring but soon fall off.† The functions of foliation in this genus are performed by flattened, fan-shaped, leathery expansions of the branchlets termed phyllodes: these phyllodes are arranged laterally on each side of the axis that produces them, much in the same manner as true leaves.

The persistency of the adult leaves of Taxads and Conifers varies from a single season to several years. In Ginkgo, Larix, Laricopsis, and Taxodium the leaves are deciduous; in *Araucaria imbricata* their persistency is the longest yet observed in this country, in many instances from fifteen to eighteen years.‡ The Kauri Pine of New Zealand, *Agathis australis*, probably retains its leaves under certain circumstances for a still longer period. The greatest variability in a single genus occurs in Pinus; in *P. halepensis*, *P. Strobus* and a few others they fall off at the end of the second year, whilst in *P. Balfouriana* and other species which have their home in the dry climate of the western plateau region of North America they are persistent from ten to fifteen years. In Abies and Picea it is not unusual to find green leaves from seven to nine years old, but the average persistency throughout these genera is from five to seven years. In the Cupressinæ the leaves continue green from three to five

* Masters in Journal of Botany, XXII. (1884), 97, and Journal of the Linnean Society, XXVII. 276, where the subject is fully discussed.

† In *Phyllocladus glauca* they are similar to the primordial leaves but rather broader. Kirk, Forest Flora of New Zealand, sub. t. 99.

‡ In *Araucaria imbricata* the length of time during which the leaves remain green on the branches is modified by situation and environment.

years, but remain in a withered or effete state on the principal axial growths for a much longer period.

The colour of the foliage is also worthy of note. From the deep sombre hues of the Austrian Pine and Common Yew to the light and airy deciduous Cypress and Maiden-hair Tree, the silvery lines of the Weymouth Pine and the greyish foliage of *Cupressus pisifera* var. *squarrosa*, there is found in the different Tribes an endless variety of tints which the green of Nature alone displays. The deep glossy green of the leaves of *Abies bracteata* renders that remarkable tree distinct from every other Abies. The pleasing glaucous hue of the Deodar Cedar is almost unique, and the rich deep colour of *Libocedrus decurrens* is scarcely less so; *Pinus radiata* is distinguished among all Pines by its cheerful grass-green foliage which affords a striking contrast to the dull grey hues of many of its congeners; the difference in colour between *Abies nobilis* and *A. Nordmanniana* is not less marked. The foliage of *Cryptomeria elegans* changes in winter to a deep bronzy green tinged with crimson which makes this plant particularly ornamental at that season, and a similar change takes place in *Cupressus thyoides* var. *ericoides*, which becomes violet-purple.* The common Arbor Vitæ is brownish green, while varieties of the Chinese species have their foliage of a rich golden yellow during the growing season. Many of the Junipers have a bluish glaucous tinge peculiar to them, and others are quite grey.

Besides the difference in tints above sketched, the foliage of coniferous plants is subject to two changes in colour, viz., VARIEGATION and GLAUCESCENCE. Variegation is due to changes taking place in the minute granules called chlorophyll bodies imbedded in the protoplasm of the cells of the leaves (and stems) immediately beneath the epiderm or skin, and which gives the foliage not only the prevailing green, but also other tints as purple, crimson, brown, etc., characteristic of the foliage of certain plants when in active growth.† Variegation shows itself in the young growth of the plants, which, instead of appearing in the shade of green natural to the species, takes some shade of yellow that varies in the different kinds from a deep golden hue to a creamy white. In some cases the whole of the newly-formed branchlets with their foliage is produced coloured. As the season advances, the tint gradually changes, first by becoming deeper, then taking a perceptible shade of green, and finally in the course of the second season, assuming the green natural to the species, but not till a new coloured growth is formed. This kind of variegation is observed to be tolerably constant in whatever description of soil the plant is growing, but the intensity of the colouring is slightly different in different soils, being most developed in clayey loams. In other cases the tips of a portion of the branches only appear coloured, the extent of the variegation ranging in different and in the same species from a mere spot to a considerable portion of the branch. It is only in this form that a white variegation appears. Plants

* The foliage of all or nearly all the Coniferæ of temperate climates changes colour in winter more or less. This is due to the low temperature of that season, which causes a peculiar transformation of the blue-green constituent of chlorophyll. A higher temperature restores the normal condition.

† The giving of colour to the foliage of plants is a subordinate function of chlorophyll. Under the influence of sunlight it is the agent that converts the inorganic matter taken up by the roots, and the carbonic acid absorbed from the atmosphere, into the organic matter of which the plant is built up.

variegated in the manner first described, continue to produce coloured foliage year after year without manifesting any special signs of debility or decay; but their rate of growth is always *slower* than that of the normal forms. Plants partially variegated often show signs of disease in the coloured parts, which turn brown and die, in some cases within a few weeks after it is produced, especially if the plant is exposed to the direct action of the sun's rays. Partial variegation in vigorous-growing kinds often disappears entirely in the course of a few years; it is also greatly influenced by the soil in which the plants are growing, being heightened in some situations or soon becoming obliterated in others.

Glaucescence is quite distinct from variegation: it makes its appearance indifferently in young and old plants. It is always present in the foliage of many species, in some of which it becomes greatly heightened by age: it also frequently appears with great intensity in the young plants of species that are normally quite green or show it but very faintly. The effect of glaucescence, as regards the aspect of the trees, is to give them a greyish silvery hue, particularly pleasing and beautiful in many plants belonging to the Cypress tribe and to the Firs: while it imparts a venerable hoary appearance to aged Pines and especially to the Cedar of Lebanon. It is due in one form to the stomata of the leaves, and it is not improbably an optical effect arising from their close proximity and formal arrangement, especially in the case of the white lines seen on the under surfaces of the leaves of the Silver and other Firs, and in the leaves of Pines, Junipers, etc. In another form it is caused by a resinous secretion which is easily rubbed off by the finger, leaving the leaf quite green.

The minute structure of the leaves of Conifers afford a most interesting study for those desirous of gaining an adequate conception of the apparatus by which the physiological functions of nutrition, respiration, etc., are carried on, but a satisfactory treatment of the subject would far exceed the limits of this work. The anatomical structure of the leaves as seen in transverse sections of them, or the most salient points of structure have of late years been so frequently given with the descriptions of species, chiefly of the Abietineæ, that the subject must not be entirely passed over. Much stress too has occasionally been placed on certain anatomical characters in the leaves as marks of generic differences, such as the position and number of the resin-canals, which on account of their constancy in the different genera into which the trees known under the general name of Firs are now distributed, are frequently mentioned in connection with them. But the similarity of the structure of the leaves of species included in the same genus together with some variability that has been observed in a single species does not admit of much reliance being placed upon the anatomical characters as a means of distinguishing species. The illustrations here given have been especially prepared for this work by Mr. N. E. Brown, of the Kew Herbarium, and are intended to convey a general idea only of leaf structure of the Abietineæ.

Fig. 15 represents a transverse section of a leaf of the common Spruce Fir, *Picea excelsa*, magnified fifty diameters. The row of small polygonal cells with thickened walls immediately beneath the epidermis or skin is technically called the hypoderm, the individual cells, strengthening cells. In the common Spruce the hypoderm consists of a single layer of cells, but among the Pines there are instances of the hypoderm consisting of two and even more layers, whilst in some species of Tsuga it is either absent or restricted to certain parts of the leaf. The shape of the hypoderm cells varies considerably in the different genera. The small shaded cells in the centre of the leaf denote the elements composing the single fibro-vascular bundle *f*, passing along the mid-rib; it is separated from the principal tissue of the leaf by a well-defined circle of small cells (endoderm); the large circular opening *r*, beneath the fibro-vascular bundle and close to the epidermis, is the resin-canal: this is lined with a layer of small cells called epithelium cells. In some leaves of this species, the resin-canal is either entirely absent or does not traverse the whole length of the leaf. The substance of the leaf filling up the greater part of the area of the transverse section is called the parenchyma or mesophyll. As shown by the figure, the mesophyll in *Picea excelsa* is wholly cellular and fairly uniform throughout: the greater part of the cells composing it contain the chlorophyll granules which give the green colour to the leaf and perform the important functions already alluded to.

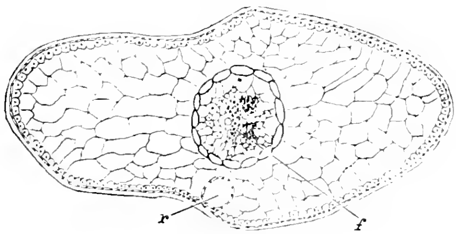


Fig. 15. Transverse section of leaf of *Picea excelsa*.

Fig. 16 represents a transverse section of a leaf of *Tsuga Brunoniana*, the Himalayan Hemlock Fir, magnified thirty diameters. In this case the hypoderm is confined to the two marginal sides of the leaf. In the fibro-vascular bundle *f* in the centre, the principal elements called phloem and xylem are more clearly differentiated than in the Spruce Fir: immediately below it is the single resin-canal *r* lined with a layer of very minute epithelium cells. In the Hemlock Firs the cellular tissue forming the mesophyll is not of uniform structure, the cells immediately beneath the epiderm being mostly elongated in a vertical direction to it. This form of cell is strongly marked in *Tsuga Brunoniana*; from their formal appearance they have received the name of palisade-cells.

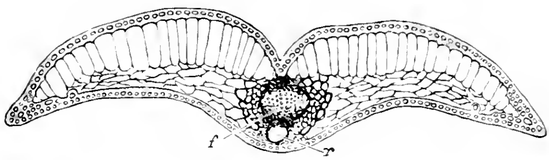


Fig. 16. Transverse section of leaf of *Tsuga Brunoniana*.

Fig. 17 shows a transverse section of a leaf of the common Silver Fir, *Abies pectinata*, magnified thirty-two diameters. Here the hypoderm consists of a single row of small cells continuous only in the centre of the leaf above and beneath the midrib and much interrupted or entirely absent in other parts. The midrib consists of two fibro-vascular bundles surrounded by a sheath (endoderm), whilst the resin-canals *r r* are very distinctly shown near the inferior epiderm at a short distance from each margin. This position of the resin-canals is characteristic of Abies throughout, differing in some of the species only by being wholly within the parenchyma (mesophyll) or close to the epidermis of the under side, and by their distance from the margin. Comparing Fig. 17 with that preceding it, and also with Fig. 19, the structural difference between the leaf of an Abies and a Tsuga is manifest, whilst the close similarity of Abies to Abietia is scarcely less evident. For further illustration, Fig. 18 shows a transverse section of a leaf of *Abies concolor*.

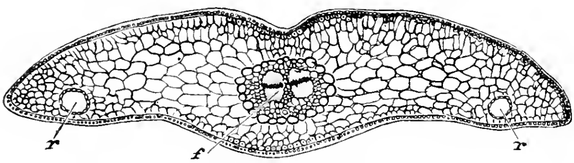


Fig. 17. Transverse section of leaf of *Abies pectinata*.

Fig. 19 shows a transverse section of a leaf of the Douglas Fir, *Abietia Douglasii*, magnified fifty diameters. In the leaves of this Fir the hypoderm, according to the late Professor McNab,* is very variable; in the section here given, it occurs only along the region of the midrib under the epiderm of the upper surface. The resin-canals are two and traverse the mesophyll near the epiderm of the lower surface as in Abies.

Fig. 20 represents a transverse section of a leaf of *Pinus Laricio* enlarged thirty diameters. The hypoderm is here a very narrow band of thick walled cells, following the contour of the leaf, whilst the mesophyll consists of a broad band of cells containing chlorophyll between it and the parallelogram enclosing the two fibrovascular bundles *f* and marked off in the centre by a layer of smaller cells. Traversing the mesophyll about midway between the hypoderm and the central parallelogram are eight resin-canals *r r* lined with thin-walled epithelium cells. In the triquetral (three-sided) leaves of the Pines, with three and five leaves in a sheath, there are fewer resin-canals, and where there are but three, there is usually one in or near each of the three angles.

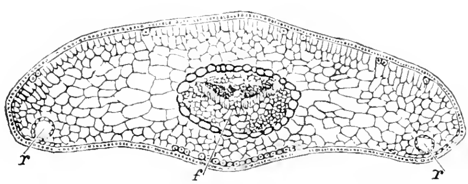


Fig. 18. Transverse section of leaf of *Abies concolor*.

The STOMATA or minute pore-like perforations of the epidermis of adult leaves should also be mentioned here on account of the important part they play in the economy of the plant. The chief points observable in their relation to the species, irrespective of their physiological significance, are their position, distribution or arrangement, and their number. As regards their position, they occur on the under surface chiefly, on the upper

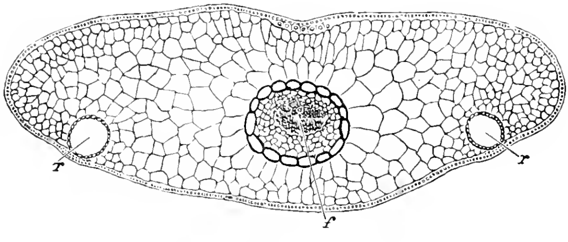


Fig. 19. Transverse section of leaf of *Abietia Douglasii*.

* Proceedings of the Royal Irish Academy, 2nd ser. II. 703.

surface chiefly, or on both, and where the leaves are three-sided as in many species of Pinus, they occur chiefly on the two flat sides. The first-named position is the most common; it predominates throughout the Taxaceæ, Abies, Tsuga, the flat-leaved species of Picea, Larix, etc. The species in which the stomata occur chiefly on the upper surface are mostly included in the Cupressineæ, that surface being the only exposed one in nearly all the genera; even those species of Juniperus with acicular free or partially free leaves form no exception. Instances in which stomata are found on both surfaces occur in Cryptomeria, Sequoia (Wellingtonia), Athrotaxis and a few others. The arrangement of the stomata is for the most part quite formal; in Pinus they are disposed in longitudinal rows, the position being indicated by grey lines which add so greatly to the beauty of the foliage of these trees, especially those with five leaves in each bundle; in Abies, Tsuga, the flat-leaved species of Picea, Larix, also in some of the Taxaceæ (Cephalotaxus, Prumnopitys, etc.) they are disposed in a longitudinal band on each side of the midrib on the under side of the leaf, forming the characteristic white bands of these species, and frequently, for descriptive purposes, called the stomatiferous bands. The silvery band on the upper surface of the acicular leaves of Juniperus is also a stomatiferous band. In Araucaria the stomata are arranged in bands composed of few or many rows; according to Bertrand there are as many as seventy rows on each side of a leaf of *A. imbricata*. Whilst the formal arrangement prevails throughout the majority of the species, there are instances in which the stomata are irregularly disposed or confined to certain localities on one or both surfaces of the leaf.

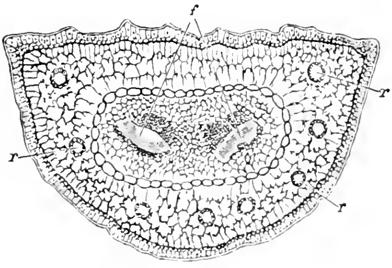


Fig. 20. Transverse section of leaf of *Pinus Laricio*.

INFLORESCENCE.

THE flowers of Taxads and Conifers are always unisexual, and the plants therefore are either monœcious when flowers of both sexes are borne on the same individual, or diœcious when the staminiferous (male) and ovuliferous (female) flowers are borne on different individuals. In the TAXACEÆ, diœcity is probably absolute in Ginkgo and in two or three of the Australian genera; it is relatively so in Taxus, Cephalotaxus and Torreya, in which flowers of both sexes have been observed on the same tree. This is not uncommon in the Yew, and when it occurs the two kinds are on different branches. In the CONIFERÆ the flowers are monœcious throughout except in Fitzroya, Araucaria and Juniperus, but in the last named genus the two sexes are often found on different branches of the same tree; and in Araucaria, at least in *A. imbricata*, diœcity is not absolute. The Australian genera Callitris and Actinostrobus are also probably diœcious.

The structure of the flowers of Taxads and Conifers will be readily understood by reference to the accompanying figures, or still better, by comparing with them specimens gathered fresh from the trees.

TAXACEÆ. The common Yew affords an easily accessible type. The staminate flowers of the Yew, *Taxus baccata*, are borne in the axils of foliage leaves and consist of an elongated axis surrounded at the base by an envelope of imbricating scales spirally arranged in three or four series, above which is a capitulum or head of peltate scales (staminal leaves) each bearing about six (three—eight) pollen sacs which dehisce lengthwise when mature.* The ovuliferous flowers are solitary and axillary, but occasionally terminal, and like the staminate flowers consist of an elongated axis wholly enveloped by numerous scale-like imbricating bracts spirally arranged in $\frac{2}{5}$ phyllotaxis, of which the terminal one bears an erect ovule and is surrounded by a fleshy appendage termed an aril, which after the fertilisation of the ovule develops into the red fleshy covering of the seed. Rudimentary ovules are sometimes found on some of the lateral scales.

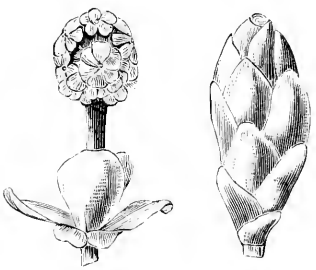


Fig. 21. 1, Staminate. 2, Ovuliferous flower of the common Yew.

The flowers of Cephalotaxus and Torreya deviate but little from this type except that in the ovuliferous flowers of the first named the bracts are in decussate pairs. But in Ginkgo the staminate flowers are produced in catkin-like umbels on the ends of short arrested branchlets or "spurs," and the ovuliferous flowers are simply stalk-like elongations bearing at their apex two, rarely more, ovules from one of which the fruit is generally developed. In Podocarpus the staminate flowers are catkin-like upon a short stalk surrounded at the base by involucral scales, solitary or clustered (umbellate in *P. Nageia*) and with the two-lobed anthers spirally arranged around the axis. The ovuliferous flowers, usually solitary or in a lax spike, consist of a slender stalk-like axis, bearing at the apex small decussate scales, the ovules being seated on the uppermost pair, one of which is usually abortive, and the fertile scale becomes fleshy; the flower is thence one-seeded as in Ginkgo. In Dacrydium the staminate flowers are small and the two-celled anthers are crowded spirally around a central axis; the ovuliferous flowers are composed of one, three or more seed-scales, each bearing an erect ovule which after fertilisation becomes invested by a tubular arillus. In the curious monotypic genus Saxegothæa the floral organs are a sort of compound of those of Podocarpus and Agathis, whilst the fruit and seed are those of a Juniper and Dacrydium. Saxegothæa is thence a connecting link between the Taxaceæ and Coniferæ.

CONIFERÆ. The inflorescence of *Pinus Laricio*, or of one of its varieties, which has been planted almost everywhere, and which bears staminate flowers and cones in abundance almost annually, may be selected to illustrate the floral structure of the Abietineæ.

* The staminate flowers of Taxads and Conifers are frequently called catkins, the vernacular name of the flowers of the Amentaceous Orders which are spikes of unisexual apetalous flowers. The view now generally accepted is that in Taxads and Conifers the aggregate of stamens constitute but a single flower.

The staminate flowers are collected in dense clusters near the ends of the previous year's shoots. Each flower consists of a central axis around which the stamens are spirally arranged, according to Dodel-Port, in $\frac{5}{13}$ phyllotaxis, the whole flower being of nearly cylindrical shape, of a yellowish brown colour and surrounded at the base by several membraneous, scale-like bracts.* Each anther is attached on the underside to a short filament, or sporophyll as it is sometimes called, inserted on the axis, and which dilates at the apex into a subpeltate

Fig. 22. Fertile branchlet of *Saxegothaea conspicua*.

expansion or connective analogous to that commonly seen in the anthers of angiospermous plants. This connective varies in shape and size in the different genera, and is the part that is highly coloured in several species, not only of Pinus but also of Abies and Picea: it was called the crest of the anther by the older botanists, and its form in Pinus is often a characteristic of species. Each anther has two pollen sacs

* The number of these involucral bracts varies considerably in the different species of Pinus, from 3—4 in *P. sylvestris* to 10—15 in *P. Lambertiana*.

which dehisce longitudinally* when the pollen is ripe, and which is then set free, and is wafted by the wind to the ovuliferous flowers. After the pollen is discharged from the anther sacs the staminate flowers increase in length for a short time and then wither and drop.†

The ovuliferous flowers are either solitary or in small clusters on the ends of young shoots of the preceding year. They arise in the axils of scale-like leaves like the foliage leaves and where a leaf-bud would otherwise have been formed; the seed-bearing cone is thence a metamorphosed shoot; it consists of an axis around which the ovuliferous scales are spirally arranged in the same phyllotaxis as the anthers of the staminate flowers, viz., $\frac{5}{13}$. Each scale is made up of two structures, of which the one that bears the ovule and seed is axillary to the other, usually called the bract. In several species of Abies, in Abietia and Larix,‡ the bract and ovuliferous scale are separable and the former conspicuously exserted; in Cedrus, Tsuga and Picea the bract does not advance beyond the rudimentary state, and in Pinus it coalesces entirely with the scale or soon disappears after the fertilisation of the ovules. This two-fold structure also occurs in the Taxodineæ, although traces of the bract are quite obliterated in the ripe cone. Traces of it are also discernible throughout the Cupressineæ in the microscopic anatomy of the scales. The ovules are exposed, that is, not enclosed in a receptacle (ovary) as in flowering plants generally, and are in pairs placed at the base of the scales somewhat obliquely in respect of the median line; these ovules are inverted, the micropyle or small opening through which the pollen tubes enter being turned towards the base of the scale.

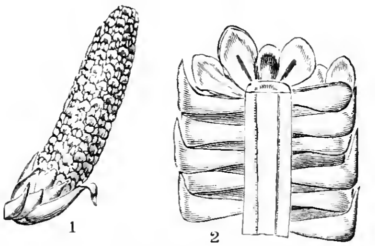


Fig. 23. 1, Staminate flower of *Pinus Laricio*. 2, Longitudinal section of same x 3.

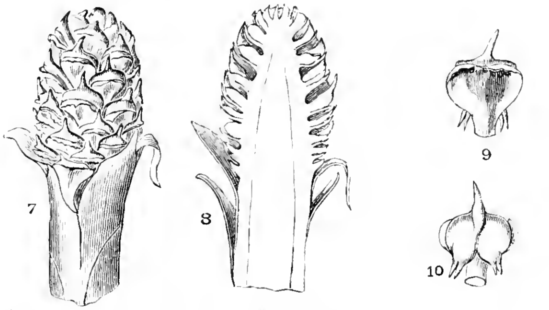


Fig. 24. 7, Ovuliferous flower of *Pinus Laricio*. 8, Longitudinal section of same x 3. 9, dorsal—10, ventral view of scale and bract with ovules x 5.

In the Araucarineæ the general structure of the Abietineæ is observable both in the staminate and ovuliferous flowers. In the genus Araucaria

* This mode of dehiscences is common throughout the Abietineæ with the exception of Tsuga and some species of Abies in which it is transverse.

† It may here be noted that although two is the predominant number of pollen-sacs in each anther throughout the TAXACEÆ and CONIFERÆ, exceptions occur in the Cupressineæ 2 — 4, in Cephalotaxus and Cunninghamia 3, in Taxus 4 – 8, and in some others.

‡ If a young cone a few weeks old, of any species in which the bract is exserted, that is, protrudes more or less beyond the ovuliferous scale as in the common Larch *Larix europæa*, or the Silver Fir *Abies pectinata*, and ripe cones of the same species be subsequently examined, it will be found that the scale has increased in size faster than the bract, so much so in the case of the Larch that the bract is quite enclosed within the scale; and in the Silver Fir it is relatively much shortened.

the chief deviation occurs in the anthers, from the prolonged connective of which hang three to six pollen-sacs instead of two, the number common throughout the Abietineæ, and on the scale of the seminiferous cone the ovule is solitary instead of being in pairs. In

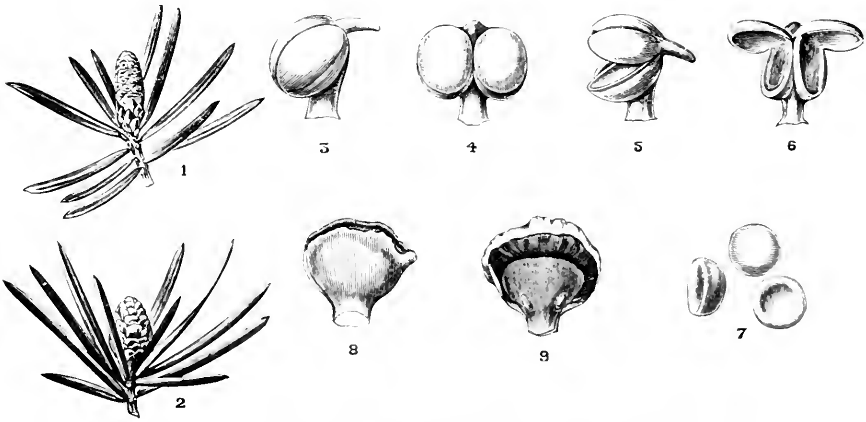


Fig. 25. *Tsuga Brunoniana.* 1, Staminate. 2, Ovuliferous flower, nat. size. 3, side 4, front view of stamens before dehiscence; 5 and 6, after dehiscence x 10; 7, pollen grains x 120; 8, back 9, front view of bract and scale of ovuliferous flower x 5.

Cunninghamia the scale of the seminiferous cone bears three ovules. In the Taxodineæ and Cupressineæ, whilst the staminate flowers are constructed on the same general plan as in the Abietineæ, the number of ovules on each scale of the seminiferous cones varies in the different genera from three to nine; they are, moreover, erect, that is to say, the micropyle through which the pollen tubes enter, is at the top. In the Cupressineæ the anthers of the staminate flowers and the ovuliferous scales are, like the adult foliage leaves, in decussate pairs, the only exception occurring in Juniperus in which the seed-bearing scales like the acicular adult leaves are in whorls of three.

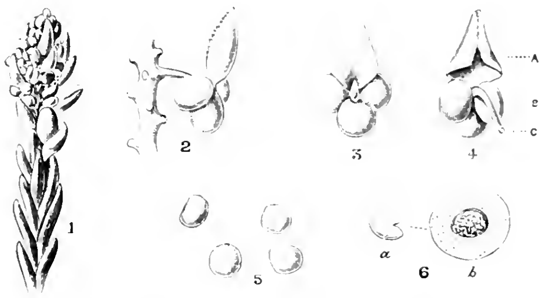


Fig. 26. 1, Staminate flower of *Sequoia Wellingtonia.* 2, Stamen attached to axis, side view. 3, The same, dorsal 4, ventral view: A, connective; B, three anther cells; C, filament. 5, Pollen grains. 6, A pollen grain as seen when placed in water; *a*, the empty extine of the bursted pollen grain; *b*, the swollen contents of the same. 1, Nat. size: 2, 3 and 4 magnified five diameters: 5 and 6, 240 diameters.

Those who have studied Botany and are acquainted with the transformations which the foliar structures of flowering plants undergo from the seed-leaves (cotyledons) through the various stages of stipules, foliage leaves, bracts, sepals, petals, stamens and carpels (seed-bearers)—the last named being regarded as the highest state of development of the foliar organs—will not fail to recognise that, although some of the states of development here named are wanting in Taxads and Conifers, the bracts and stamens are really metamorphosed foliage leaves with which they strictly agree as regards position and arrangement.

Direct evidence of the bract being a metamorphosed foliage leaf is sometimes afforded by abnormal cones as that here figured, which is a proliferous cone of *Abies Veitchii* gathered many years ago by Mr. Maries in Japan, the bracts of which had reverted to foliage leaves.* That the stamens also are metamorphosed foliage leaves is shown by the occurrence of intermediate states in monstrous growths, such as may be sometimes observed in *Callitris robusta*, a beautiful Australian Conifer cultivated in the Temperate House at Kew, in which the uppermost leaves pass into stamens bearing anthers at their base, and these into true peltate stamens with the anthers on the under surface. A similar sequence has also been observed in species of Juniperus, Cupressus, etc.

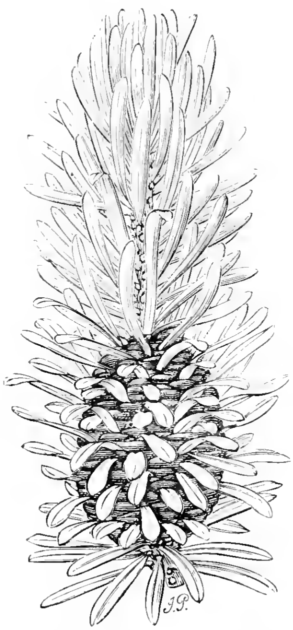


Fig. 27. Proliferous cone of *Abies Veitchii* with the bracts transformed into foliage leaves, and with the axis prolonged into a branchlet with ordinary foliage. Nat. size.

But the morphological interpretation of the ovuliferous or seed-scale is by no means so clear, and various hypotheses respecting it have been broached, the discussion of which has given rise to a mass of literature far too voluminous to admit of quotation in this place. Whether it is simply a modified leaf (Lindley), an open carpellary leaf (R. Brown), a *dédoublement* of the bract (Brongniart), a rachis (F. Mueller), a cladode (Baillon), a greatly developed placenta (Sachs), or any other form of growth, this much may be accepted as consistent with the facts of morphology and anatomy: "That the fruit-scale is something super-added to the bract; that it may arise either from the base of the bract or apparently from the axis just within or above it; that its structure is neither that of a leaf proper, nor that of an ordinary shoot; but that it does present close resemblance in structure to a cladode."†

The position of the staminate flowers and the cones in respect of the branches or axial growths that produce them is either distinctly terminal or lateral in the axils of the leaves. In the TAXACEÆ—Both sexes are lateral and axillary in Taxus, Torreya, Cephalotaxus, Podocarpus; terminal in Saxegothaea and on the short arrested branchlets or "spurs" of Ginkgo. In the CONIFERÆ—The staminate flowers are terminal at the points of the young shoots nearly throughout the Cupressineæ, whilst the strobiles or cones are either

* Cones of *Tsuga Brunoniana* in which some of the bracts had reverted to foliage leaves were sent to the author by Mr. Imbert Terry from Strete Raleigh, near Exeter.

† Masters in Journ. Linn. Soc. XXVII. 327.

lateral or terminal on very short lateral branches. In the Taxodineae both positions occur: terminal in Sequoia, Sciadopitys, Taxodium and Athrotaxis; lateral in Cryptomeria. In Araucaria both kinds are lateral, or terminal on short lateral branchlets: in Cunninghamia both kinds are apparently terminal. Throughout the Abietineae, except in Cedrus, and there perhaps only pseudo-terminal, the staminate flowers are lateral; the cones are lateral in Picea, Abies, Larix and Pinus: and mostly terminal on short lateral branches in Tsuga, Abietia and Cedrus.

The staminate flowers are, probably without exception, far more numerous than the seminiferous ones. The reason of this is manifest: the agency by which the pollen is conveyed to the ovules is the wind; but the wind being an uncertain mode of transport, it is of great consequence that the pollen should be produced in such quantities as to admit of its being disseminated as thoroughly as possible to ensure the pollination of the ovules. Throughout the Abietineae and Araucarineae the production of pollen is very abundant, and occasionally even surprisingly great, of which instances will presently be adduced.

With respect to arrangement and form, the staminate flowers are capitate (collected into small heads) in Taxus, Torreya and Cephalotaxus; solitary in the Cupressineae, Sequoia, Athrotaxis, Araucaria, Cedrus and others; umbellate in Ginkgo, Sciadopitys and Laricopsis; paniculate in Taxodium; occasionally spicate in Pinus; often crowded in Abies; sessile and dispersed in Larix. The ovuliferous flowers are solitary or clustered, but rarely in large numbers; frequent instances occur in Pinus in which pseudo-whorls of three, five, or more are common as in *P. Pinaster*, *P. muricata*, *P. radiata*, *P. tuberculata* and others; and in Cephalotaxus they are sometimes clustered on axillary peduncles.

Being destitute of calyx and corolla, the flowers of coniferous plants are also wanting in the brilliant hues that distinguish the flowers of most of the higher orders. Nevertheless there are some species which have the connective or exposed part of the anthers of the staminate flowers highly coloured; in *Pinus ponderosa* the flowers are bright red, and being produced in large clusters are very conspicuous; in *P. Laricio* and its allies they are yellow; in *P. excelsa*, purple; in *Abies Pinsapo*, rose-purple; in *A. amabilis*, coral-red; in *A. nobilis*, violet-crimson; in *Cupressus Lawsoniana*, crimson; in the Chinese Juniper, the Thuias and most of the Cupressineae they are yellow. Nor are the young seminiferous cones always destitute of a pleasing colour as in the common Larch and Douglas Fir, in which the scales are a soft pink and in the Siberian Larch dark purple before pollination. The quantity of pollen produced by the staminate flowers of a single tree is often surprisingly great; a puff of wind has been observed to scatter the pollen of an *Araucaria imbricata* like a cloud of dust; the surface of the ground beneath a Spruce Fir that has shed its pollen is made quite yellow with fine dust; and in Pine and Fir forests the quantity of pollen is sometimes such as to produce effects almost exceeding belief. "In years peculiarly favourable to the flowering of coniferous trees, vast clouds of pollen are borne on gentle winds through the Pine forests and are often swept right beyond them so that not only the seminiferous flowers, leaves and branches of the trees are powdered over with the yellow pollen, but also the leaves of adjoining trees, and even the grasses and herbs of the meadows around. In the event of a thunder-storm at such a period, the pollen may be washed off the plants and run together by the water as it flows over the ground, and then, after the water has run off, streaks and patches of a yellow powder are left behind on the earth—a phenomenon which has given rise on various occasions to the statement that a fall of sulphurous rain has taken place." * Many well-authenticated instances have been recorded:—Dr. Engelmann found in the streets of St. Louis, after a rain-storm from the south, in March when no Pines north of Louisiana were in bloom, Pine pollen which must have come from the forests of *P. palustris* on Red River, a distance of about 400 miles in a direct line. At Bordeaux during the months of March and April these so-called sulphur rains are not infrequent; they are caused by clouds of pollen dust wafted by westerly winds from the plantations of *Pinus Pinaster* which cover the sand dunes of the Girond. "In Inverness-shire, a great shower of the pollen of the Scots Pine took place in 1858; the ground was covered by a layer of this substance in some places to a depth of half an inch, and the deposit was noticed at places thirty-three miles apart. The whole surface of the great lakes in Canada is not infrequently covered by a thick scum of the same pollen. Similar occurrences have been noticed in the forests of Norway and Lithuania." †

But the most remarkable part played by the pollen of Conifers when dispersed by the wind and carried beyond the reach of the seminiferous cones it was formed to fertilise is the nutrition it affords as an organic constituent of the dust which supports the so-called "red snow"—a phenomenon that has always excited the wonder and admiration of the naturalists who have studied it, even in a higher degree than it has of the more general observers of Nature who are unacquainted with its structure.

"This red snow is now known to be a microscopic Alga of almost ubiquitous distribution on the higher mountain ranges above the snow line, a wonderful organism consisting of a cell wall furnished with a pair of minute cilia, and with numerous chlorophyll grains coloured by a red pigment thickly dispersed through the enclosed protoplasm: it thence belongs to a fascinating group of cryptogamic plants named FLORIDEÆ in reference to their brilliant colours. These minute plants derive their nutrition from the carbonic dioxide absorbed by the melting snow from the atmosphere and from the inorganic and organic constituents of the dust distributed in it, of which the pollen grains of Conifers forming the forests below the snow line are found to be an ingredient, and whose occurrence in situations where one might suppose all vital functions would be extinguished is scarcely less remarkable than the simplicity of their structure and the richness of their colour. Red snow is found on the Alps of Switzerland and the Tyrol,

* Kerner's "Natural History of Plants," Oliver's Translation. Vol. II. p. 151.

† "Coal," by the Professors of the Yorkshire College. p. 24.

on the Carpathians, on the Pyrenees, on the Sierras of California, and even in Greenland. On the Alps, amongst the materials which constitute the dust, pollen grains of Conifers occur with great frequency especially those of the Fir *(Picea excelsa)*, the Arolla *(Pinus Cembra)*, and the Mountain Pine *(Pinus montana)*. These pollen grains have been swept up into the high Alps by storms and soon become partially decayed." *

In all the material investigated by Professor Kerner red-snow cells were found mixed with pollen grains of these Conifers.

FERTILISATION.

THE essential facts of fertilisation in Taxads and Conifers, viz., the fusion of the male sexual cell contained in the pollen grain with the female sexual cell within the ovule, are the same as in all flowering plants, but the apparatus by which it is effected, as shown in the foregoing section, is much simpler. In Great Britain the fertilisation of Taxads and Conifers usually takes place in May, earlier or later according to the season. At that period the pollen is ripe and the scales of the ovuliferous flowers, although for the

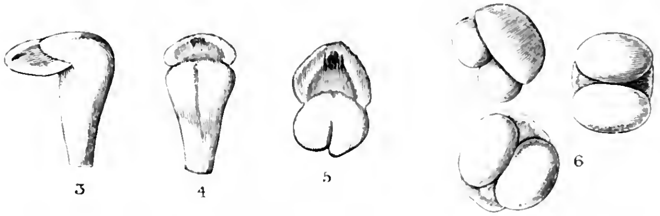


Fig. 28. Anther of *Picea* [illegible]: 3, side; 4, dorsal; and 5, apex view. Magnified six diameters. Pollen grains × 200.

most part closely imbricated or appressed when first developed, separate sufficiently to afford safe and easy access to the pollen grains wafted to them by the wind.

The structure of the pollen grains is essentially the same throughout the Taxaceæ and Coniferæ, but there is a slight difference in size and in the number of contained cells in the different genera. To the naked eye the pollen grains appear like dry homogeneous dust, but under the microscope they are found to be not simple bodies, but composed of distinguishable parts. They are spherical or egg-shaped: each grain is made up of two, three or more cells enclosed by a cell-wall which consists of two layers, a thinner outer yellowish layer termed the *extine* (analogous to the exospore of the spores of ferns and other cryptogams), and an inner colourless thicker layer termed the *intine* (analogous to the endospore of ferns, etc.).† The entire inner space of the pollen grain is at first filled with granular protoplasm which afterwards divides into two portions, a larger and smaller, separated from each

* Kerner's "Natural History of Plants." Oliver's Translation. Vol. I. pp. 37, 38.

† In the Cupressineæ the pollen sacs and their contents bear a still more striking resemblance to the corresponding organs of fructification in Lycopodium, Selaginella, etc. The sporangium and its contained microspores.

other by a thin septum, and each is provided with a nucleus. It is the larger of the two that grows out into a pollen-tube when the pollen grains are brought into contact with the ovule; the outer cell wall, the extine, ruptures, and the thicker inner wall, the intine, presses through the chink in the form of a teat-like outgrowth which lengthens into a pollen-tube; the whole contents of the larger pollen-cell effuses gradually into the pollen-tube; the nucleus shifts to the end of the pollen-tube which pushes its way through the tissues of the ovule into the embryo-sac. In Pinus the pollen grains have, in addition, two small outswellings, one on each side, filled with air which diminish considerably the relative weight of the grain and act as wings for its transport through the air; these wing-like appendages arise from the outer layer of the cell-wall and increase rapidly in size when the pollen is ripe.

The ovules at the time of pollination consist of small masses of spongy tissue which are thus differentiated:—There is the nucleus or embryo-sac* in which the ooplasm or egg-cell is embedded; joined to this on the under side are several cell-layers that form an enveloping sheath, whilst on the upper side is a funnel-shaped opening called the micropyle on which the pollen grains fall. In the Abietineæ the micropyle is turned *away* from the free margin of the ovuliferous scale, in the Cupressineæ it is turned *towards* it. The nucellus or embryo-sac just before fertilisation becomes filled with a tissue called the endosperm, and produces at its apical end egg-cells which vary in number in the different tribes from two to fifteen, and which are always in close proximity to each other beneath the micropyle. When pollination takes place, the lining of the micropyle is rendered sticky by drops of a mucilaginous fluid secreted from it by which the dry pollen grains are retained and afterwards drawn through the micropyle, when the pollen-tube issuing from the larger cell makes its way through the tissue of the endosperm, and with the nucleus at its end enters one of the egg-cells and its fertilisation is effected. The tissue on the under side of the ovule increases in size by cell division, closes over the micropyle and ultimately forms the testa or shell of the mature seed which in some species of Pinus (*P. Cembra*, *P. edulis*, *P. Sabiniana*) is so much thickened that the seed resembles a nut.

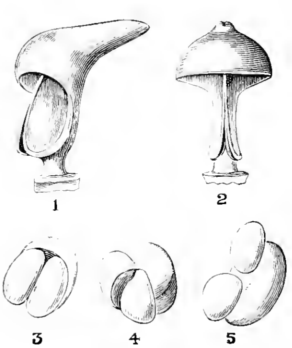


Fig. 29. *Abies firma*. 1 and 2, anthers after dehiscence × 10: 3, 4, and 5, pollen grains × 120.

The process of fertilisation here described is that which takes place in all those species whose seeds are matured in the autumn of the same year in which pollination is effected. But in Pinus, Cupressus (excluding the section Chamæcyparis), Juniperus and those genera in which the seeds do not ripen until the second or third season after pollination, the fertilisation of the egg-cell is temporarily arrested. The manner in which this retardation is brought about in *Pinus Laricio* has been carefully worked out by Dodel-Port:—"After pollination the ovuliferous flowers, with the exception of the bracts, grow rapidly

* The archegonium of some authors.

till they attain about half their natural size; the seed-scales thicken in such a way as to press closely one upon the other so as to leave no space between them: the weight of the cone causes a bending of the short foot-stalk, so that in the autumn of the first year the half-grown cone takes a sub-pendent or horizontal position which remains unchanged through the winter: the pollen-tubes within the ovules not having completed the fertilisation of the egg-cells also cease growing. It is not till the beginning of the second summer of the cone development that the pollen-tubes reach the egg-cell of the embryo-sac, so that actual fertilisation does not take place till twelve or thirteen months after the pollination of the ovule. After this has been effected, the maturation of the cone is completed in the course of the second season; the cone scales become lignified, and the ovules are transformed into ripe seeds."

It is easily conceivable that pollen wafted in large quantities by the wind may fall on the ovuliferous flowers of a different species, and that hybridisation would ensue to a greater or less extent where different species of the same genus are growing in proximity to each other. Direct evidence of hybridisation among the Coniferæ is, however, of the slenderest description, the number of recorded instances that have come to the knowledge of the author not exceeding half-a-dozen,* and from these no definite conclusions can be drawn; they only show that hybridisation has taken place between two closely allied species or between geographical forms of the same species. In one instance in which the cones of *Abies Pinsapo* had been fertilised with the pollen of *A. Nordmanniana* the seeds were sown in a French nursery, with the result that the greater part of the progeny conformed to the seed parent and comparatively few plants showed intermediate characters.

FRUCTIFICATION.

An essential distinction exists between the mature ovuliferous flowers or fruits of the Taxaceæ and those of the Coniferæ, the seeds of the former being solitary and enclosed in a succulent or fleshy envelope, whilst those of the latter are numerous and enclosed by ligneous separable scales; in Juniperus only are the scales fleshy and coalesce into a berry-like fruit.

Taxaceæ. In Taxus, the ovule after fertilisation becomes invested with a fleshy envelope, technically called an *arillus*, which grows from below upwards, but is open at the apex. In Cephalotaxus, Torreya and Ginkgo it is the *testa* or outer covering of the ovule that becomes fleshy, the seed itself being enclosed in a hard woody shell. In Podocarpus and Saxegothaea it is a part of the floral axis which bears the scales and seeds that becomes fleshy; and in the curious Tasmanian monotypic Microcachrys, a connecting link between the Taxaceæ and Coniferæ, it it is the scales of the young cones that become pulpy and highly

* *Abies Pinsapo* × *A. Nordmanniana*. Revue Horticole. 1890. p. 231. *Abies lasiocarpa* × *A. amabilis*. Silva of North America. XII. p. 126. *Pinus Thunbergii* × *P. densiflora*. Abietineen des japanischen Reichs. 83. *Pinus sylvestris* × *P. montana*. Flora helvetica. XLVII. 145. *Abietia Douglasi* var. *Standishii*, from *A. Douglasii* × *A. pectinata*. Gordon, Pinetum, ed. II. p. 26. *Juniperus Kanitzii*, from *J. communis* × *J. Sabinioides* (?). Kerner Natural History of Plants, II. 565. A progeny from *Abies Pinsapo* × *A. cephalonica* was obtained artificially by the late M. Vilmorin, of Paris Revue Horticole. 1889. p. 115.

coloured. But in Phyllocladus, a remarkable Australian genus (Tasmania and New Zealand) with an outlying representative in Borneo, the scales of the young cones which are at first fleshy become hard and ligneous in the mature fruit.

CONIFERÆ. The Abietineæ claim the first notice on account of the large size and handsome appearance of the cones of many of the included species, and also as affording a simple type of structure by which that of the other tribes will be easily understood; this structure is shown in the accompanying figures. The seed-bearing scales are hard and ligneous in texture, imbricated, closely appressed and spirally arranged around a common axis; they are nearly of the same thickness throughout except in the species of Pinus in which the leaves are in fascicles of less than five, and in which the scales of the cone are thickened at the apex on the dorsal side (the side *away* from the

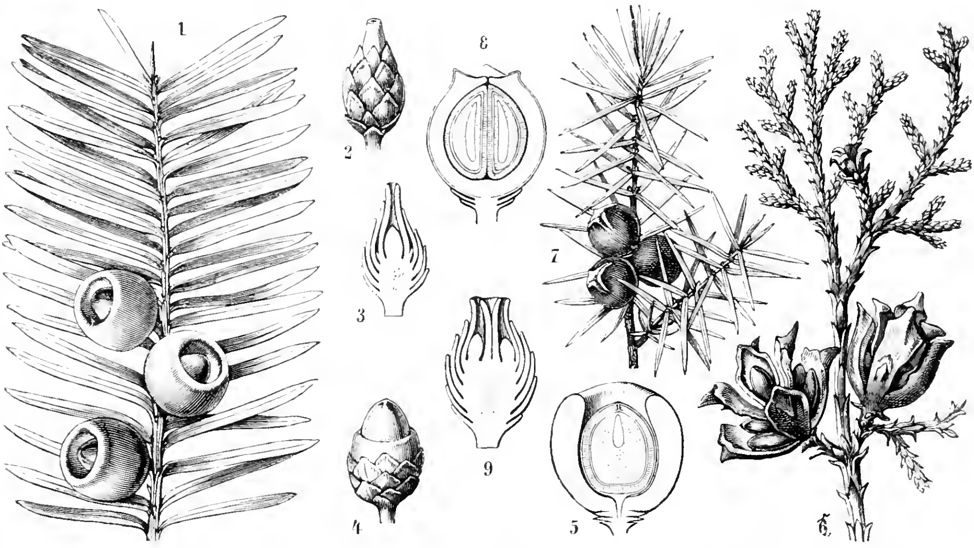


Fig. 30. 1, Branchlet of Yew *(Taxus baccata)* with ripe fruits. 2, Tip of ovule projecting from between the scales of the female flower of Yew. 3, Longitudinal section of the same. 4, Young seed of Yew partly enclosed in an aril. 5, Longitudinal section of ripe seed. 6, Branchlet of Arbor Vitæ *(Thuia occidentalis)* with ripe fruits. 7, Fertile branchlet of common Juniper *(Juniperus communis)*. 8, Longitudinal section of ripe fruit. 9, Ovuliferous flower of *Juniperus communis*. 1, 6 and 7, Natural size; the others enlarged.

This and Figs. 30 and 31 from Kerner's "Natural History of Plants," by permission of Messrs. Blackie and Son, Ltd., and the Bibliographisches Institut of Leipzig.

axis);* near the base of the scale on the ventral side, the side *towards* the axis, the seeds are seated. At the base of the scale on the dorsal side in those genera coming under the general denomination of Firs and in the Larches is attached the bract which is developed into a separable organ.

The fruits of the Abietineæ are generally of conical form modified more or less in different genera, being nearly cylindric in Abies, globose in Cedrus, ovoid in many of the Pines and greatly elongated in others.

The fruits or strobiles of the Cupressineæ are constructed on the same plan but consist of fewer scales often bearing more than two seeds each;

* This thickening is sometimes called the apophysis, a term borrowed from Cryptogamic Botany.

the scales are arranged in decussate pairs and are attached to the axis in a peltate manner (Cupressus) or coalesce with it at the base on the ventral side (Thuia). In Euthuia the seed scale is approximately of the same thickness throughout; in Cupressus and Thuia, section Biota, it is much thickened at the apex; in Libocedrus and Fitzroya it is thicker at the base than at the apex, and in Juniperus the scales become fleshy and by their coalescence form a berry-like fruit technically called a *galbulus*.

The fruits of the Taxodineæ (Sequoia, Cryptomeria, etc.) may be regarded as intermediate between those of the Abietineæ and Cupressineæ, combining the spiral arrangement of the scales of the former with much of the structure of the latter. The cones of the Araucarineæ closely approach those of the Taxodineæ in structural details, differing chiefly in the scales (except Cunninghamia) bearing but a single seed and in the spheroidal form of the whole fruit.

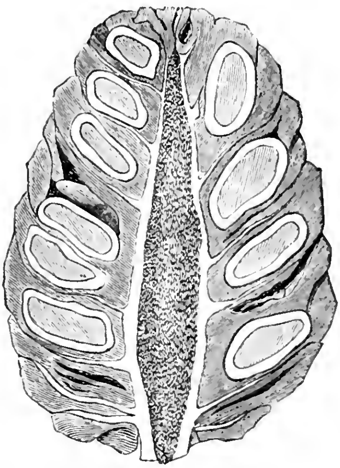


Fig. 31. Longitudinal section of a cone of the Stone Pine, *Pinus pinea*, showing the relative positions of the axis, scales and seeds. Two-thirds natural size.

The fruits or cones of the different tribes, genera and species differ enormously in size and weight. The galbuli of the Savin Junipers are smaller than the smallest of garden peas, whilst the cone of the Moreton Bay Pine, *Araucaria Bidwilli*, is almost as large as a man's head. The small cones of *Larix americana* do not much exceed half an inch in length; the cones of the Californian Sugar Pine, *Pinus Lambertiana*, are often two feet long. It takes several cones of the common Hemlock Spruce to weigh an ounce; a single cone of *Pinus Coulteri* weighs from four to five pounds and occasionally more. It is a noteworthy fact that nearly all the species of Fir and Pine which bear the largest cones inhabit the Sierras of Oregon and California, and their continuation into Mexico, *Abies nobilis* and *A. magnifica* among the Firs, and *Pinus Lambertiana*, *P. Sabiniana*, *P. Coulteri* and *P. Ayacahuite* among the Pines.

Although the cones of a great majority of the species are of a dull and unattractive colour, there are some remarkable exceptions the cones of *Abies Webbiana* during the period of growth are a deep violet-blue and strikingly beautiful; those of *A. homolepis*, *A. Veitchii*, *Tsuga Brunoniana* and *Larix Griffithii* are, under like circumstances, marked ornaments of the trees that bear them on account of their colour. The cones of *Abies nobilis* are bright pea-green during their progress towards maturity which, with the symmetrically arranged scales with their protruding bracts, renders them very beautiful objects. The ripe arils of the common Yew are bright coral-red, in one variety orange-yellow, which when produced in quantity impart to the trees by contrast with the deep green foliage a very ornamental appearance.

The fruit of all the Taxads with very few exceptions,* so far as

* The fruits of the Rimu of New Zealand, *Dacrydium cupressinum*, require fifteen or sixteen months to attain maturity.—Kirk. Forest Fl. N. Zeal. 29.

known, ripen in one season. In the CONIFERÆ a large proportion of the species also maturate their fruits in one season. In Pinus, Cedrus, Araucaria, Cupressus in part and Juniper maturation is not complete till the second season.* The seeds are dropped either by the falling away of the scales (Abies) or by a separation of them at a sufficient distance to allow of their escape. The hard cones of the Pinaster group of Pines, notably the Californian species *P. muricata* and *P. tuberculata*, often

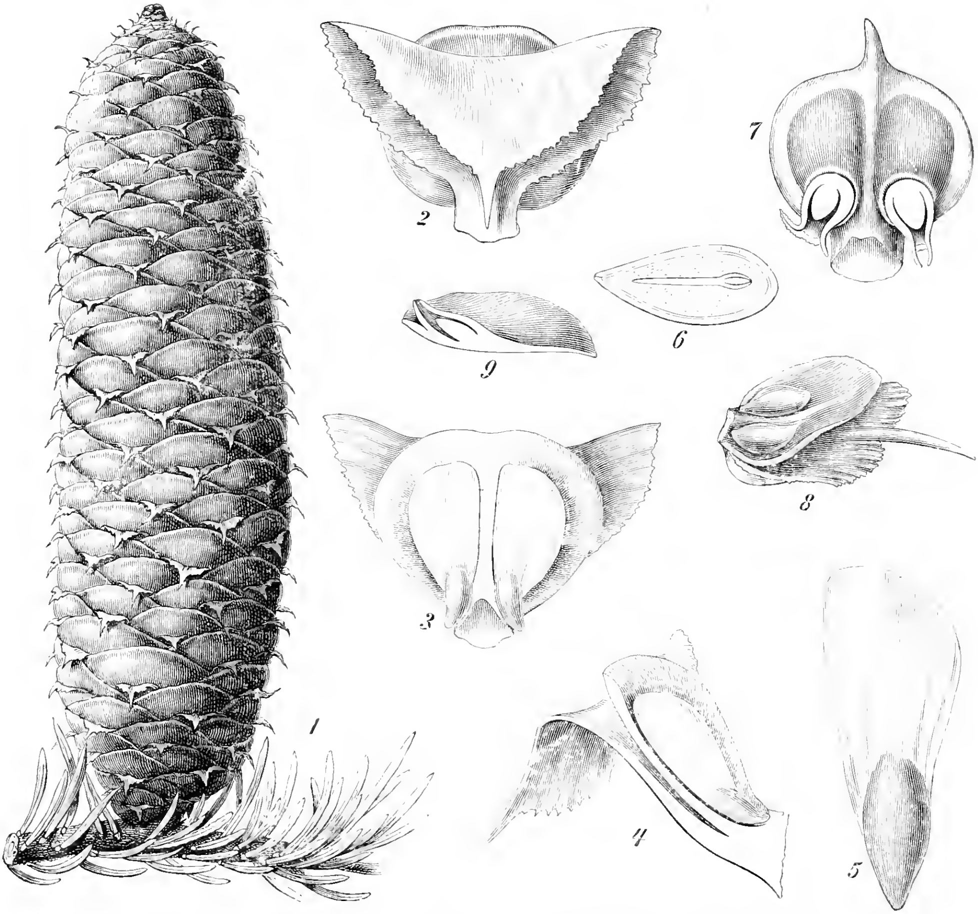


Fig. 32. 1, Cone of *Abies pectinata*. 2, Bract and ovuliferous scale of the same seen from the outside. 3, The same seen from the inside and showing the two-winged seeds. 4, Longitudinal section of bract and ovuliferous scale showing a seed inserted on the latter. 5, A winged seed of *Abies pectinata*. 6, Longitudinal section of seed. 7, Ovuliferous scale of Scots Pine. 8, Ovuliferous scale of the Larch (*Larix europaea*) showing two ovules and bract below it. 9, Longitudinal section of the ovuliferous scale of the Larch. Fig. 1 natural size, all the others enlarged.

remain closed and attached to the trees for years, only opening when a forest fire or an exceptionally hot and dry season causes the scales to split asunder and li[illegible]ate their seeds.

* The seeds of *Pinus* [illegible] re not mature till the third season, and this may probably be the case with oth[illegible] Pinus.

THE SEED.

As already stated, the seeds are produced singly, in pairs, or in greater number according to the ovules in each scale, but sometimes fewer by abortion in those species in which the ovules on each scale are more than two (Cupressineæ and Taxodineæ). They are enclosed in a bony, leathery or membraneous tegument called the *testa* which in the Abietineæ is usually expanded into a membraneous wing. The endosperm enclosing the embryo consists of a farinaceous or fleshy albumen more or less impregnated with resin, but which in the case of a few of the larger seeds of Pinus as

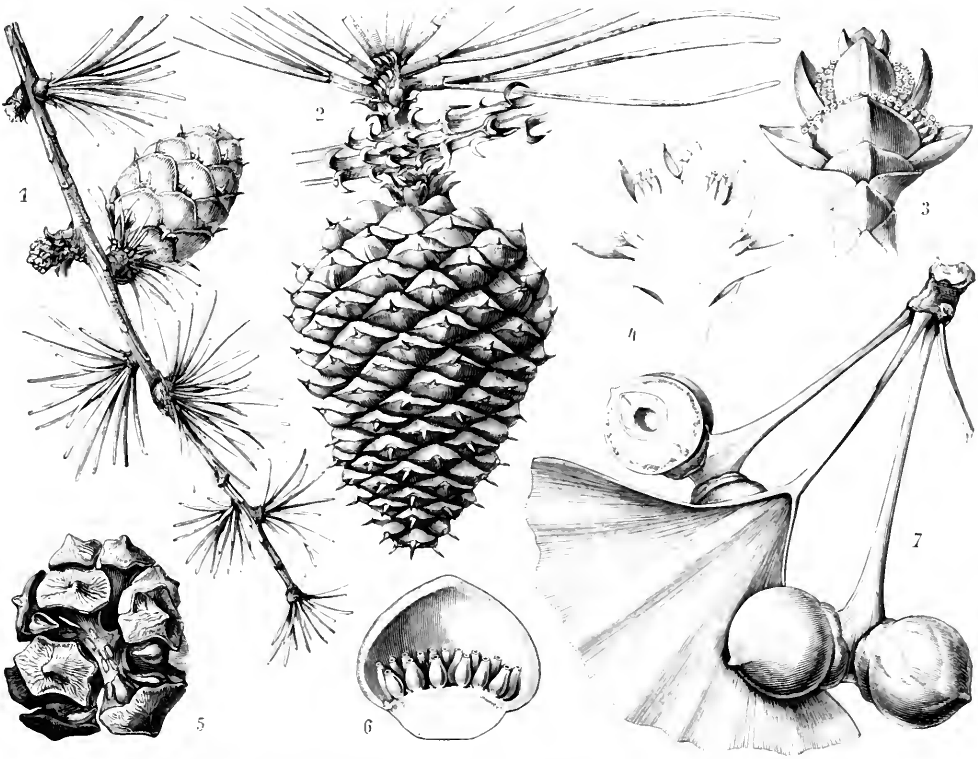


Fig. 33. 1, Branchlet of Larch, *Larix europæa*, with ripe cone. 2, Branchlet of *Pinus rigida* with ripe cone. 3, Ovuliferous flower of *Cupressus sempervirens*. 4, Longitudinal section of the same. 5, Ripe cone of the same. 6, Single carpel of the same with numerous ovules. 7, Fruiting "spur" of *Ginkgo biloba*. Figs. 3, 4, and 6 enlarged.

P. pinea, *P. edulis*, *P. Sabiniana* is edible and occasionally used for food by the poorer inhabitants of the countries in which these Pines are abundant.

The seeds vary much in size and shape in the different genera, and even in species included in the same genus. Thus in Pinus they are mostly ovoid or obovoid, with the greater diameter of the smaller seeds as those of *P. Strobus* not more than one-fifth of an inch, whilst those of *P. Sabiniana* are almost as large as a filbert. In Abies and Cedrus they are broadly wedge-shaped; in Taxodium angular; in Sequoia disk-like and compressed; in some of the Cupressineæ ear-shaped, etc. In Araucaria the scale, bract and seed all coalesce into an elongated wedge-like body.

The seeds of Taxads and Conifers differing so much in size, it follows also that there is a corresponding if not a proportionate difference in weight. A few instances for illustration are selected from a table compiled by Mr. E. J. C. Preece.* In this table the gramme is taken as the unit of weight which is equivalent to about 15·5 English grains, or in other words the English ounce is equal to 28·3 grammes. Thus, in Abies the small-seeded *A. balsamea* has 157 seeds to the gramme, whilst *A. cephalonica* and *A. Nordmanniana* have but twenty. In Picea, the common Spruce, *P. excelsa* has 150 seeds to the gramme, whilst the small-coned *P. alba* has 340, and the Sitka Spruce nearly 1,000. In Pinus, whilst one seed of *P. Sabiniana* almost weighs a gramme, and only two of *P. pinea* and three of *P. Coulteri*, it takes 200 of the Scots Pine to make up the same weight. It requires over 300 of the small seeds of Wellingtonia and 360 of *Cryptomeria japonica* to weigh a gramme, a larger number than Lawson's Cypress which takes about 250.

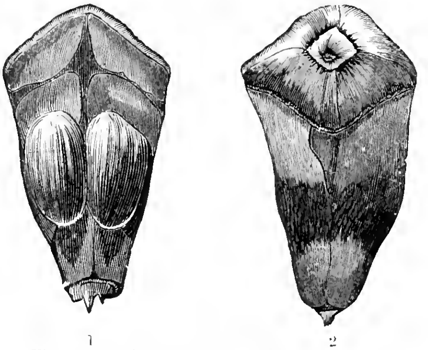


Fig. 34. Scale of cone of *Pinus pinea*. 1, Inner (ventral) face with two seeds. 2, Outer (dorsal) face showing the swollen apical portion called the *apophysis* with its central protuberance. Nat. size.

It is a very remarkable fact that some of the largest of trees spring from the smallest of seeds. Thus, the gigantic Sequoias of California, the Wellingtonia and the Redwood have seeds less than one-tenth of an inch in diameter, and each seed contains no more matter than a grain of mustard seed. The seeds of the Deodar Cedar are smaller than those of some of our garden herbs, and the seeds of the Hemlock Firs are among the smallest of tree seeds. The seeds of *Pinus monophylla* and *P. koraiensis*, both low trees, are half as large again as those of their congener, *P. Lambertiana*, which towers to ten times their height, and many other instances might be cited. There is, however, no necessary connection between the size and weight of seeds and the dimensions of the plants that spring from them. The essential physiological condition consists in the albumen or food material stored up in the seed being in sufficient quantity to supply the embryo plant with nutrient matter during germination and until the cotyledonary leaves and rootlets of the young seedling are sufficiently developed to assimilate it from the atmosphere and soil.

Various provisions are met with which serve the dispersion of the seeds of Taxads and Conifers. The bright colour and sweet flavour of the aril of the Yew doubtless attract birds, and the contained seed is carried by them a considerable distance from the parent tree; and this probably happens with the succulent fruits of Ginkgo, Cephalotaxus, Torreya and Juniper. The membraneous wing into

* Forestry, VII. (1883), p. 186.

which the testa of the seeds of most of the Abietineae is expanded, is evidently designed as an aid to their dispersion by the wind. Soon after the maturation of the cones, the persistent scales fall backwards or outwards from the axis to permit the ripened seed to escape. The scales are very sensitive to moisture, and in many species exhibit rapid movements when wet. This is especially well seen in the cones of *Tsuga canadensis* in which the widely open scales become completely closed in twelve minutes. This property of the cone-scales is found to be very efficient, first in loosening the winged seeds from the scales which bear them, and secondly in favouring the wide dispersion of the seeds, as the cones open and close many times before all the seeds are sown, thus securing their transport in different directions by the varying winds.*

The seeds of each species produce plants "after its kind," but innumerable departures from a fixed type are of constant occurrence, and many of them so remarkable, that were their origin unknown they would, on superficial glance, be taken for quite distinct species. Among such may be noted the Irish Yew, Clanbrasil's Fir, the erect Lawson's Cypress, and the Whipcord Arbor Vitæ. Besides these, which may be called extreme forms, every bed of seedling plants shows numberless variations in habit, foliage or some minor particular. Taxads and Conifers therefore, like many of the lower forms of vegetation as Ferns, are polymorphous, a principle that manifests itself throughout the Order, but is much more common in some tribes than in others; it is less frequent in Pinus than in Abies, very usual in the Yew, and most common in the Cypress tribe (Cupressus, Thuia, Juniperus, etc.). It is most observable in plants in their young state, but when the departure from the usual type is not very great the difference gradually disappears as the plant becomes older.

ABNORMAL GROWTHS.

Exceptional formations or deviations from the ordinary mode of growth, or monstrosities as they are called, are of frequent occurrence among Taxads and Conifers. Many such malformations are due to diseases caused by fungi, the attacks of insects and other animals, and even to the operations of Nature as winds, storms, etc. Those due to diseases and insect agency are treated of under their respective heads; but there are some which cannot be traced to either cause, and which require separate notice. For the following selected instances the author is almost wholly indebted to Dr. Maxwell Masters, the eminent authority on vegetable Teratology, from whose writings on the subject they have been extracted.

The malformations occurring amongst Taxads and Conifers not caused by disease or insects may be grouped under several distinct headings, but by far the greater number of observed instances are referable to the following:—

I.—Androgyny in which both sexes occur in the same axis or parts of the same cone.

* Prentice in Botanical Gazette. 1888, pp. 236, 237.

II.—PROLIFICATION restricted in the cases here noticed to the prolongation of the axis of the seminiferous cone along which are produced foliage leaves, sometimes also transitional forms instead of the usual seminiferous scales.

III.—FASCIATION by which is understood the union of parts usually separate in their adult condition, and its opposite or FISSION which implies the division of organs usually entire.

ANDROGYNOUS CONES.—Many instances have been recorded of the presence of staminate and ovuliferous flowers on the same axis. Malformed cones of *Picea excelsa* have been observed in which the lower part of the axis was covered with stamens whilst the upper terminal portion produced bracts and scales like an ordinary seminiferous cone. The stamens of the lower division were serially continuous with the bracts above. Some of the lower scales of the ovuliferous portion were in the axils of the uppermost stamens which last were somewhat modified, the anther cells being diminished whilst the scale-like connective had become more elongated and pointed; in fact more or less resembling the ordinary bract.

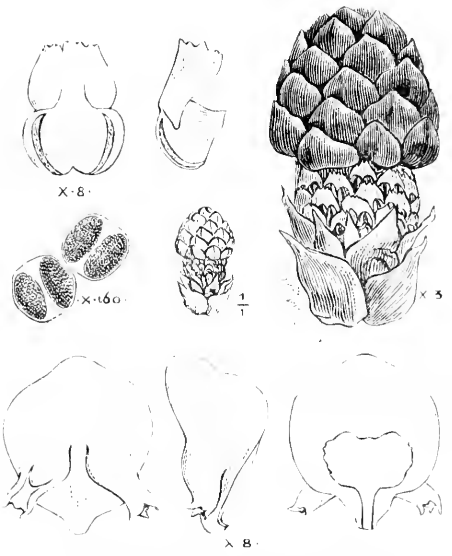


Fig. 35. Bisexual cone of *Pinus Thunbergii* with details of structure and pollen grains.

Similar changes have been observed in *Picea alba*, *P. nigra*, *Pinus Thunbergi*, and *Larix americana*, and a very remarkable case in *Cupressus Lawsoniana* in which the lower scales of the staminate flower that were serially continuous with the leaves bore anthers, whilst the upper scales also serially continuous with the leaves bore ovules. One scale even bore an anther on the outer and an ovule on the inner or upper surface of its basal portion.

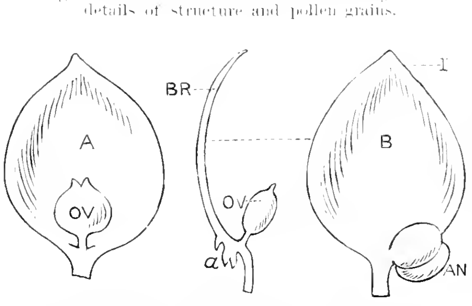


Fig. 36. Scale of *Cupressus Lawsoniana* bearing an anther on the outer, and an ovule on the inner surface × 5.

PROLIFICATION.—Foliar prolification of the inflorescence is frequent, especially in *Cryptomeria japonica* and the common Larch. The elongation of the axis which occurs in the seminiferous cone is frequently associated with a more or less foliaceous condition of the bracts, which seem to be serially continuous both above and below with the ordinary leaves. The scales too become notched and bipartite, and show between the lobes the rudiment of a bud which in a further stage develops into a shoot bearing leaves. This form of prolification is not uncommon, and the appearance presented by it in various genera is essentially the same. The bracts become more or less leafy and pass gradually into the condition of ordinary leaves, so that the general appearance is as a branch growing through the cone. An instance of this kind of prolification was sent to the author of this work by Captain Norman, R.N., of Cheviot House, Berwick-on-Tweed. The axis of a cone of the common Spruce, *Picea excelsa*, had grown beyond the apex from one to two inches, the prolonged part being clothed with ordinary foliage leaves: the bracts serially continuous with them below were much modified, differing only from the ordinary foliage leaves in being shorter and thinner: the scales seated in their axils bore two rudimentary ovules, apparently imperfect as none of them had been fertilised.

Fig. 37. Branchlet of *Cryptomeria japonica* var. *Lobbii* with proliferous cones.

Fig. 38. A, proliferous Larch cone; B, leafy bract and seed scale; C, leafy bract, the scale rudimentary; D E, abnormal scales with traces of ovules. Nat. size.

In a proliferous Larch cone the woody scales were found to be more or less winged at the sides, notched and bipartite at the apex. Sometimes the lateral lobes of the scales were infolded so as partially to conceal the ovule at the base and suggest the idea of a partially closed carpel. The proliferous cones of *Abietia Douglasii* are chiefly remarkable for the fact that in passing to the leafy state the bracts gradually lose the tricuspidate apex which usually characterises them.

The proliferous cones of *Sciadopitys verticillata* are of great interest; in the ordinary cones of this species the bracts are nearly completely concrescent with the seed scale, but in the specimen figured the bracts and the seed scales are more or less detached one from the other; moreover the bracts gradually assume the condition of the perulæ such as surround the buds. In this plant, then, the bracts instead of becoming more leafy as they do usually in proliferous cones, revert to the vaginal or perular condition. The metamorphosis is, in this case, retrograde instead of progressive, or to speak more correctly, development has been arrested instead of enhanced. From the axil of each of these perulæ proceeds a "needle" or phylloid shoot of the ordinary character, so that in these cones we have it in evidence that the perulæ are modifications of the leaves, that the "needles" or phylloid shoots are axillary to them, that they occupy the same relation to the perulæ as the seed-scale does to the bract in ordinary cases, and further that they have the same essential structure as the seed-scales of this and all other genera.*

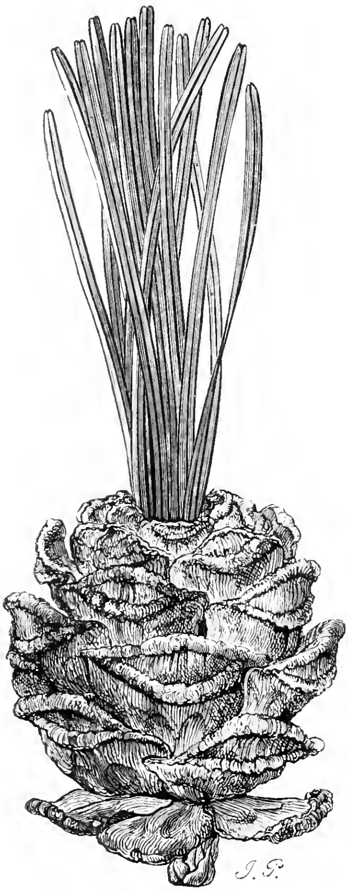


Fig. 39. Proliferous cone of *Sciadopitys verticillata*. Nat. size.

FASCIATION. Although malformations referred to this heading are more common among other families of plants, especially herbaceous species, they have been occasionally noticed in Taxads and Conifers—in the branchlets of *Pinus Pinaster*, *P. sylvestris*, *P. excelsa*, *Larix europæa*; in the leaves of *Taxus baccata*, *Cupressus obtusa*, *Juniperus communis*, *J. chinensis*. The opposite phenomenon or FISSION as it is technically called, is probably of less frequent appearance. In the Kew Museum is preserved a cone of *Picea excelsa* dividing into two, each part bearing bracts and scales. A similar occurrence is sometimes seen in the staminate flowers of *Cedrus Libani*.

A curious instance of fasciation in the Scots Pine was sent to Messrs. James Veitch and Sons by a correspondent in Buckinghamshire; it resembled very closely that figured in the "Gardeners' Chronicle" of April 10th, 1886, which was sent to the Editor from Chatsworth, and

* Many other instances of malformation in the sexual and other organs of Taxads and Conifers are figured and described by Dickson in Journ. Bot. Soc. Edinb., July, 1860. Caspary, De Abietin. flor. fem. Struct. Morph. 1861. Parlatore in Ann. Sc. Nat, ser. 4 p. 215 (1865). Carrière in Rev. hort. 1887, p. 509. Also by Eichler, Oersted and others.

a similar instance was seen by the author on *Pinus Coulteri* at The Frythe, near Welwyn. These out-growths, frequently called "burrs," are sometimes the result of injury by mites or other insects. In the branch from Buckinghamshire the fasciation took a circular form of about nine inches in diameter, and presented the appearance, on superficial view, of a cushion of the common garden Thrift, *Armeria maritima*.

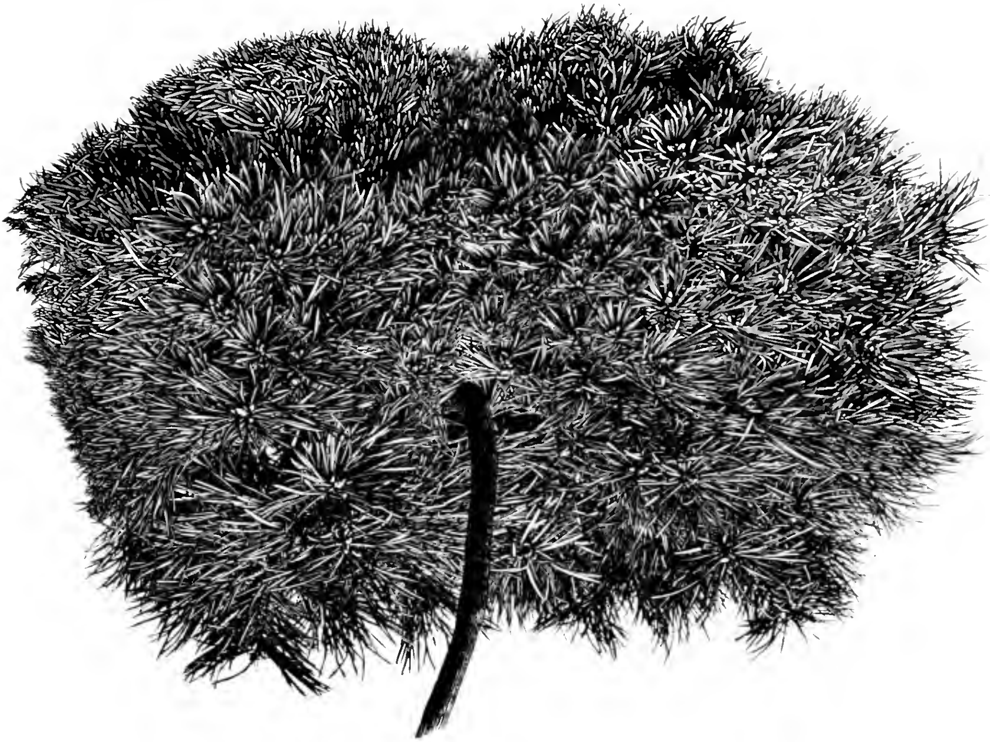


Fig. 40. "Burr" on a Scots Pine. (From the *Gardeners' Chronicle*.)

PATHOLOGY.

THE DISEASES OF CONIFERS.*

By Professor Marshall Ward, D.Sc., F.R.S., F.L.S.

Speaking broadly, there are two great classes of diseases which imperil the life of Conifers. There are, on the one hand, diseases due to the more or less directly injurious action of other living organisms—animals and plants—which injure or destroy the roots,

* Reprinted from the Report of the Conifer Conference held at Chiswick, October 7th and 8th, 1891, by permission of the Council of the Royal Horticultural Society.

stems, leaves, etc., of the Conifer, and so bring about the death of the whole or of parts of it: and, on the other hand, there are dangerous physical conditions of the soil, climate, atmosphere and so forth, which render the life of the Conifer more or less precarious or even impossible.

As a matter of fact, however, these two classes of dangers are frequently found acting together, and so a given case of disease may be complicated owing to the co-operation of many factors. In other cases it is found that the symptoms known to be characteristic of a particular disease are so closely simulated in diseases due to quite other causes than those which produce the primary malady, that confusion results, and barren lines of action are started by the practical man who fails to discriminate between the various cases.

Instances of this kind are so instructive that we may take as an example the well-known disease of Pines characterised by premature shedding of the leaves, as yellow and brown needles, which collect in dense heaps beneath the trees. In some cases it is certain that the leaves of young Pines are cast suddenly, and in dangerous quantities, after a sharp frost, or at least after a night so cold that the still soft foliage is chilled below a point which we might call the death-point for these organs. In other cases, however, similar leaf-casting occurs under conditions which are very different in their action. Young Pines suddenly lose their "needles" in warm sunny weather when the ground is frozen hard; or these organs fall in showers after a period of drought in a hot summer.

Now although the symptoms which preface and accompany the above cases of premature leaf-casting are in the main similar—the green leaves turn yellow, and then brown, and rapidly fall, shrivelling in heaps, to the ground below—the disease is a different one, and is caused by different agents in each instance, and it is even possible to obtain fairly obvious evidence of this. In those cases where the fall is due to the direct action of frost or of cutting cold winds—*i.e.*, where the leaves are killed by the sudden abstraction of heat from their tissues—keen observers have found that those basal parts of the "needles" which are enclosed in and protected by the sheathing-scales of the short branches ("tufts") may remain fresh for some time after the exposed parts have turned brown and shrivelled up. In the second class of cases, however, no such partial shrivelling of the leaves is seen; the tissues dry up all along the "needles" from tip to base completely, and this is because they have been killed by drought—either because the roots in the frozen soil cannot supply water to replace what is being transpired in the bright sunshine, or because the weather is so hot and dry that there is not enough water in the immediate environment at all.

Different as are the above causes of premature leaf-casting, there are still others, of which the following is the most prevalent and difficult to deal with. The leaves turn yellowish, with brown and purplish spots and patches on them, and fall in showers as before; but this time the disease is found to be epidemic in character. Towards the end of the summer numerous tiny black spots may be observed on the dying and dead leaves, and these are the spermogonia of a definite fungus (*Hysterium Pinastri*, one of the *Phacidiaceæ* of the Discomycetes). In wet seasons, or if the leaves be kept moist through the winter, the higher fructifications and asci may be obtained. Researches have shown that Göppert* was quite right, so long ago as 1852, in attributing this epidemic to the ravages of the mycelium of the above fungus: the hyphæ invade the leaf tissues during wet seasons, kill the cells, and so bring about the browning of the "needles." When large quantities of needles have been thus ruined, they suddenly fall in the showers which bring dismay to the forester and horticulturist, and give the name "shedding" (*Schütte* of the German foresters) to the disease.

These are not the only causes of premature leaf-casting in Conifers, but they are good examples of the commonest types, and I have brought them forward here to show you how very easy it is for anyone unacquainted with the facts to draw erroneous conclusions as to the causes of the phenomena; and it must be remembered that wrong conclusions—*i.e.*, wrong diagnoses—lead to improper treatment in plant-diseases, as they do in human diseases. The diseases of Conifers are, in fact, like the diseases of other living beings, cases of disturbances in the struggle for existence going on among the structural elements of the tissues, etc. The discussion is here confined to only two categories of these diseases—those due to fungi and those due to disturbing action of the inorganic environment:† the simplest plan will be to take some of the groups of Coniferæ *seriatim*, and touch briefly on their prominent maladies.

I. *The Pines.* Owing to their very resinous nature, the Pines generally are not so apt to suffer from injuries which result from the exposure of open wounds as are many other trees, and it is astonishing how much knocking about the hardy species will endure; breakages from wind, heavy snow, the cutting and biting of man and other animals, and so forth, are readily healed over by occlusion in the case of most of the species.

A very common cause of disease and death in Pines is the breaking of the ascending water-current from various actions of an unsuitable environment.

* "Verhandlungen des schlesischen Forstvereins," 1852, p. 67.

† Those diseases which are due to the injurious action of animals, especially insects, being treated of separately.

Speaking generally, the Pines require light, open, and well-drained soils, as deep as possible; and many aspects of disease in them are due to the non-fulfilment of these conditions. Unquestionably one of the worst of these dangers results from the clogging of the soil at the roots, whether due to wet clay, stagnant water, the covering up or hardening of the surface—*e.g.*, by means of pavements, etc.—or other processes.

The general course of events is much the same in all these cases. The primary cause of the injury is want of oxygen at the roots, for without due supply of that gas in the water to which the living and absorbing parts of the smallest root-fibrils have access the cells of the latter cannot do their work. That is to say, the roots are unable to take up water containing oxygen and mineral constituents in solution, at periods when the "evergreen" leaves are transpiring large quantities of vapour into the atmosphere. Consequently the young branches and tips of the tree may die off rapidly, and if the source of mischief is permanent the whole plant will die.

But the class of diseases due to "wet feet"—as it is often called—is even more complex than this. The persistent rotting of dead rootlets in a wet soil not only implies loss of root-power as above referred to; it also entails the direct consumption of oxygen and the fouling of the water by poisonous products of decomposition which diffuse through the dying tissues to higher ones which were still healthy, and might have sufficed to supply new rootlets, etc., had the state of undue moisture been merely temporary.

Moreover, the presence of excessive moisture and heavy wet soils prevent the necessary warming of the absorbing rootlets, and cases are not uncommon where the stiffness and moisture of a soil, though insufficient to cause the death of the absorbing cells by asphyxia—*i.e.*, the deprivation of free and dissolved oxygen—or by direct poisoning, are still so powerful in preventing the necessary rise of temperature which must take place before the absorbing living cells can obtain, and pass on, the proper supply of water which the losses from the aërial parts of the plant demand, and by means of which the minerals needed can alone be furnished, that symptoms of death by drought make their appearance, the leaves turn yellow and then brown, shrivel and fall, and the tree may even die.

I have already shown how a very similar state of affairs may be brought about when young Pines have their aërial parts exposed to dry air and hot sunshine at a time when the soil is frozen hard, and the roots are rendered inactive by the low temperature of the ground. The proper understanding of all these matters in detail requires considerable acquaintance with the microscopic anatomy and physiology of the plant, but anyone may readily grasp the main points concerned, and will see that preventive measures can only be put into action intelligently and with hopes of success if these points are apprehended.

Obviously young Pines in beds should not be exposed to powerful insolation at a time when their roots are in hard frozen soil as above described, and in those cases where such dangers are imminent a piece of gauze or other shelter will reduce the chances of disaster.

Equally obvious is it that suitable drainage operations may make all the difference to a locality not quite fitted for growing such plants, and I want to take this opportunity of insisting upon the very important fact—which applies to other plants as well as Conifers—that the operation of drainage does not consist in merely removing superfluous moisture; far more important is the pressing into the interstices of the drained soil of atmospheric oxygen, which does so much work of various kinds in the labyrinth of passages which it traverses, that a whole lecture would not nearly exhaust the treatment of this subject alone. Another extremely pertinent point in this connection is that the drained soil can be warmed by the sun's rays, or by the higher temperature of the air referred to, not only more easily, but also more equably.

Passing now to the diseases due to unsuitable conditions in the sub-aërial and atmospheric environment, the following points may be considered.

Pines, especially when the foliage is young, and still more particularly when the plants themselves are young, are apt to lose many leaves, and even to be killed, by undue chilling of the surfaces, cold dry winds being perhaps the most fatal agents in this country. I have already referred to that form of leaf-casting which is caused by this; but it is perhaps commoner to see parts of the tree only, in the case of the more tender Pines, with their foliage brown and shrivelled, than to have a general fall of the leaves.

A curious class of diseases, not common in the Pines, perhaps, but stated as occurring in *P. Strobus* and some others with thin cortex, are the various kinds of "rifts" *i.e.*, more or less vertical fissures which extend up and down the exposed trunks of trees facing the south-west. The particular kind of rift here referred to rarely, if ever, appears in trees grown in the open from their youth onwards, but is very apt to occur on the south-west aspect if older trees previously closed up and well sheltered are exposed by a cutting. I see no reasons for rejecting the explanation that such rifts are caused by the direct rays of the sun beating on the thin cortex when the air is at its highest temperature; whether the cells are killed directly by the sun's rays, or whether the damage is due to excessive evaporation of their water, is as yet not certain.

Of all the sub-aërial agents which damage Pines, however, none are perhaps more to be feared than the acid gases of our larger manufacturing towns. Sulphurous acid, hydrochloric acid, chlorine, coal-gas, and such-like chemicals are fatal to Pines even in very small quantities; and it is no doubt to these, rather than to the increased percentage of carbon dioxide, soot, or to the diminished light, that the foggy exhalations of large towns owe their enormous power for evil. Nor can we wonder at this when we reflect that many Pines are mountain species, growing normally in those purest of atmospheres which attract us for the very reason of their purity.

I now pass to the consideration of those diseases of Pines which are directly traced to the injurious action of fungi on or in their roots, stems, or leaves.

These fungi belong almost exclusively to the groups of parasitic Ascomycetes, Uredineæ, and Hymenomycetes. It is true that *Phytophthora omnivora* (one of the Peronosporeæ) attacks and destroys the seedlings of these and other Conifers; but the rule is that Conifers are exempt from diseases due to the Peronosporeæ, Ustilagineæ, Gymnoasceæ, or Gasteromycetes, and also from those caused by Bacteria (possibly with one exception*) and Myxomycetes.

* Vuillemin, "Sur une Bactériocécidie ou Tumeur Bacillaire du Pin d'Alep," *Comptes Rendus*, November 26th, 1888. It may also be remarked that the roots of certain Conifers may have hyphæ of *Gasteromycetes* attached to them, though, so far as I can discover, they do not induce diseased conditions in the tree

A complete list of the parasitic fungi which injure the Pines would carry us too far, and I must content myself with the following selection of them.

Some of the most mischievous are *Trametes radiciperda* (known also as *Fomes annosus*, *Polyporus annosus*, *Heterobasidion annosum*), *Tr. Pini*, *Polyporus mollis*, *P. vaporarius*, *P. Schweinitzii*, and *Agaricus melleus*.

These fungi, which are distinguished by technical characters the discussion of which must be passed over here, differ considerably in their mode of action and manner of inducing disease,* but they all agree generally in that they eventually destroy the timber of the trees, by dissolving and consuming the structural elements which compose it. Now since the timber of the Pine furnishes (1) the channels up which the water and nutritive materials have to pass from the roots to the leaves, and (2) the supporting columns by the strength of which the crown of foliage can alone be held aloft and exposed to the light and air, it follows that such destruction results in disease and death to the tree as a whole.

Trametes radiciperda, now known very thoroughly from the recent researches of Brefeld,† who also proposes to re-name it *Heterobasidion annosum* from the remarkable conidial forms which he has discovered, attacks the living roots of *Pinus sylvestris*, *P. Strobus* and others, sending its snow-white mycelium beneath the cortex, and travelling thence up the stem, to finally penetrate the wood by way of the cambium and medullary rays. The rotting of the wood rapidly follows, with symptoms so peculiar that the presence of this fungus can be concluded with certainty from them. Owing to the reddish discoloration of the timber which results, this disease has been termed the "red-rot," a name which involves confusion however, as several other similar diseases of timber cause such discolorations.

This disease is extremely difficult to eradicate, because the mycelium travels from root to root in the soil, and the spores are carried by subterranean animals from one place to another; moreover, the matter has become more complex since Brefeld discovered the second form of conidial spores. Of course the fructifications should be destroyed by burning, as also the dead and dying branches, stumps, etc. Hartig has found that moats, dug so as to cut off sound trees from infected ones, have been of service.

Agaricus melleus, though a less pronounced parasite, is not less destructive; the details of its action on the timber are different, and its mode of spreading from root to root in the soil, by means of its long, purple-black, cord-like mycelial strands, called *Rhizomorpha*, also differs. But the net results are much the same in both cases. Very tangible signs of the presence of *Agaricus melleus*, in the absence of the tawny yellow "toad-stools," are afforded by the copious outflow of resin from the diseased roots and base of the stem of the affected trees, and by the above rhizomorphs in the rotting wood and soil around.

Most of the *Polypori* mentioned are decidedly wound-fungi—that is to say, they only attack successfully those parts of the timber which are

* For a more detailed account of these matters *see* "Timber and some of its Diseases," by H. Marshall Ward, M.A., F.R.S. (Macmillan and Co.)

† "Untersuchungen aus dem Gesammtgebiete der Mykologie,' H. VIII. 1889, p. 154. *See* also R. Hartig, "Zersetzungserscheinungen des Holzes" (Berlin, 1878).

already dead and exposed to the air; their influence for evil should not be underrated on that account, however, for although they are saprophytes living on the wood, their entrance into the trunk and branches means more or less rapid hollowing of the heart-wood (thereby rendering the tree liable to be thrown by winds, etc.) and the gradual production of injurious substances which soak into the sound parts and pave the way for the advance of the destroying mycelium into living organs. Hence, though such fungi are saprophytes, strictly speaking, in their local action, they nevertheless act towards the whole tree — taken as a living individual — as parasites which may induce dangerous diseases.

Remedial measures are of course to be directed to the careful tending and covering of wounds, a mode of procedure which has long been carried out on various trees at Kew, and with decided success, I believe.

I have already spoken of *Hysterium Pinastri* as the cause of leaf-casting. *Herpotrichia nigra** causes a tiresome disease on *Pinus montana*, and also on the Spruce and Junipers at high altitudes. *Hysterium brachysporum* kills the leaves of the Weymouth Pine, and Farlow and Seymour† give a long list of American forms that will necessitate much careful investigation before we can determine which are truly parasitic and which merely saprophytic.

There is in Germany a disease of the Scots Pine known by a name which I may translate "Pine-twist." Its prominent symptoms are contortions and curved malformations of the tips of the leading shoots, caused by the invasion of a fungus known as *Caeoma pinitorquum*. The hyphæ of this parasite so torture the epidermal region of the young shoots that their growth in length is no longer equal on all sides; considerable deformity may result from the curvatures of the healthy parts about the dead infested regions, and even the death of the tips occurs in bad seasons—*i.e.*, seasons too wet for the Pine, but very agreeable to the fungus. In dry summers, however, the fungus-layers may die off, and the injured spots be occluded.

But of all the fungus diseases which affect Pines, none is more interesting, and few more disastrous, than the one induced by a form long known as *Peridermium*, and of which *P. Pini* is the best known. This makes its appearance on various Pines as bladder-like bags of spores protruding from the leaves or cortex, and springing from a mycelium which destroys the cell-tissues, and which may kill the upper parts of the tree by ringing its stem or branches.

As long ago as 1874, Wolff‡ showed that the form referred to is merely the æcidium stage of a uredinous fungus found on the leaves of certain species of Senecio, and known as *Coleosporium*. Further investigations partly confirmed and partly contradicted this conclusion, and led to the separation of species of *Peridermium* which invade the *cortex* and *branches* of the Pines (*e.g.*, *Pinus sylvestris*, *P. Strobus*, *P. Laricio*, *P. montana*, etc.) from others which infest the *leaves* of various species of Pinus.

The results are too lengthy to describe in detail here, but the gist of the matter may be put as follows.

* R. Hartig, "Allgemeine Forstliche und Jagd-Zeitung," January, 1888.

† "A Provisional Host-Index of the Fungi of the United States," Part III. 1891. pp. 160—166.

‡ "Bot. Zeitung," 1874.

The *Peridermium* (or *Æcidium*) *Pini* of authors comprises several distinct species:—

(1) *P. oblongisporium* on the leaves of *Pinus sylvestris* and *P. austriaca*, the æcidial stage of *Coleosporium Senecionis*.

(2) *P. Cornui* on the cortex of the Scots Pine, and which is the æcidial stage of *Cronartium Asclepiadeum*.

(3) *P. Strobi* on the cortex of *Pinus Strobus*, *P. Lambertiana* and *P. Cembra*, and which is the æcidial form of a *Cronartium* found on species of Ribes.*

(4) *P. Pini*, on the cortex of *Pinus sylvestris*, has nothing to do with *Coleosporium Senecionis*, and numerous attempts have in vain been made to settle what its Uredo-spore stage is, or on what host it grows; so that here again is a puzzle awaiting solution by those who have the opportunity.

Several other forms of *Peridermium* are known on various species of Pinus. The following have hitherto been included with the above under the common name *P. Pini*, but no one will now be so bold as to retain them until further investigations have decided as to their relationships. The forms in question occur on the cortex of *Pinus montana*, *P. maritima*, *P. halepensis*, *P. mitis*, *P. Tæda*, *P. ponderosa*, *P. rigida*, *P. radiata*, *P. Sabiniana*, *P. contorta*, and some other American Pines; as well as on the leaves of the Indian *P. longifolia* and of the American *P. palustris*.

The great damage done by the cortical forms of *Peridermium* is two-fold in character. In the first place the cortex and cambium are killed at the spot invaded, and this injury may go so far as to ring the stem or branch. Then in the second place, an abnormal formation and excretion of turpentine is excited, and this soaks into the wood and renders the passage of water upwards difficult or impossible. The natural consequence is the perishing of the parts above the infested places, and in dry summers such a result is apt to follow rapidly. Sections of Pine-stems, cut to 3—5 cm. thickness, thus permeated with turpentine, are semi-translucent; and, as has long been known to continental foresters, the abnormally resinous branches are excellent for torches, fuel, etc. With isolated Pines, in parks and gardens, etc., it is not difficult to eradicate the disease in its early stages by judicious pruning, and burning the infested parts; far greater difficulties, of course, are met with in the treatment of forests. This disease is likely to do much damage in nurseries, and I think you will admit that a strong case is made out in favour of the need for care and further observations as regards the weeds growing in the neighbourhood of all places where Pines are cultivated from seed.

II. *The Firs.* I take this group in the broadest sense, including in it the genera *Picea* (the Spruces), *Abies* (the Silver Firs), *Tsuga* (the Hemlock Firs), and *Pseudotsuga* (the Douglas Fir). Much that has been said of the Pines is also true of these predominantly mountain trees. I shall therefore pass at once to the description of the diseases due to fungi, merely remarking that those maladies traceable to unsuitable climate, soil, atmosphere, etc., are much as before.

Here, again, some of the most disastrous forms of disease are those due

* Sorauer has confirmed this quite recently, finding that the spores of *P. Strobi* develop into *Cronartium Ribicola* (Dietr.), on *Ribes rubrum*, *R. nigrum*, and *R. alpinum* ("Zeitschrift für Pflanzenkrankheiten," 1891, B. i. H. 3, p. 183).

to hymenomycetous fungi which rot the timber, such as *Agaricus melleus*, *Trametes radiciperda* and *T. Pini*, *Polyporus vaporarius*, *P. borealis*, *P. fulvus*, etc., and it is scarcely necessary to add anything to what was said of these when treating of the Pines. Again, also, it happens that, with the exception of *Phytophthora omnivora*, which destroys the seedlings of Spruces and Silver Firs, the disease-inducing fungi all belong to certain sections of the Hymenomycetes, Ascomycetes, and especially the Uredineæ.*

Undoubtedly one of the most extraordinary of all these forms is *Calyptospora Gœppertiana*, a uredinous fungus which alternates between the Silver Fir (*Abies pectinata*), on the leaves of which it develops an æcidial form long known as *Æcidium columnare*, and the Red Whortleberry (*Vaccinium Vitis-idæa*), a common under-shrub in the German Fir-forests, the stems and leaves of which it distorts and kills by means of the mycelium of its Uredo-form (known as *Calyptospora* or *Melampsora-Gœppertiana*).

Another remarkable case is that of the "Witches' brooms," very common in Europe, and by no means rare in this country. I have myself found these on *Abies Pinsapo*, as well as on *A. pectinata*, in Windsor Great Park. "Witches' brooms" are curiously tufted masses of twiggy branches which take their origin from parts of the stem attacked by the mycelium of *Æcidium elatinum*, the Uredo-form of which is as yet unknown, and possibly does not exist. The life-history was worked out very thoroughly by the late Professor de Bary.† The hyphæ so irritate the growing tissues of the young shoots that the latter gain enormously in diameter, and put forth numerous shoots which alter their whole character. Thus, instead of growing outwards in a nearly horizontal plane, they turn vertically upwards, and branch copiously in a fastigiate manner; then their leaves are smaller, and arranged in regular spirals around the erect twigs. These leaves are infested by the mycelium, and eventually bear the Æcidia, and fall prematurely. This mycelium is perennial in the cortex, cambium, and wood of the stems, and does much damage by stopping the leaders, and paving the way for rot-fungi. It happens not infrequently in this country that the mycelium simply sojourns in the stems, and does not lead to the full development of the "Witches' broom," but only causes tumour-like swellings of the axis. The treatment of infected trees resolves itself into careful pruning and removal of the monstrous organs. It would be well worth the time of some capable investigator to undertake further researches into the nature of this disease. This malady, by the way, has nothing to do with the "Witches' brooms" developed on Birches, Cherries, Hornbeams and other Dicotyledons which are due to the ravages of various species of *Exoascus*, curious ascomycetous fungi allied to the one that causes "Bladder-plums." Farlow has found *Æc. elatinum* on *Abies concolor*‡ and *A. balsamea*, and it will probably turn out to be more widely spread than has been hitherto suspected.

The Silver Firs suffer from a number of other Uredineæ, of which

* The general application of these remarks to Coniferæ as a whole may have to be modified when *Ustilago Fussii* (Niessl.) on species of Juniperus has been properly investigated.

† "Bot. Zeitung," 1867.

‡ "A Provisional Host-Index of the Fungi of the United States." Part III. 1891, pp. 158—170.

Cæoma Abietis pectinatæ is a form reminding us, by its habit and behaviour, of *Calyptospora Gœppertiana*.

The Spruces *(Picea)* are also apt to suffer much from Uredineæ, of which the genus *Chrysomyxa* is one of the most important. Several species of this fungus do considerable damage to the leaves, by causing them to fall prematurely—*e.g.*, *C. Abietis*,* *C. Rhododendri* and *C. Ledi*—the former being autœcious, and only occurring in the Teleuto-spore stage, so far as is known; the two latter being heterœcious, the Æcidia developing on the leaves of the Spruce, and the Uredo-forms on the leaves of *Rhododendron ferrugineum* and *R. hirsutum*, and on those of *Ledum palustre*. Farlow says that *C. Abietis* occurs on *Tsuga canadensis* which suggests the probability that this form again is more widely spread than has been supposed hitherto. Münter states that *Picea alba* is not affected by this disease. I quote from Sorauer,† and cannot speak from my own knowledge; but Farlow does not give this fungus on *P. alba*.

Spruces (and to a less extent Silver Firs and Pines) are often affected with a disease caused by an Ascomycete *(Nectria Cucurbitula)*, the hyphæ of which find their way through small wounds in the cortex, into the sieve-tubes, etc., of the phloem, and set up a struggle for existence, which is very interesting to the biologist, though it may be viewed with different feelings by the horticulturist. It appears that so long as the Fir is doing well, the parasite is confined to the resting parts of the phloem, and cannot make its way into the active cambial region, the living cells of which go on dividing and growing quite normally; if the attacked branch is particularly vigorous, the formation of a layer of cork may be accomplished, which cuts off all the diseased tissues, which then dry up and are thrown off.

It is a particularly instructive fact, however, that if the season is one unfavourable to the rapid and vigorous development of the cambium, or the tree generally, or if conditions exist in the soil or atmosphere which retard the vegetative activity of the cells, the mycelium of the *Nectria* is enabled to conquer the tissues of the cortex, and even to kill the cambium and penetrate into the young wood. If this happens all the parts above the attacked place are apt to dry up and die, evidently from the stoppage of the water currents up the stem; this very often occurs with thin watery twigs—so-called "unripened wood"—such as may be found in shaded situations, or in very damp summers.

From the dead cortex come the white conidial cushions, about as large as pin-heads, followed by the scarlet stromata with immersed ascogenous fructifications.

There are many other very interesting points about this disease; and as it is a type of an exceedingly important series of diseases very little understood in England, attention should be directed to some of the results.

While relying for the most part on the researches of Hartig‡ so far as this particular species is concerned, it is only right to say that the following conclusions are based on some experience of my own.

* Beautiful figures of this are to be found in Willkomm. "Die mikroskopischen Feinde des Waldes," 1867, Taf. IX. The text is now chiefly of historical interest.

† "Pflanzenkrankheiten," 2nd edit. 1886, Vol. II. p. 248.

‡ "Untersuchungen aus dem Forstlichen-Botanischen Institut zu Munchen," I. p. 88.

These *Nectrias*, though very common indeed, are usually found as decidedly saprophytic fungi, living in the dead wood and cortex of fallen branches, or the parts of trees killed by entirely different agencies—*e.g.*, frost, breakage, insect injuries, etc.—and experiments show that the germinal tubes developed from the spores are unable to penetrate the sound tissues of living branches. On the other hand, it is quite easy to infect a tree if the sound cortex be punctured with the point of a scalpel on which a few spores have been rubbed. The puncture kills a number of cells, and the hyphæ feed on the solution of food-materials thus formed; and it is only from a position of advantage like this that the mycelium, waxing in vigour day by day, is able to invade the tissues around, and gradually kill and destroy those that are not active enough to resist it. As already said, the mycelium may fail to do more than establish itself in the more worn-out portions of the inner cortex, and may then be cut out and cast off by layers of cork. There is considerable reason for believing that it makes all the difference to the fungus what kind of start it gets; if the mycelium is still young and feeble, the active tissues of the cortex may cut it out very soon, and the ordinary observer can find no trace of the invading fungus, or of disease: but if it starts in a bed of dead and dying cells capable of yielding it sufficient food-materials (the hyphæ can grow in a matrix flooded with turpentine) its rate of spread depends almost entirely on what resistance is offered by the vegetative activity of the cells around. Hartig found that the germinal hyphæ of *N. Cucurbitula* find entrance into Spruce Firs through the wounds caused by certain insects (especially *Grapholitha pactolana*), and also through such as are caused by the heavy blows of hailstones, which bruise and tear the tissues of young shoots. In the case of other *Nectrias*, which cause wounds on non-coniferous trees, I have convinced myself that ruptures caused by frost, mechanical injuries (*e.g.*, such as are produced by climbing trees to pluck fruit, etc.), pruning, etc., afford the opportunities of entrance to the fungi.

There is a deeper problem beneath all this, however, and that refers to the exact nature of the mutual actions and reactions between the hyphæ and the living cells of the host: all I can say here is that it is pretty clear that the hyphæ excrete some poison-like substance which the living cells of the cortex and cambium either break up and destroy, or merely resist the action of, so long as they are strong, well-fed, and vigorous. Once let such cells fall below a certain standard of health and activity, however, and the hyphæ make their way in and demolish all before them. Obviously the factors of the inorganic environments—soil, temperature, light, atmosphere, and so on—may determine the balance of events in this connection.

In conclusion, I may add that *Nectria Cucurbitula* is not uncommon in this country, where it is usually found on dead branches, and Farlow reports the occurrence of this species on *Pinus Strobus* in the United States, and of several other species on other North American Coniferæ.

The Douglas Fir has, so far, shown but few fungus diseases in this country and on the Continent, but since *Agaricus melleus* and *Trametes radiciperda* are among its enemies, it is not improbable that it may be found to suffer from maladies not found on it in (or at least not reported from) its native country. Farlow adds *Trametes Pini* to the list of its hymenomycetous enemies. So recently as 1888* Von Tubeuf discovered a disease on this Fir which may prove very troublesome in wet districts. The tips of the branches droop, and their leaves fall off, but remain hanging by means of a greyish mycelium, which holds them together as if attached to the tips by means of spiders' web. This mycelium gives rise to sporophores and sclerotia, which prove it to be a *Botrytis (B. Douglasii*, n. sp.), and if it turns out to be as destructive as some of its congeners *(e.g.*, the *Botrytis* of the Lily-disease†) foresters will certainly have to reckon very seriously with it. The damage is done by the mycelium penetrating between the cells of the leaves and young shoots, and killing the tissues forthwith. One source of danger is that this fungus can live as a saprophyte in the dead foliage, etc., on the ground, as well as parasitically in the living shoots; and that it develops very efficient resting organs known as sclerotia, which enable it to tide over unfavourable seasons.

It appears that this *Botrytis* has also been observed on the Larch, and on Silver and Spruce Firs. It is as yet too soon to attempt to decide as to the extent of the danger with which the fungus threatens us; we know very little, moreover, as yet, as to the capabilities of the Douglas Fir itself in this country. Perhaps the greatest damage so far done to it is by winds, but for my own part I feel that this Conifer is still too new to the British Islands‡ to be finally reported upon, and it is not surprising that we know as yet very little about its diseases. It is with the Firs as with the Pines, as regards the large number of diseases due to fungi: the American list is very long, and our own is by no means either short or exhausted.

The Hemlock Fir, Silver Fir and Spruce suffer in Germany from a leaf-fungus *(Trichosphæria parasitica)* which reminds one in many respects of some of our *Erysipheæ*. The seedlings of these and other Firs are destroyed by *Phytophthora omnivora* and by a *Pestalozzia* lately re-examined by Von Tubeuf. Almost as I write§ comes the announcement of another disease of the Spruce, said to be found "all over Germany," and due to the hitherto unsuspected parasitism of a *Septoria*, and so the work goes on.

III. *The Larches.* The European Larch is apt to suffer very much from combinations of circumstances in the environment, when planted in this country; and when one compares the conditions under which it is attempted to grow it with those prevailing in the natural home of this tree, the wonder is, surely, not that our Larches suffer, but rather that any of them escape. The European Larch is a native of the Alps and of the higher mountains of northern Europe, growing naturally at altitudes which ensure a pure atmosphere, brilliant sunlight, plenty of distributed moisture, and rapid drainage; in its mountain home it has a relatively long and thorough winter rest, from which, like Alpine plants generally, it rapidly awakens late in spring, and then makes vigorous growth through the brilliant and comparatively hot summer.

In this country the diseases of the Larch are almost all initiated by late frosts, damp soil, insufficient sunlight, and alternations of periods of drought

* "Beiträge zur Kenntniss der Baum-Krankheiten" (Berlin, 1888).
† Annals of Botany, Vol. II. 1888, "A Lily Disease."
‡ I am told that it was only introduced in 1826.
§ "Zeitschr. f. Pflanzenkrankh." B. i. H. 3, 1891, p. 179, *see* also B. i. H. 1, 1891, p. 47

with periods of excessive moisture, in various degrees of combination. Late frosts, or chills which approach such, are among the most deadly agents. The tender tufts of bright green foliage, to which the Larches owe their spring beauty, are usually forced out in this country from a month or six weeks too soon (as compared with what occurs in the Alps, etc.—and the succulent shoots and leaves are thus apt to suffer from the sudden oncoming of cold winds or frosts as they slowly drag along their precarious development. Once they get well over this early dilatory period of sprouting, all is safe; their safety is ensured in their mountain heights by (1) their not beginning to awake from the long winter rest till danger of frosts is practically over, and (2) by the extreme rapidity with which they run through the period of tenderness. Our damp climate, moreover, is calculated to bring it about that the roots of Larches, as of other Conifers, run risks not likely to be incurred in the rapidly drained soils of their Alpine homes. But the conditions referred to thus briefly are just those which favour certain enemies of the Larch at the very time that they are acting prejudicially to that tree itself.

I have great confidence, therefore, in the well-thought-out view, first put forward, I believe, by one of the most distinguished and able of modern investigators (Professor Robert Hartig, of Munich) that the appalling liability of the Larch to disease at low altitudes, and in climates which are too moist and variable during the spring and early summer, is due to the co-operation between the factors of the inorganic environment and the directly injurious action of its living enemies.

The Larch suffers severely from several fungus diseases—*Agaricus melleus*, *Trametes Pini*, *Polyporus sulphureus* and others being among them; but all other forms have sunk into insignificance beneath the overwhelming importance of *the* "Larch-disease," or "Larch-canker," due to the parasitism of a minute discomycetous fungus known variously as *Peziza Willkommii*, *Lachnella calycina*, *Dasyscypha calycina*, etc.*

The main facts† which are of importance to foresters are, that this *Peziza* develops from its spores a mycelium which, when once it has established a hold in the inner cortex of a branch of the Larch, can go on growing and extending into the cambium; this it kills, destroying a larger area year by year, and producing the so-called "canker" patch, which is simply a shrivelled mass of dead tissues impregnated with exuded turpentine or resin. If the dead patch extends all round the branch or stem, all the parts above may die off, partly because, the cambium being destroyed, there is no more wood developed at that region to carry up the water supplies to the leaves, and partly because the resin blocks up the wood which it permeates.

To understand how it is that the Larch-fungus spreads so rapidly and with such dire effect in Great Britain, it is necessary to note some peculiarities not always properly appreciated.

Peziza Willkommii, like other fungi, requires merely water, oxygen, and a suitable (not very high) temperature for the germination of its spores; given these, the germinal hyphæ are developed anywhere. The mere *germination* of a spore may, therefore, take place on any damp

* For the synonyms consult Phillips, "British Discomycetes," p. 241.

† An illustrated detailed account of this and similar diseases is given in "Timber and some of its Diseases" (Macmillan and Co.).

surface exposed to the air—*e.g.*, the soil, the bark of old trees, or the thin cortex and leaves of the twigs and young trees, etc. But millions of spores may go through this process of *germination*, and then the germinal hyphæ die off for want of further food-supplies; whereas if any one of these hyphæ finds its way into the succulent cortex of a Larch, it is nourished at the expense of the tissues, spreads into the cambium, and brings about the disease referred to as the "canker of the Larch." As a matter of experiment—and only by experiment can we arrive at such knowledge—it is found that if spores of this fungus germinate on the sound bark, cortex, leaf, or other part of the Larch-tree, the germinal hyphæ fail to effect an entrance; if, on the other hand, the spores are sown on a wound, however slight, in the cortex of the tree, it is able to enter and infect the latter.

Now the thin cortical covering of a young Larch stem or branch is a dangerously tender envelope to the tissues below, and it is rapidly protected later on by a rather thick coating of cork. As a matter of fact the corky "periderm" begins to form, just below the epidermis, before the end of the first year, and is increased every year afterwards. When the tree is about twenty years old the real bark begins to be formed, owing to the development of internal layers of cork. Obviously the period most dangerous to the Larch is that during which its cortex is still tender and its leaves succulent and delicate. In its Alpine home this period is rapidly passed through; in the lowlands of Europe and in damp insular climates this period is apt to be a dilatory one, and severe checks from frosts, cold winds, periods of dull, misty, "sunless" days, etc., are apt to cause the trees to suffer in all kinds of ways. But such periods are not calculated to check the spread of fungus-spores to any comparable extent; and so we may regard these conditions as disfavouring the Larch, but not its enemy. Moreover, such conditions indirectly *favour* the fungus, for the tender shoots and young leaves of the Larch are apt to be cut by frosts, bruised and torn by winds, broken by snow, and injured in various ways by the inclemency of weather which would not injure them before the buds opened, or after the twigs and leaves were hardened and in full working order. In fact, if we could persuade our Larches to remain dormant for a month later in the spring, they would escape the evils of which they now run the gauntlet, as it were.

It is during this period of dalliance in the opening of the buds and pushing of the young shoots that all kinds of small wounds are made by frost-cracks, bruises from hail and wind, breakages from the snow and storms, and, I believe, insect-injuries, and it is into these small wounds that the hyphæ of the *Peziza* penetrate. This view is fully borne out by the observations in the open that the young "cankers" commonly start around the base of a dead shoot; that trees growing in damp situations are particularly apt to suffer; the prevalence of the disease is greatest in neighbourhoods and seasons where and when certain insect-enemies of the Larch abound (*e.g.*, the moth *Coleophora laricella*, and the aphis *Chermes Laricis*).

In the case of park trees, and such specimens as horticulturists are dealing with, much may be done by careful pruning and paring, combined with drainage and protection; but unquestionably this Larch-disease is a difficult matter to struggle with when once it has made headway. The best "cure" is, of course, prevention—*i.e.*, plant sound trees, learn to recognise the earliest stages of the disease, and if it appear cut out the young patches and burn every trace of diseased cortex.

A subterranean fungus known as *Rhizina undulata* has lately been found to be very destructive to young Larches, Silver Firs, and other Conifers (*e.g.*, *Tsuga Mertensiana*, *Pseudotsuga Douglasii*, *Picea sitchensis*, and *Pinus Strobus*). It seems to belong or be related to the Pezizas. An obscure group of fungi known as *Rhizoctonia* also still need careful investigation.*

It will probably be observed that I have followed no very strict classification of the Conifers in this paper, but have simply chosen groups convenient for the purpose in hand. I propose to take the remainder of the Conifers in equally arbitrary groups, and first of all certain of the Cupressineae.

IV. *The Junipers.* The most remarkable diseases of the Junipers are those due to various species of a uredinous fungus known as *Gymnosporangium*, the hyphae of which so irritate the cambial region of the stems of these Conifers (in which the mycelium is perennial) that peculiar woody swellings are produced, sometimes in such quantities as to distort, and even kill, the stems. From these swollen parts of the branches the Teleuto-spores are produced in enormous quantities during the spring, and some most remarkable facts have been elucidated by the researches of recent years—facts which show that there is still much to be done before we have exhausted the biology of these disease-inducing fungi.

It has long been known that these *Gymnosporangia*, confined to the various species of Juniperus, are merely the Teleuto-spore condition of forms which when growing on certain species of Rosaceae—*e.g.*, Pear, Hawthorn, Mountain Ash, Service-tree, etc.—present a totally different appearance; these aecidial forms on the Rosaceae received the name of *Roestelia*.

A number of careful experiments have been made in this country by Mr. Plowright, one of the best authorities in England on the Uredineae, and he came to the conclusion that about four species of *Gymnosporangium* may be upheld as far as this country is concerned. These species occur on *J. Sabina* and the pear; *J. Sabina* and the Hawthorn and others; *J. communis* and Hawthorn, etc.; and *J. communis* and the Mountain Ash.†

The results of such infection-experiments from various sides were to arouse suspicions as to the autonomy of some of the species, though some of the main points were confirmed by all. Credit is due to Mr. Plowright for establishing the converse culture of the Aecidio-spores on the Juniper, in the case of *G. clavariaeforme*.

Recent experiments have raised the whole question of the species of *Gymnosporangia* again, and I mention this here because it seems to me of importance that the question should be settled, as it affects the cultivation of Pears, Apples, Hawthorns, and other Rosaceae as well as Junipers and other Conifers.

Tubeuf says that if *G. clavariaeforme* is sown on Crataegus, it produces *Roestelia cornuta*. On the Mountain Ash and on *Cydonia vulgaris* it only goes so far as to produce spermogonia. On other hosts it grows

* "Sitzungsbericht des Botanischen Vereins in München," Jan. 12th, 1891.

† "British Uredineae and Ustilagineae," p. 233.

and infects the leaves but does not get beyond the production of yellow lumps.

Whether further researches show that these results are confirmed or not, it is now certain that we have in these forms of *Gymnosporangium* and *Rœstelia* parasitic fungi which are highly polymorphic,* and a number of specialised races or varieties are heterœcious between Cupressineæ and Rosaceæ (as many other "Rust-fungi" are between Gramineæ and dicotyledonous plants), causing diseases of the cortex and wood of the one, and of the leaves in the other. Obviously it is advisable to take these facts into account where it is wished to grow either of these classes of plants in the best way.

V. *Other Conifers.—Conclusion.* *Agaricus melleus* is recorded by Farlow as occurring on *Chamæcyparis sphæroidea (Cupressus thyoides)* and the same authority mentions *Botrytis vulgaris* on Sequoia; whether these are parasitic, I do not know, and in fact the whole of the very long list of American Conifer-fungi wants careful overhauling before we can decide as to their share in producing diseases. I have found the roots of Wellingtonia badly infested with mycelium which seems to be that of a Hymenomycete; and Araucarias occasionally suffer from similar forms.

The Yew seems to be very little affected with fungi; at least I can recall no satisfactory case of fungus disease in this Taxad.

Little or nothing seems to be known of the diseases of Cryptomeria, Taxodium, Cephalotaxus, Gingko (Salisburia), or Podocarpus and other allies; and I know of no records of specific diseases of the Cedars. Two species of *Cladosporium* are said to injure Pines, and Hoffmann† attributes the "Witches' brooms" of the Scots Pine to these Pyrenomycetes. Several Æcidia are known to grow on the scales of various cones (*e.g.*, *Æ. Strobilinum*, *Æ. conorum*), and there is a curious form in Finland and Sweden (*Æ. coruscans*) which so alters the aspect of young Spruce-shoots that they resemble cones.‡

Several Conifers, especially the Pines, are known to have subterranean fungi at their roots, but apart from any symptoms of disease. The fungus causes the attacked root to swell and alter its form, and the symbiotic compound body is called a *Mycorrhiza*. These curious phenomena lie outside of my present theme, however, as also do the no less remarkable abnormal-looking outgrowths—so-called "knees"—from the roots of *Taxodium distichum*, and the nodules caused by fungi on the roots of Podocarpus.

More to the point at present are the cases of "sooty-leaves" of *Araucaria excelsa* and the Yews, due to the black mycelium of species of *Capnodium*, and those of the Silver Fir, due to *Apiosporium*. It has been suggested that *Septoria Pinii* occurring on the leaves of *Picea excelsa* may be the spermogonia of the *Hysterium (Lophodermium) nervisequum* found on that plant. An observation of Farlow's in 1884,§ that certain Æcidia on the Firs of the White Mountains only occur on the dwarfed trees at great elevations, seems deserving of further examination.

* I purposely omit discussion here of such points as Kienitz-Gerloff's discovery of alleged Uredo-spores among the Teleuto-spores of these fungi.

† "Allgemeine Forstliche und Jagd-Zeitung," 1871, p. 236.

‡ Not to be confounded with the cone-like deformations on the same plant due to insects (*Chermes viridis*).

§ "Appalachia," Vol. III. part 3, Jan. 1884, quoted by Sorauer, p. 219.

A *Cucurbitaria (C. pithyophila)*, reported as occurring on the cortex of living and dead branches of Coniferæ, also requires investigation. The same remark applies to Cooke's *Asterina cupressina* on leaves of Cupressus, and to Saccardo's *Meliola Abietis* on Abies, Ellis's *Coryneum juniperinum* on leaves of American Junipers, Cooke's *Dothidea halepensis* on Pines and *D. sphæroidea* on Junipers, and the *Pleospora laricina* of Rehm; also a large number of as yet very obscure forms, such as *Sphærella*, *Stigmatea*, etc., etc.

With regard to a large number of these forms, and to even more numerous foreign forms, we are as yet quite in the dark as to whether they are parasites or not.

Experience warns us, however, that in many cases, epidemic fungus-diseases suddenly force themselves on our attention owing to some form, hitherto occurring sparsely and known only to the curious expert, having become suddenly favoured in its struggle for existence. I have already given you several examples, notably that of the Larch-disease, into the life-struggles of which we have succeeded in peering rather deeply. Surely such considerations should alone suffice to extend and cement that sympathy between the practical horticulturist and the persistent, though perhaps unobtrusive, investigator which, I am happy to see, is becoming more and more pronounced as each understands better the ways and high aims of the other.

It should be borne in mind, finally, that plant-diseases, like human diseases, cannot be fully elucidated by a layman—though it is astonishing how frequently the contrary assumption is acted upon in the case of both. There seems to be a fatal temptation in the idea of disease to the minds of most men, and the consequence is quackery or even disaster.

INSECTS INJURIOUS TO CONIFERÆ.*

By Mr. W. F. H. Blandford, M.A., F.Z.S.

Of all families of trees, the Conifers suffer most severely from the attacks of insects, owing to the large number of species which they support, and to the difficulty which, on account of their physiological characteristics, they have in withstanding injury. The wide area over which forests of these trees extend increases the danger of insect-attacks in accordance with a well-known law which holds with injurious insects, and it is among Conifers alone among trees, and among the forest species of Pine, Fir and Larch that have happened those repeated instances of widespread destruction over large forest areas which, occurring even before economic forestry began to change the character of the primitive mixed woods, probably increased in number and severity at that epoch, and have continued at intervals to the present day.

* Abridged from the Report of the Conifer Conference by permission of the Council of the Royal Horticultural Society.

The immense importance of the destruction caused by these attacks has given an impetus to the study of forest insects on the Continent, and a not inconsiderable mass of literature has sprung up. In this the foremost place must be given to the works of Ratzeburg. Besides Ratzeburg and his pupils and successors in Germany, Perris in France, Lindeman in Russia, and Packard in the United States have especially contributed to our knowledge of Conifer-feeding insects. In Great Britain less has been done to advance our knowledge of them, perhaps because owing to geographical position and climate its insect population is comparatively small, and serious damage fortunately rare. There are many papers scattered through British journals of entomology and sylviculture on those six or seven species of insects which have done serious injury to Conifers, but there is a deficiency of information with regard to the less important kinds.

In the large number of insects feeding on these trees only a few are of habitual importance, but exceptional abundance of a normally unimportant species will bring about unexpected damage. This sometimes occurs in Great Britain, and one may hear complaints of damage which is not assignable to any of the regular destroyers, but which cannot be identified in the absence of specimens. It is about these casually destructive species that we require to know more.

The special liability of some Conifers (Pinus, Picea, Abies, Larix) to injury by insects, and the important character of such injury, are due to the following facts:—

1. There is a large number of insects which attack them. Kaltenbach enumerates 299 on the forest Conifers in Europe. This number falls, indeed, far short of the 537 assigned to the Oak, but neither list can be taken as strictly accurate.

2. Every part of the tree is liable to energetic attacks from one insect or another—the roots, the bark of the trunk and branches, the wood, needles, shoots, and lastly the cones, the seed-production of which may be greatly lessened by insects feeding in their interior.

3. A common form of injury, especially on the Continent, is defoliation. Now complete defoliation of a Conifer, other than the Larch, usually means the death of the tree, because of the slowness with which the injury is repaired. If an Oak is stripped, it grows a new crop of leaves late in the year, provided that the defoliation is sufficiently complete and sufficiently early; but if a Spruce or Pine be stripped and survive, not only are no further needles produced the same year, but next year's growth may be delayed a month, and the new needles are stunted and form the curious "bristle-needles" figured by Ratzeburg. The tree will take four or five years to recover its normal covering of needles, and with them its normal process of growth: so that during that period the total increment will only equal, or may even be less than, that of a single ordinary season.

4. Defoliation renders a tree liable to the attacks of other insects, especially of the much-dreaded bark-beetles, which have so often completed the havoc begun in European forests by hordes of caterpillars. Damage by storm, snowfall, frost, or by forest fires or caterpillar-defoliation, together with careless forestry and the slovenly accumulation of loppings, felled timber and unbarked logs, serve to foster the development of such insects till serious injury is risked. The thin-barked Spruce suffers more than the Pine, and it was the forests of this tree that were so terribly ravaged by bark-beetles in the Harz Mountains during the last century. Except the Pine-beetle (*Myelophilus piniperda*), no bark-beetles cause extensive damage in Great Britain; still many injurious kinds do occur which might cause trouble if the circumstances which favour them be disregarded through over-confidence in their supposed innocuousness. Every forest tree cannot possibly be in a perpetual state of robust health, and there is one period when every tree is liable to insect-attacks—after transplantation.

5. Not a few insects feed during some part of their lives on or in the young shoots of Conifers, in the leader or the extremities of the lateral branches. When the leader perishes the upward growth is checked until one or more branches of the top whorl twist round to supply its place. So lateral branches are destroyed or have their growth stopped, and the tree becomes altered in shape and appearance. Such mutilated Pines abound in almost all woods in the South of England.

6. The practice of growing large pure woods of Conifers of uniform age tends especially to widespread ravages. Most Conifer-feeding insects will not touch deciduous trees, and many are confined to a single species of Conifer. Others, again, limit their attacks almost completely to a single period in the life of a tree. *Hylobius abietis* is very destructive to trees under seven years old, comparatively harmless to those of ten or more years. In a pure wood, the conditions favourable to increase of an insect pest exist over the whole area at once, and there is no limit to the supply of food, the facilities for egg-laying or for migration to fresh districts from the part infected.

Wireworms. Seedling Conifers, if the nursery be placed in a well-chosen situation, secure from the inroads of *Hylobius abietis*, are usually exempt from the attacks of special Conifer-feeding insects. Their chief enemies are the polyphagous wireworms, the larvæ of the "click-beetles," and the grubs of the cockchafer. Wireworms occasionally do much harm in ground newly broken for nursery purposes. The damage lessens when the ground has been cultivated for some time, for the destruction during the first year or two is due to wire-worms which, having sprung from eggs laid before the bed was formed, exist already in the soil. When trees are actually growing there the parent beetles lay eggs less readily or not at all, and thus the bed is gradually cleansed. When very young Conifers are attacked they are gnawed completely through just above the roots, and such cut plants sometimes strew the bed. Seeds are also destroyed before germination.

It is desirable to examine the ground selected for the nursery, and to reject the plot if it appears badly infested, or to cleanse it thoroughly before planting. As the acreage required is small, there should be no difficulty in doing this by methods known and practised in agriculture, such as paring off and burning two inches of the top-soil early in the autumn, or dressing with gas-lime, chloride of lime, or ammoniacal waste, and leaving it fallow till the effect of the poison has worn off. Fallow land kept clean and free from weeds during the period of egg-laying in June will have comparatively few wireworms, but in the absence of better food these probably feed on humus, especially when young.

If seedlings are actually attacked, hand-picking is a good remedy when facilitated by the use of potatoes, carrots or sliced mangold, laid on the ground as a bait and regularly visited. A dressing of rape-cake or mustard-cake, popular in hop-growing, may be tried, but the value of it under these circumstances remains to be proved. Serious injury from wireworm is unlikely to extend beyond the first year of growth.

Pine-weevil. The worst enemy to young Conifers, either in a badly situated nursery or after planting-out, is the large clumsy Pine-weevil, *Hylobius abietis*, a blackish brown beetle of convex shape, with coarsely sculptured elytra sparsely decked with patches of yellow hair. The weevils lay their eggs in spring and early summer, in dead but not dry Pine or Spruce-wood, choosing especially the cut stumps of recently-felled trees; also unbarked logs and the lower part of the stems of dead standing trees. Under the bark the grubs gnaw irregular galleries in the sapwood, changing at the ending of these to pupæ. Like the grubs of all weevils, they require shelter, and will not feed exposed to daylight on loose brushwood, etc. They will, however, flourish in the closely packed sawdust of a saw-pit, which will serve excellently as a focus of infection. The duration of larval life is very variable, and depends on the climate and the season. As a rule, if the eggs are laid in the spring of one year the imagos make their appearance in the summer and autumn of the year following, live through the winter and lay their eggs in the spring; or they may appear in the spring and live through the following winter after egg-laying. In any case the life of the perfect beetle lasts a year or thereabouts, and does not, as is the case with most insects, finish at the period of egg-laying. No injury whatever to growing plants of any value is done by the feeding of the grubs: it is entirely the work of the perfect beetles, which proceed on foot to young trees, preferring Pine, but also attacking Spruce, Larch, Cypress, etc., and occasionally Oak and deciduous trees when pressed by hunger.

The insects can fly, but hardly ever do so, except at pairing-time. They, therefore, frequent the neighbourhood of their breeding-places, and judicious selection of the site for a nursery away from such localities where the insect breeds will keep the trees free until they are planted out. The beetles ascend the young trees and feed on the bark of the shoots and smaller branches, gnawing out circular holes with shelving sides, which may reach the sapwood. In bad attacks these holes are placed so closely as to coalesce, and thus patches of bark are completely destroyed, the branches or the entire tree being killed. Flow of sap and of resin follows the injury, the latter being often very conspicuous. The trees chosen are usually from three to six years old, but younger ones are not rejected, and those up to fifteen years are sometimes attacked. Specimens can commonly be taken upon still older trees, and they will probably attack any tree the lower branches of which are not more than seven feet from the ground, above which height they do not ascend. They cannot injure old bark, and the damage done to trees above ten years old is usually insignificant.

The preventive treatment of this insect consists in keeping the ground as free as possible from unbarked logs and trunks, heaps of rubbish and of sawdust, and in preventing egg-laying in the stumps of recently-felled areas. This is done by barking the exposed parts of stumps, earthing them over and beating down the earth, or by washing them with an arsenical wash either of sodium arsenate, Paris-green, or London-purple. Young plants can be protected by surrounding the base of the stem with dry earth beaten flat with the spade, or with gas-lime or similar compounds, or by "grease-banding" the base of the stem, and in the case of Spruce, by planting with them a few Pines, which will be attacked in preference. If the area planted is clean, beetles can be prevented from entering it from outside by surrounding it with dry trenches with vertical sides about a foot deep. Into these they drop, and can be collected in large numbers, especially if brushwood be placed at the bottom.

Pissodes. Two insects which somewhat resemble *Hylobius abietis* deserve passing mention: these are the beetles of the genus *Pissodes*, *P. pini* and *P. notatus*. Both occur chiefly in the North of England and Scotland; but *P. notatus* is likely to occur in any artificially-formed Pine plantation if the young trees have been imported from a locality which it frequents. Neither species is very common, but *P. notatus* at least has been reported as injurious in Scotland. The weevils are smaller than *Hylobius abietis*, more variegated in colour, and the thighs are not toothed. They lay their eggs on Pine trunks, and the larvæ feed under the bark where they hollow out pupal chambers. *P. notatus* attacks young trees from three to six years old, *P. pini* older trees. The injury caused by both is to be met by careful removal of attacked trees and others which, being sickly, are liable to cause attack, and by selecting sites for nurseries so that the trees shall enjoy good general health. They do most mischief to Pines planted in unfavourable situations.

Pine-sawfly. As the trees grow up they suffer less from *Hylobius abietis*, but new enemies arise, especially defoliating larvæ. In Great Britain, the most important of these are the Pine-sawflies, *Lophyrus pini* and other species of similar habits. The females in late spring cut a longitudinal slit in a Pine-needle and lay in it from ten to twenty eggs, repeating the process on the adjoining needles till about 120 eggs have been deposited. The larvæ hatch in a fortnight or rather more, and live together in small companies on Pine-shoots, feeding on the needles, from the midribs of which they strip away the sides. They fortunately confine their attacks to the older needles, and not to the young ones of the first year. Towards the end of their two months' life they devour the needles completely, disregarding the mid-rib. They are caterpillar-like, with twenty-two legs, and are somewhat variable in colour, being usually lighter or darker green, darker along the back, with a blackish head and a lateral series of black spots. After five or six moults each larva makes a very small oval cocoon of leathery texture in rubbish at the foot of the tree, or in moss, etc., under the surface of the layer of needles on the ground. In warm countries, and with us in warm seasons, a second brood of flies appear from these cocoons in August and September, and in the autumn their larvæ feed up very largely on the needles of that year, which are then suitable for food, and remain in shelter throughout the winter in their cocoons, not actually changing to pupæ till about three weeks before the flight-time. The winter period is always passed in the cocoon by the summer larvæ if there is no autumn brood.

The larvæ can be destroyed by shaking them down on to cloths and there killing them, or they may be crushed *in situ*, by grasping them with a gloved hand or a wad of tow, or with a metal implement like a pair of scissors, with two large flat blades meeting face to face. They can also be killed by spraying with a solution of hellebore, or sprinkling it on as a powder; but better results would be got by the use of paris-green, as for fruit trees. The objections to the use of arsenic on fruit trees do not apply here, except when there is risk of injury to game.

The pupæ of *Lophyrus* can be destroyed by raking up the brushwood and upper layer of needles under the infected trees in the winter with the contained cocoons, and conveying the heap to a spot where it may be safely burned. A very serious objection to this plan is that it deprives the soil of its natural surface-covering of needles, and if persisted in for a long time it will injure the health of the trees. It should not be resorted to without good cause, and when other remedies cannot be adopted. The removal of brushwood, etc., as opposed to this covering of needles, is always valuable for the prevention of insects.

Larch-miner. A special form of injury is that inflicted on Larch-needles by the larvæ of a tiny moth, *Coleophora laricella*, which lays its eggs at the end of June on the needles of the lower branches of Larches about ten to fourteen years old. The caterpillar mines into and feeds upon the interior of the needle, which becomes dry, yellow and twisted; it then bites off the tip and detaches the needle about its middle so as to form a tube in which it lives and passes the winter, concealed in a crack or under a bark-scale. In the spring it feeds on the new needles, and enlarges its tube by spinning a fresh needle along its side, biting it off and hollowing out the adjacent surfaces; in this tube it changes to a pupa, and ultimately to a moth. This insect is common in many English Larch plantations, whose foliage when the attack is bad has a dull withered look which is very conspicuous; it does not kill the tree, but keeps it year after year in an unhealthy condition.

Practical treatment is difficult: picking off the injured shoots is very troublesome, and the only successful plan is to remove badly-attacked trees, and burn the foliage before the moth flies in June. It is best prevented by growing Larch in a suitable mixture, and not in pure woods. Special importance attaches to this and other Larch-feeding insects because the wounds which they make probably serve as a *nidus* for the spores of Larch-canker.

Pine-shoot Moths. The insects which cause destruction to the shoots of Pines are chiefly the caterpillars of the genus *Retinia* and the beetle

Myelophilus (Hylesinus, Hylurgus) piniperda. The *Retinias* are small moths belonging to the group *Tortricina* (Leaf-rollers), of oblong form, reddish brown or grey in colour with somewhat elaborate markings of paler streaks and bands, assimilating in tint to the colour of Pine-bark of different shades, a feature specially characterising Conifer-feeding moths. By far the most important species in Great Britain is *Retinia buoliana*, though the scarcer *R. turionella* has got more credit as an injurious species; it is equally destructive in habits. *R. buoliana* appears at the beginning of July, *R. turionella* some three weeks earlier.

Both moths lay their eggs singly on young Pines at the base of the buds of the terminal shoot or lateral branches; into these the caterpillars bore, hollowing out the centre bud, and then attacking the lateral buds in the same way so as to destroy the whole or part of the terminal whorl. The larvæ live in the shoots through the winter, and pupate there in the spring. Their presence is easily recognised by the altered and stunted shoots which have failed to grow, and break off at a touch, as well as by the flow of resin caused by the feeding. The effect on the tree of the loss of the terminal shoot has been already mentioned; the lateral branches injured by *R. buoliana* subsequently grow twisted, and take on a characteristic curved "post-horn" shape which lasts for many years after the injury.

These insects suffer, fortunately, from the attacks of many parasitic enemies, for practical treatment has met with little success. The infested shoots have been persistently cut off and burned for many years in succession without real benefit resulting: this treatment is only applicable to small isolated areas, and should be tried during the month before the appearance of the moths. Egg-laying takes place in the evening, and it is sometimes worth remembering that the moths can be kept off small patches of trees which it is important to preserve by lighting weed-fires to windward, so that the smoke will drift over. This is not capable of extended application, but may be employed to protect ornamental trees which sometimes suffer severely in the neighbourhood of large Pine woods. These insects are most troublesome when trees are crowded together, neglected, and grown on unsuitable soil, and, as is usually the case, when the wood is not mixed.

Pine-beetle. *Myelophilus (Hylurgus) piniperda* is, next to *Hylobius abietis*, the most injurious insect to Pines in Great Britain, over the greater part of which it is very abundant. There are, however, many districts where it does not occur, or has not been observed, but almost any Pine-wood will yield evidence of its presence to a careful searcher. It is a small oblong brown beetle of the family *Scolytidæ*, or Bark-beetles.

The female, about the beginning of April, chooses a tree for oviposition. Those selected are newly dead or dying Pines, especially freshly felled timber, unbarked logs and stumps, or trees injured by storms, snow, or fire. Occasionally the beetle makes use of Spruce and Larch. She commences boring under a projecting scale, where the bark is thick, often on the under side of a fallen trunk, if it is free from the ground, and excavates a gallery in the bast running, with the exception of the entrance which is oblique, along the axis of the trunk. It is from three to four and a-half inches long, and takes from three to five weeks to construct.

The eggs, which may reach 120 in number, are placed in small hollows excavated alternately along its two sides. They hatch in a few days, and the larvæ begin to construct lateral galleries at right angles to that of the mother. The larval galleries are at first small, but increase in size with the growth of their inmates and soon take an irregular course. The larvæ, when full grown, change to pupæ in a small cavity hollowed out in the bark at the end of the burrow and appear as perfect beetles in June or July, emerging from the tree by eating out a circular exit-hole from the pupal chamber. Those which hatch from the first-laid eggs are considerably in advance of the grubs coming from eggs laid at the end of the five weeks' task of the mother, whose dead body can be found at the end of the burrow. The borings of the parents are not at first conspicuous, but can be detected later by the dust thrown out from between the scales of bark, whereas the holes made by the exit of the beetles, which are in no way concealed, at once indicate that they have bred in the trunk. The special form of injury done to Pines consists in the boring of the mature beetle into the young shoots for feeding purposes. This is effected by making a lateral hole in the shoot at a distance varying from one to five inches below its tip. This hole becomes marked with a circular ring or collar of exuding resin, and from it there is bored a burrow for about an inch up the pith of the shoot, which is killed, or, if the burrow is only partially completed, crippled. These shoots break off readily above or through the entrance hole, and strew the ground after a high wind. Their loss, repeated year after year, produces a striking change in the appearance of the tree, which loses its compact crown and becomes "stag-headed," the foliage being thin and scanty, and dead branches sticking out. It is also liable to the attacks of other insects, and to fungoid diseases.

It is to be noted that *Myelophilus piniperda* never breeds in the shoots where it feeds, and certain cases recorded where it is supposed to have done so are due to a confusion between its larvæ and those of *Retinia*, or of certain other beetles (*Ernobius*, etc.).

Spruce-gall Aphis. A peculiar form of injury is that caused by the sucking of the two kinds of *Chermes*—the Spruce-gall aphis, *C. abietis*, and the Larch aphis, *C. laricis*.

On the Spruce the *Chermes* appear in the spring as short, oval, wingless insects of an ochreous colour, furnished with a bristle-like rostrum. They have passed the winter in crevices and under bark scales, and early in April attach themselves each to the base of a young leaf, which reacts by a small swelling. These forms are parthenogenetic females, the foundresses of the colony, and lay a mass of eggs at the spot (generally at the junction of two branches) to which they attach themselves. The larvæ hatching, penetrate the surrounding parts of the shoot with their beaks; the shoot swells as do the bases of the needles, and a growth commonly known as a "Pine-apple gall" or "Spruce-gall" results. This gall somewhat resembles a small Fir-cone about an inch long, with the surface divided into small convex areas, each bearing a short needle-like projection in the middle; these are deformed needles which, becoming swollen, touch each other on the outside of the gall, but which are separate inside, so that the gall contains a series of cavities or chambers. In these cavities the larvæ live in numbers, either entering the chambers during the growth of the gall, or being enclosed by the swelling of the surrounding needles.

The galls sometimes completely surround the base of the shoot, sometimes they are only developed on one side. The larvæ are closely packed in the chambers, from twenty to fifty being found in each one. When they are fully grown in August they acquire wings and leave the chambers by apertures left by the shrinking apart of the leaves. These insects are winged females, and their special function is that of spreading the species on to other trees. The effect of the galls on the tree is to cause crippling of the attacked shoot, and when they are abundant the general growth of the tree is much impaired.

Larch-bug. The females of *Chermes laricis*, which also pass the winter under bark, etc., appear in the spring like those of *C. abietis*; they also are wingless, oval, of small shape, and of a purplish black colour, and have a long bristle-like sucker with which they penetrate the needles to feed on their sap. Towards the end of April they lay forty to fifty eggs on the twigs. The young produced scatter themselves over the needles, and do not live enclosed in a gall; at first very minute and blackish, they grow rapidly and become covered with a whitish woolly down exuding from pores on their body, giving the trees the appearance of being covered with minute scattered snow-crystals. About June they acquire wings and spread the species, while further broods are produced till the autumn. This insect occurs on Larches of all ages, being found, perhaps, most frequently on trees of ten to twenty years old; it not infrequently affects young Larches in nurseries, and may there be very troublesome.

Wood-wasps. There are many insects which take possession of the dead or dying tree to lay their eggs therein whose larvæ burrow into and penetrate the wood, making it useless for commercial purposes. Of these the most important are the wood-wasps, *Sirex gigas* and *juvencus*, large Hymenoptera of elongate shape. *S. gigas* is yellow-and- black, and of a decided wasp-like appearance, while *S. juvencus* is deep blue, with the middle segments of the abdomen reddish in the male.

These insects appear to be somewhat widely distributed in Great Britain and Ireland, and are occasionally not rare. Owing to their striking appearance and loud buzz in flight, they attract general attention, and are probably as rarely overlooked as any indigenous insects. Not a few recorded specimens are obviously imported in foreign timber. The females of both species lay their eggs exclusively on Conifer-wood, choosing, as is so often the case, sickly or dying trees, or those that are actually felled or dead. *Sirex gigas* appears to attack principally the Spruce and Silver Fir, sometimes the Larch and non-European Conifers like the Deodar.

Sirex juvencus, on the other hand, attacks the Scots Pine freely, as well as the Spruce, Silver Fir, and Larch. The eggs are deposited in cracks running through the bark into the sapwood, or in holes made by the strong ovipositor, and not rarely on patches of bare wood where the bark has been torn off by accident. This sometimes gives an opportunity for injury to otherwise healthy trees. The larva, whose life extends over two years, is a stout, elongate white grub, readily distinguished by an upwardly directed point on the last segment; it bores obliquely towards the heart of the tree in the long axis of the trunk, making a gallery which gradually increases in size, and eventually turns and approaches the surface. At the end of this gallery it changes to a pupa, separated from the outside only by a thin layer of wood or bark, which is gnawed through by the imago upon emergence. The time of development of the larvæ is increased by drying of the wood; and if timber containing larvæ is cut up into planks, the insects may eventually emerge in the interior of buildings, etc., and in that case they are stunted and small.

It is by this injury to otherwise sound timber that the insects are important, but they occasionally complete the destruction of Conifers that would perhaps have lived several years longer. The only remedy against their attacks in a wood which they inhabit consists in careful removal of all infected trees, which are sometimes indicated by the attacks of woodpeckers, and other dead or dying wood in which they can and do breed. Standing trees which have lost patches of bark by accident should have the wounds tarred over or dressed with a plaster of lime, cow-dung and clay, or other suitable mixture. Timber, when felled, should be removed before the imagos appear in summer. These remedies are also suitable to ward off the attacks of wood-feeding longicorn beetles, as *Acanthocinus ædilis*, *Callidium violaceum*, etc., which may do a certain amount of damage in a very similar manner.

It will be seen that the enemies of the Pine in Great Britain are far more numerous and important than those of any other Conifer. Of the sixteen or more species referred to in detail, twelve at least attack the Scots Pine, and of these eight are confined to that tree, and to foreign species of *Pinus*. The Spruce shares its particular pest, the gall-aphis, with the Larch, which has a special enemy in *Coleophora laricella*. Silver Fir is liable to injury from wood-wasps, but does not exclusively support any important species. This liability of the Pine is no doubt due to its being the only forest Conifer indigenous to Britain, where the Spruce is as yet free from the serious enemies which attack it over the greater part of Europe.

The preventive measures to be adopted against insect-attacks can be gathered from what has been said, but it is necessary again to point out that no Conifer-wood can be kept free from the risk of insect-injury unless it is freed from newly dead and dying wood, cut branches, and fresh stumps. There is no need for the systematic removal of the covering of needles, the natural protection to the ground, nor, as a rule, of small twigs and branches much under an inch in diameter.

It is not rarely objected by those anxious to free a wood from insects that this thorough cleaning is too costly to be put into practice. Without it the insects cannot be kept down, and it is for them to look at the cost of labour and the opportunity for disposal of such timber, and decide whether it is cheaper to let the insects flourish or not.

The first cleaning-up of a neglected forest is no doubt costly, but after that has taken place there is plenty of evidence to show that systematic and orderly removal of dead wood is profitable in the long run, unless exceptional destruction of timber over scattered areas by storms or snowfall should unduly strain the forest resources.

ECONOMIC PRODUCTS.

THE economic products of Coniferous Trees come chiefly under two heads, TIMBER and RESINOUS SECRETIONS; the uses to which the bark, foliage, fruits and seeds are applied, are to these relatively unimportant.

CONIFEROUS TIMBER.

THE timber yielded by the stems of coniferous trees is of universal importance. It possesses qualities that render it exceedingly serviceable for building and other constructive purposes, as durability, strength, lightness, elasticity, fineness of grain, etc. It also abounds in quantity immensely in excess of that of any other Order of Trees, so that it is also the cheapest and most easily obtained. In the northern hemisphere, the timber used in building may be said to be almost exclusively coniferous, obtained from the Fir and Pine tribe, and in populous countries as Great Britain, Holland, Belgium, etc., where it does not exist, or cannot be grown in quantity sufficient for the supply, and where natural forests have long since almost disappeared, it forms an important article of commerce.

The physical properties of coniferous wood are the result of its anatomical structure and specific gravity, the former being the chief factor in determining its strength, elasticity, fineness or coarseness of grain, and the latter its weight, hardness, durability and heating power.

The anatomical structure of coniferous wood is, in all its most important details, essentially the same as that of the broad-leaved (dicotyledonous) trees and shrubs, a conception of which may be easily obtained from an examination of the stem or branch of any of our native trees, and one that has completed at least three years' growth will be the best for the purpose. If a cross section of such a stem be made, and the surface of the section be made sufficiently smooth, the following arrangement of the parts will be readily recognised by the naked eye:—1. A central pith which is larger or smaller according to the kind of tree or shrub to which the branch belongs, large in the Elder, small in the Sycamore, a mere point in the Oak. 2. Around the pith is a series of rings or concentric circles, the number of such rings corresponding precisely with the age in years of the stem examined. 3. The rings are crossed by lines of a paler colour, all radiating from the central pith: these lines are Medullary Rays.

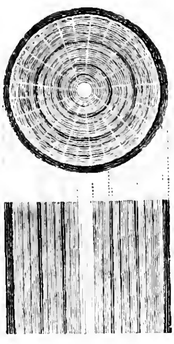


Fig. 41. Transverse and longitudinal section of a three years' old stem.

4, The whole is surrounded by and enclosed in an epidermis or covering familiarly known as the bark.

To comprehend the histology or minute structure of the parts thus exposed to view, a preparation of the material by certain simple chemical reagents and the aid of the microscope are necessary. For those who desire to study the subject practically, text books devoted to the subject should be consulted;* a brief sketch of the most important anatomical structures revealed by microscopic examination can only be here given.

If a three years' old stem of a Scots Pine be substituted for that represented in Fig. 41 it will be found that the rings are more sharply separated from each other: the inner part of the annual zone, or part nearest the centre, is lighter in colour and looser in texture, whilst the outer portion is darker in colour and more compact in texture; each ring, in fact, shows two zones, the inner representing the spring, the outer the summer growth of each year; the cause of this difference will be presently adverted to. These zones of spring and summer growth are observable in all coniferous wood: in some species, as in the common Yew, they pass more or less gradually from one into the other; in others, as in *Tsuga canadensis*, *Abies pectinata*, *Pinus excelsa*, they are more sharply defined. The relative dimensions of the spring and summer wood, the width of the annual rings, their uniformity or want of uniformity, have considerable influence on the properties and value of the timber.

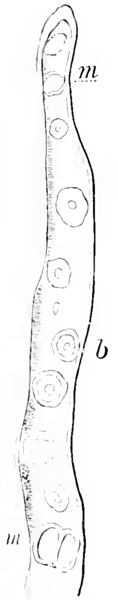


Fig. 42. Tracheide from young wood of Scots Pine with bordered pits as *b*. *mm* are pores connecting the tracheide with a medullary ray. × 250.

The pith in the centre of the stem is composed of cells with cellulose walls† which when first formed are filled with protoplasm which disappears as the formation of the cambium layers and woody tissues derived from them proceeds. Under a high magnifying power the cambium or formative tissue is seen to consist of cells in radial rows arranged with considerable regularity. The cells are filled with protoplasm in which a nucleus can often be detected; the growth of the stem and branches proceeds by the division of these cells by longitudinal walls.

The ligneous element of the stem consists of fibre technically called prosenchymatous tissue. This tissue is composed of elongated fusiform cells enclosing a narrow cavity and whose ends are dove-tailed between one another. The individual cells are termed tracheides; they are formed from the cambium by cell division and have ligneous walls which show on their inner side lines of striation and certain irregularities of growth that have obtained the name of "bordered pits." As the formation of new tracheides proceeds, the walls of the older ones become gradually thickened till the original cavity is quite filled up: they then

* Such as "Practical Botany" by Bower and Vines; Scott's "Introduction to Structural Botany," etc.

† Cellulose is secreted from the protoplasm; it is the primitive membrane of the cell free from all matter subsequently taken up by the roots and deposited within it. The cell is the common starting point of all elementary organs, and protoplasm is the formative and living part of the cell.

constitute heart-wood fibre. The tracheides formed in spring have thinner walls and larger cavities than those formed in summer which have thicker walls and are more compressed. This is the cause of the difference observable in the inner and outer zone of the annual rings mentioned above.

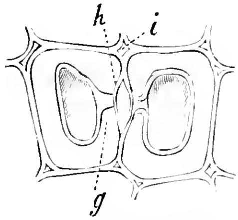


Fig. 43. Transverse section of two wood-cells (tracheides) of Scots Pine, each with a pore *g*; *h i*, intercellular spaces. × 400. Copied from Thome.

"Bordered pits," although not peculiar to, nor found in all coniferous wood, are a conspicuous anatomical feature in the most important coniferous woods used for economic purposes. Their form and position are best seen in a rapidly growing herbaceous shoot of the Scots Pine or any of the common Pines. "When the cell-wall begins to thicken, comparatively large spaces remain thin, but as the thickening augments, it reaches even the thin spaces. The outline of the thin spaces of the wall in the wood of *Pinus sylvestris* (also of *P. Laricio* and *P. excelsa*, see Figs. 45—47) appear circular on a front view; the edge of the thickening mass which arches over it grows also in a circular manner and contracts the opening; thus the front view of such a pit shows two concentric circles, the larger of which corresponds to the original thin space, and the smaller to the inner edge of the thickening. Now since this process takes place on both sides of a partition wall of two cells, a lenticular space is enclosed by the two over-archings divided in the middle by the original thin cell-wall, each half of this pit cavity communicating with the cell cavity by a circular opening. When the wood-cells lose their protoplasm and become filled with air and water, the thin cell-wall disappears and the two pits form a single cavity which is bounded by the over-arching thickening mass, and is united with the adjoining cell cavities by a circular opening."*

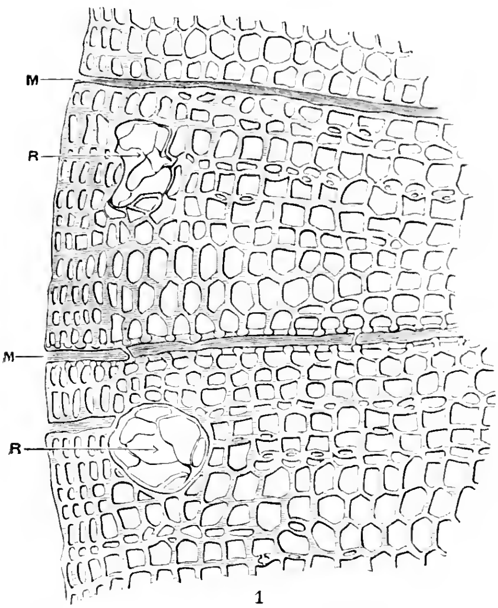


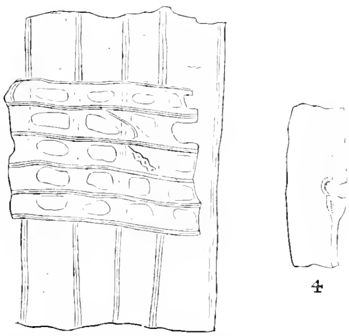
Fig. 44. 1. Transverse section of part of one year's growth of stem of *Pinus excelsa*. M. medullary rays; R. resin-ducts. × 150.

The annual rings are traversed radially from the pith to the bark by medullary rays, the earliest formed only reaching into the first-formed rings, the others originating in later ones. These rays in respect of their number and size have some influence on the technical properties of the wood.† The medullary rays are differentiated from the other tissues

* "Sach's Text Book of Botany," Vines' Translation, page 23.
† Schlich Manual of Forestry, Vol. V. p. 8.

in the cambium; the cells are less elongated than the tracheides and are composed of somewhat different elements, being mostly with cellulose walls and arranged something like bricks in a wall transversely to the wood-cells.

2



4

Fig. 45. 2. Radial section of a one year old stem of *Pinus Laricio* showing "pits" of wood-cells and part of a medullary ray. 4. A pit of a wood-cell in transverse oblique section. × 150.

Interspersed among the tracheides, and most conspicuous in the summer wood of the outer annual ring are intercellular spaces running parallel with the stem, called resin-ducts which are a distinguishing feature of coniferous wood: they are formed of a cylinder of large irregular cells with very thin walls. In these ducts turpentine is secreted, which is not only of itself an important economic product, but also has important effects on the technical properties of the wood. Resin-ducts also occur in the medullary rays so that "the whole of the wood may become impregnated with turpentine which on exposure to the air may become oxydised into resin. The quantity of resin in coniferous wood varies with its specific gravity, and depends on the greater or less development of the summer wood in or near which most of the ducts are formed."* Fig. 44 shows the position and form of two resin-ducts in a transverse section of an herbaceous shoot of *Pinus excelsa* at the end of the year's growth, and Fig. 48 shows a resin-duct in a transverse section of part of an herbaceous shoot of *Pinus Laricio.*

2

Fig. 46. Tangential section of wood of *Pinus excelsa* showing the medullary rays and pits in the walls of the wood-cells. × 150.

The bark of coniferous trees which has for the most part but a temporary duration, is composed of cork tissue which, when first formed on the herbaceous shoot, is made up of cells similar in structure to those of the pith. To keep pace with the growth in thickness of the enclosed wood cylinder, the cells, of which the young cork tissue is made up, undergo relatively rapid changes during the growing season; they are formed by bi-partition from the adjacent cambium, and their walls soon become suberous. The innermost layer of cork tissue thus formed is termed phellogen, and from this new layers are constantly formed in a centrifugal direction.† The layers of cells next the epiderm soon lose their cell-contents and as the bark already formed is

* Schlich, Manual of Forestry, Vol. V. p. 14.

† According to Sanio, it also happens that when cork is beginning to be produced, the formation of permanent cells proceeds centripetally, or an alternation of centripetal and centrifugal cell-formation takes place in the young cork tissue. "Sach's Lehrbuch." Vine's Translation, p. 107.

pressed outwards by the continuous growth of the enclosed wood, the outer portion loses all vitality; the epiderm with adjacent dead tissue splits under the action of the weather and in time is cast off, but before this happens, a new envelope formed by the cork tissue is always present.

The latest-formed outer rings of wood are familiarly known as sap-wood, technically *alburnum*. It is the medium by which processes vital to the tree are carried on, such as the conveyance of the water and food-stuffs taken up by the roots to the extremities of the branches, the foliage, etc. The sap-wood is of little value as timber, being

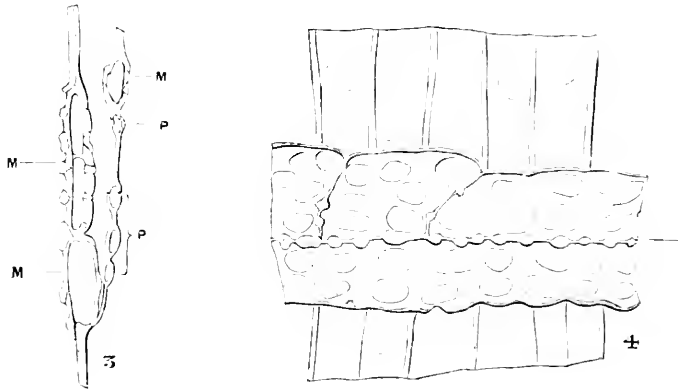


Fig. 47.—3, Transverse; 4, longitudinal section of parts of a medullary ray M, with pits P from first year's growth of *Pinus* [illegible]. × 150.

soft in texture and decaying rapidly on exposure, but when saturated with resin its heating power is very great. When the older formed wood-cells cease to perform vital functions, they become changed and the original cavity is filled up with mineral substances deposited by the upward current from the roots: it then forms the *heart-wood*, and so far as the tree itself is concerned, it is practically dead, the living part being represented by a shell enclosing it. Evidence of this may be seen in old Yew and Pine trees still in active growth, but whose trunks are hollow through the decay and removal of the heart-wood.

As previously stated, the anatomical structure of coniferous wood is the chief factor in determining its STRENGTH and ELASTICITY. By Strength is understood the amount of resistance the wood offers to the separation of the fibre of which it is composed, by any external force applied to it. The ultimate strength is usually measured by the force in pounds per square inch of section which must be exerted in order to break it: transverse strength is the most important, it measures the resistance which wood offers to breakage by a force acting at a right angle to the grain.* Among the strongest European coniferous trees are the Larch, Spruce Fir, Scots

* Schlich, Manual of Forestry, Vol. V. p. 46.

Pine, Silver Fir and Cembra Pine; and among the strongest American species are the Douglas Fir, the southern Pitch Pine *(Pinus palustris)*, the Yellow Pine *(P. ponderosa)*, the Noble Fir *(Abies nobilis)* and Lawson's Cypress.

The transverse strength of coniferous wood is ascertained by experiment. The results given in the following table were obtained by the Timber Inspector to the British Admiralty. Lengths of the wood to be tested were cut seven feet long and two inches square, and placed on supports six feet apart; water was then poured into a vessel suspended from the middle until the piece broke. English Oak was taken as the standard and valued at 1·000.

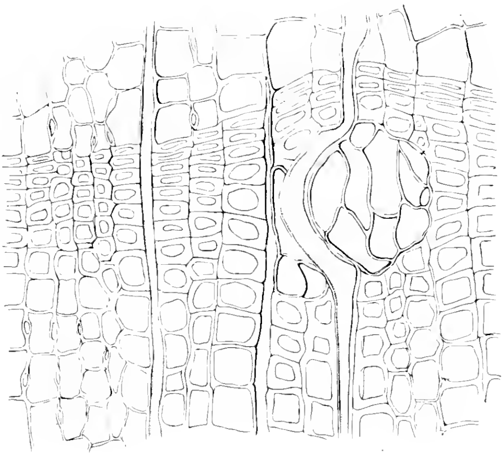


Fig. 48. Transverse section of a stem of *Pinus Laricio*, showing A, the end of a year's growth; B, the beginning of new growth; M, medullary rays; R, resin-duct. ×150.

	Relative strength.	Breaking weight in lbs. per sq. in.
Pitch Pine *(Pinus palustris)*	1.109	262
Dantzic Fir *(Pinus sylvestris)*	1·087	219
Kauri Pine *(Agathis australis)*	0·892	204
Canada Spruce *(Picea nigra)*	0·831	168
Canada Red-pine *(Pinus resinosa)* . . .	0·810	163
Russian Larch *(Larix sibirica)*	0·776	157

By Elasticity is understood the change which the minute parts may undergo in shape without fracture of the wood when an external force is exerted upon it. The elasticity of coniferous wood appears to depend in a great measure on what is called "even grain," or uniformity in the size and arrangement of the wood fibre which is greatly dependent on the rate of growth, and this, of course, is influenced to some extent by climate and environment. The best even-grained coniferous wood has equal annual rings with narrow summer zones and fine medullary rays. The most elastic European coniferous woods are the Yew, Larch, Spruce Fir, Scots Pine and Silver Fir;* and among the most elastic American species are the Western Larch, southern Pitch Pine, Spruce Pine, Noble Fir, Prince Albert's Fir, Douglas Fir and Lawson's Cypress.†

The elasticity of the wood of the Yew was observed centuries ago which led to its being employed in making bows for archery. The elasticity of the coniferous woods mentioned above materially enhances their utility in the various purposes of carpentry to which they are applied. The property is, however, most decisively demonstrated by the readiness with which molecules of the wood receive and transmit the vibrations of sound; this is especially the case in the Fir and Pine tribe. The late Dr. Tyndall, in giving the results obtained by the experiments of Wertheim and Chevandier to determine the velocity of sound through different kinds of wood, showed that the velocity along the fibre of Fir wood is fourteen times the velocity in air; in other words, that whereas sound travels under ordinary circumstances through air whose temperature is 60° Fahr. at the rate of 1,120 feet per second, it travels through Fir wood at the rate of 15,218 feet in the same period of time. Also along the fibre of Pine wood it is ten times the velocity in air. He also further proved the elasticity of Fir wood by a beautiful experiment, by which musical sounds generated in one apartment of a building were transmitted through a long deal rod and perfectly reproduced in another.‡ The high degree of elasticity in the molecular structure of Fir and Pine wood renders it a suitable material for the construction of certain parts of several musical instruments, as the violin, piano, etc., for which it is much employed.

The DURABILITY of coniferous wood is dependent in some measure on its specific gravity, or the ratio which the weight of a certain volume of wood bears to that of an equal volume of water, but no definite law can be formulated from the relationship. The specific gravity of the wood may be expressed with numerical precision, but sufficient data are not forthcoming to co-ordinate with it the duration of time which wood will last in a sound and useful condition under stated circumstances, or when out of the reach of destructive agencies. The most durable European coniferous woods available for utilisation are the Yew, Larch, Spruce Fir and Scots Pine, all of a relatively high specific gravity; but more durable than either of them is the wood of the common Cypress *(Cupressus sempervirens)* which no longer exists in sufficient quantity for any general economic use. Some of the most durable and in some respects the most valuable of the American coniferous woods belong to the Cypress tribe, the specific gravity of most of which is relatively high. The

* Schlich, Manual of Forestry, Vol. V. p. 41.

† Jesup Collection of Woods of the United States, by C. S. Sargent.

‡ Lectures on Sound, pp. 41, 80.

southern Pitch Pine, Western Larch, Douglas Fir and Deciduous Cypress yield very durable timber, the specific gravity of which is high, especially of the two first named. On the other hand the almost worthless wood of the Wellingtonia, and the coarse-grained, rapidly decaying wood of *Abies concolor*, *A. Fraseri*, *A. balsamea* and others have a low specific gravity.*

Some remarkable instances of the durability of the wood of some coniferous trees have been recorded:—

> The Deodar pillars of the great Shah Hamaden Mosque, in the capital of Kashmir, are probably more than 400 years old, and to all appearances they are perfectly sound. Some of the bridges in Srinagar that are built of Deodar timber are said to be of still greater antiquity; the wood of which the piers are constructed are alternately wet and dry and apparently suffer no decay.† A building erected by order of the Emperor Akbar (1542–1605) was taken down some time between 1820 and 1825, and its timber (Deodar Cedar) was found to be so little impaired as to be fit to be employed in a house built by Rajah Shah.‡
>
> The gates of Constantinople which were destroyed by the Turks in 1453, after having lasted eleven hundred years, were made of the wood of the European Cypress. And the doors of St. Peter's at Rome, which had lasted from the time of Constantine to that of Pope Eugene IV. (1431–47) were of Cypress wood, and were found when removed, to be perfectly sound.§
>
> Robert Brown of Campster relates that in one of the dark damp forests near the Pacific coast of north-west America, Dr. Cooper saw trunks of *Thuia gigantea* lying prostrate with several Spruces (*Picea sitchensis*) three to four feet in diameter growing on them, having evidently taken root in the decaying bark, and extended their roots into the ground adjoining; while the interior of the Thuia logs was found still sound, although partially bored by insects. Judging of the age of the Spruces by the ordinary rules, these logs must have lain hundreds of years, exposed to the action of one of the most humid of climates.‖
>
> In the *Toronto Globe* of April 9, 1863, Mr. W. D. Ferris, writing from New Westminster, British Columbia, states that the trunk of a Douglas Fir, showing no signs of decay, had been discovered partially embedded in the earth long enough to allow a Hemlock Spruce (*Tsuga Albertiana*) to grow upon it which was fully one hundred and fifty years old.
>
> The prostrate trunk of a *Prumnopitys spicata* was observed in a valley near Dunedin, New Zealand, to be enfolded by the roots of three large trees of *Griselinia littoralis* with trunks three and a-half feet in diameter, which must have grown from seed since its fall. On felling these trees it was found that they were approximating three

* The woods of *Thuia gigantea* and *Cupressus thyoides* have a low specific gravity, but they are reckoned amongst the most durable of American woods.

† Brandis, Forest Flora of N. W. India, p. 519.

‡ Loudon, Arboretum et Fruticetum Britannicum, IV. p. 2430.

§ Idem. p. 2467. The wood of *Cupressus sempervirens* used in very old buildings in Italy that are known to have stood from 600 to 1,000 years, is still sound.

‖ Monogr. Thuia in Trans. Bot. Soc. Edinb. IX. p. 369. Further remarkable instances of the durability of *Thuia gigantea* timber are recorded in "Garden and Forest," II. (1889), p. 192.

hundred years, during which the timber of the Prumnopitys remained sound, and was afterwards split into posts for fencing purposes.*

A piece of the wood of *Juniperus oxycedrus* was unearthed in 1884 by Mr. C. H. Sharman in the island of Madeira, where this species attains timber-like size. It had lain in the ground without life but undecayed, and had retained its peculiar perfume during four hundred years.†

The FRAGRANCE of the wood of many coniferous trees is powerful, and generally of a resinous odour, in many instances it is also agreeable and even useful. Thus the wood of the Red Cedar, used in the manufacture of pencils, is a familiar example of agreeable fragrance without being too powerful; the wood of the Cembra Pine is much used for wainscotting and the inlaying of wardrobes, on account of its odour being not only agreeable, but also obnoxious to insects. The woods of the Deodar Cedar, Yellow Cypress, the American Arbor Vitæ, the Chilian Libocedrus and the Spanish Juniper are all agreeably fragrant and more or less obnoxious to insects.

The timber of coniferous trees is used throughout the temperate regions of the world for well-nigh every purpose for which wood is in request; for house-building almost to the exclusion of every other kind; for out-of-door carpentry of every description; for railway ties and street paving; for joinery and indoor fittings; for the coarser kinds of furniture, boxes for packing, frames and backs of musical instruments, children's toys and turnery. And within the last few years a new industry has arisen which has for its object the conversion of coniferoas wood into pulp for the manufacture of pasteboard and paper.

The coarser kinds of printing paper, packing paper and pasteboard are made from wood pulp obtained chiefly from Pine and Spruce wood. Paper manufactured from the wood of the Red Cedar (*Juniperus virginiana*) is found to be useful for underlaying carpets and for wrapping wool, fur, and other articles liable to be injured by moths which are driven away by the peculiar odour of the wood. The wood from which this paper is made is chiefly the waste of the pencil factories.‡ In the north-eastern States of North America, the upper part of the trunk, as well as the branches and chips of the Pine and Spruce trees, are gathered up and ground into pulp. Formerly these were left by the lumbermen, and by the middle of the following summer they became thoroughly dry and afforded the best material for starting a great fire when a careless hunter or tramp should happen to drop a lighted match; for these fires which have done such immense injury can generally be traced to this source.†

Two methods are chiefly followed in the preparation of wood-pulp,

* Kirk. Forest Flora of New Zealand. p. 6.

† Gardeners' Chronicle. XXIII. 1885. p. 369.

‡ English Mechanic ex Gardeners' Chronicle, V. s. 3. 1889. p. 23.

§ Garden and Forest. I. 1888, p. 290.

the mechanical and the chemical. The two methods give different results, the product of the mechanical being more granular, whilst that of the chemical method is more fibrous and makes a better felt; the former product is termed paper-pulp, the latter cellulose. Both methods are well described in Dr. Schlich's "Manual of Forestry," * which the reader desirous of further information should consult. An enormous amount of coniferous cellulose is now prepared both in Germany and in the United States, which is also used for other purposes, as tubes, vases, laboratory utensils, carpets, wax-cloth, packing materials, etc.

Among the minor products of the coniferous forest applied to economic purposes, the following are the most important:—

Foliage. In North Carolina Pine-fibre matting is manufactured from the leaves of *Pinus palustris.* The green Pine leaves collected in the forest are first cleaned and then placed in a large iron cylinder set on end and surrounded with steam pipes; they are then thoroughly steamed, the vapour being carried through pipes into an ordinary distillery worm in an adjoining building. Pine-leaf oil, a valuable antiseptic, is obtained in this way at the rate of about one half gallon for 100 lbs. of leaves. The leaves are then boiled to remove the silica which is found in their outer covering, and which can be used in tanning leather. The leaves are next boiled again and bleached, and are then ready to be dried which is done by machinery; the fibre is then ready for manufacture. Pine-leaf fibre has been found valuable by surgeons in the treatment of fractures and in dressing wounds; it is an excellent disinfectant, and probably many other uses will be found for this long-neglected product of the Pine forests.†

Wood Refuse. In the Landes, Basses-Pyrénées and adjacent districts in the south-west of France, an immense quantity of the wood of *Pinus Pinaster,* chiefly of trees that have been exhausted of their resinous products, is converted into charcoal. Two methods are followed:—One, the more primitive and more simple but at the same time attended with a great waste of material, consists in setting fire to a heap of the wood arranged in a particular manner and covered with loose soil, the heap being allowed to burn until the wood is carbonised sufficiently for use, which usually takes from four to five days; by this method the volatile products of the wood, as tar, pitch, etc., are, for the most part, lost. The second method is more expeditious and more efficient in its action but far more costly, as it involves the construction of an expensive apparatus in a fixed station, and the inconvenience and labour of bringing the material to it often from a long distance. The essential part of the apparatus consists of a large iron retort for holding the wood to be converted into charcoal, and which is heated over a furnace till the conversion —usually in a few hours—is effected. Connected with the retort are various contrivances for collecting and condensing the volatile products of the wood, so that whilst the operation itself occupies a much shorter time, it is also attended with a minimum waste of material.

The wood of the stumps of *Pinus longifolia* in the Himalayan region and of *Pinus palustris* in the southern States of North America

* Vol. V. pp. 162, 163.
† Garden and Forest, I. (1888), p. 469.

that have been notched and mutilated for their resinous secretions, is often so full of resin that it can be used as torches in the place of candles in huts and even in mines. Lamp-black used in the manufacture of printer's ink is obtained in the south-west of France by burning the roots and stumps of *Pinus Pinaster* in closed masonry chambers. And in all parts of the world where coniferous trees abound, especially throughout the sub-arctic regions of Europe, Asia and North America, the wood when not used for constructive purposes is the chief and often the sole source of fuel for the inhabitants.

Bark. The bark of *Tsuga canadensis* is rich in tannin and it is the principal material used in the eastern provinces of the Dominion and the northern United States for tanning leather. The bark of *Pinus longifolia* is similarly used in northern India, and that of *Dacrydium cupressinum* in New Zealand. And along the inner and higher Himalaya the bark of *Abies Webbiana* is often used for roofing shepherds' huts.

RESINOUS SECRETIONS.

IN the description of the anatomical structure of coniferous wood given in the preceding pages, mention is made of "resin-ducts" or intercellular passages in which turpentine is secreted. These "resin-ducts" are widely distributed throughout the CONIFERÆ, but in the TAXACEÆ they are either altogether absent as in Taxus, or they are confined to certain organs only as in Torreya and Dacrydium. In the CONIFERÆ, more especially in the Fir and Pine tribe (Abietineæ), they are found in all the organs, root, stem, pith, medullary rays, bark, leaves, etc., always following the direction in length of the organ in which they occur, but often branching; they are thence visible in transverse sections, in the leaves as shown in pages 33—35, and in the young stem as shown in Fig. 44, page 83. From recent investigations into the origin and properties of resin by Dr. Heinrich Mayr of Munich, we learn the following interesting facts:—

Only in an invisible molecular form in the protoplasm can existing resin pass into an intercellular space, so that the cell-wall is only permeable for resin so long as it is in process of formation. A secretion of resin in the canals or "ducts" can only occur during the first year or two of the formation of the annual rings.

Finished cell-walls, whether lignified, thickened or not, cannot be permeated by resin so long as the respective walls are saturated with water, and as in the living tree both sap- and heart-wood are always saturated, it follows that all cell-walls of normal wood in the living tree are always free from resin.

All resin-holding spaces are surrounded by an impervious, continuous cell-tissue, and are therefore completely isolated. The resin cavities are entirely closed on all sides, and never open at the exterior in an uninjured tree.

There is no spontaneous exudation of resin towards the surface; every outflow of resin is pathological; where *primo aspectu* a spontaneous outflow appears to occur, as on the buds and cones of different Conifers, a close investigation shows that it is connected with exudation into an intercellular space, or caused by the drying up of the outer layers.

With the conversion of the sap- into heart-wood, the resin-canals are filled up by tyloses,* so that a subsequent flow of resin from the sap- to the heart-wood or *vice versa* is impossible.†

The quantity of turpentine secreted depends much on the greater or less development of the summer wood in or near which most of the resin-ducts are found: it is also greatly influenced by the heat or moisture of the climate, the former acting as a stimulant, the latter as a check to the secretion. The quality varies with the age and vigour of the tree, the humidity of the atmosphere and the season in which it is collected.

The Pines in the Mediterranean region, and especially the plantations of *Pinus Pinaster* in the south of France, supply turpentine in greater quantity and of better quality than that obtained further north, while the Pine forests of Sweden and Norway supply only the coarser products as tar and pitch. The turpentine of American commerce is procured chiefly from the extensive "Pine Barrens" of the South Eastern States, where, during the great heats of summer, it flows from the trees so copiously as to require but a comparatively small amount of labour to obtain it. In the great pine woods of Canada it would not at present repay the cost of collecting for exportation, in consequence of the cheaper rate at which it is procured further south. The Coniferæ of the Himalaya yield but a small amount of resinous products owing to the humidity of the climate, with the exception of *Pinus longifolia* which is spread chiefly through the outer or tropical range between 1,500 and 6,000 feet elevation, where the greater heat more than counteracts the excessive humidity. And in Britain although the more equable temperature of summer and winter, especially in the districts of the greatest rainfall, is favourable to the rapid growth of the trees—the resinous products are not sufficiently abundant to be worth collecting.

The crude turpentine consists of two principal ingredients, a volatile oil commercially known as Oil of Turpentine, and Colophony the crystallised resin, which can be separated by distillation. Oil of turpentine, a hydron-carbon having for its chemical formula $C_{10} H_{16}$ in its pure state is a colourless liquid of powerful odour, almost insoluble in water but dissolving in alcohol or ether and absorbing oxygen rapidly from the air, especially when mixed with ceruse or white-lead; it dissolves sulphur and is a good solvent for grease. It is also a powerful solvent for resins which form the bases of most varnishes, and from its great volubility, it quickly flies off or dries away, leaving a thin coat of the varnishing substance on the surface to which it has been applied. It is the only known volatile oil that mixes readily with paint without affecting its properties, diluting it so that it may flow freely from the painter's brush, causing

* For explanation of these processes *see* "Sach's Text Book of Botany," Vines' Translation, p. 24.

† Ex Gardeners' Chronicle, XIV, s. 3 (1893), p. 327.

the paint to dry rapidly. Colophony is the solid matter that remains after the separation of the oil of turpentine; its chemical formula is $C_{20} H_{16} O_2$; it differs in appearance and properties according to the amount of impurities contained in it; the best colophony is brownish yellow, crystallises in small rhombic prisms, is insoluble in water, but is dissolved in alcohol; it is a non-conductor of electricity, and in its fossil state it is known as amber.

The principal seats of the resin industry are:—(1) Districts around Bordeaux in France which are covered with plantations of *Pinus Pinaster*; (2) in the north of Italy on a much smaller scale where Venetian turpentine is prepared from the resinous secretions of the common Larch; (3) in southern Norway and Sweden where the coarser products as tar and pitch are procured from *Pinus sylvestris*; (4) in the Pine Barrens of the southern States of North America, the source of the greater part of the turpentine of British commerce, which is obtained from *Pinus palustris* and *P. Taeda*; and (5) on the outer or sub-tropical Himalayan zone where the Indian supply is obtained from *Pinus longifolia*. The *modus operandi* of collecting the crude resin in each region is different, and is attended with widely different results. In the south of France the processes employed are conducted with the greatest economy of material with a minimum of injury to the trees, so far as the nature of the operation admits. In Georgia and South Carolina the aim of the resin-collectors is to obtain the greatest amount of crude resin with the smallest expenditure of labour and time, without any regard to the fate of the trees they attack. A comparison of the two methods is highly instructive.

French method. Towards the end of February the rough outer bark of the maritime Pine, *Pinus Pinaster*, is trimmed off at the place intended to be tapped, so that only a thin layer of bark is left covering the sap-wood, the part of the tree in which the resin is most abundant. Early in March an incision is made in the shape of a longitudinal groove of small dimensions by a special instrument called an *abchotte*, much resembling a carpenter's adze but smaller. The resin trickles through the orifice thus made in drops which thicken in contact with the air; one portion of it solidifies and adheres to the surface of the groove, the remainder flows into a vessel placed below to receive it. The resin ceases to exude about the middle of October when the collecting ceases, but it is renewed in the following March and continued for several years, usually about five, from the same trees; the trees are then left for two or more years untouched when the collecting is renewed from a fresh incision; by this method the trees retain their vigour for many years and their timber is not impaired. Once a week the groove is freshly cut by slicing off a thin shaving from the upper side, so that whilst the groove becomes gradually longer, its width remains unaltered.

The crude resin is collected in earthen pots varnished on the inside, placed at the lower end of the groove and held by means of a zinc collar fixed across it. As the pot becomes filled, the collector empties it into a kind of pannier, holding about four and a-half gallons, called an *escouarte* which, when full, is conveyed to reservoirs formed of wood or brick let into the ground and dispersed through the forest. The solidified resin adhering to the sides of the groove, locally called *barras*, is either mixed with the crude resin or packed separately in palm-leaf baskets. The resin is ladled from the reservoirs into casks and conveyed to the factories to be converted into oil of turpentine and colophony.*

American method. During the winter a receptacle called a "box" is cut into the trunk of the trees intended to be tapped, at about a foot from the ground; the incision is made transversely across the stem and obliquely inwards, the length being twelve to fourteen inches, the breadth six to seven inches, and the depth about as much. A circular space about two and a-half feet broad is then cleared around the trees and in it is placed a series of heaps or layers of all the inflammable material scattered around which on the first dry day in early spring is set on fire, the object being to clear the ground of all inflammable matter from which the outbreak of a forest fire might originate during the dry season when the collecting of the resin is most active. Nevertheless this very precaution is often the cause of forest fires that spread for miles, involving the irreparable destruction of hundreds both of young trees and of trees in their best period of development.

In the early spring, when the sap begins to move, the process of collecting the crude resin is commenced by an incision being made by an axe in the bark about eight inches long and two inches broad above the "box" and perpendicular to the upper edge on each side at the angles, a process called "cornering," and the bark in the interspace is stripped off from the sap-wood by an instrument made especially for the purpose. Every week an addional portion or "chipping" is removed, so that the surface of the sap-wood laid bare is constantly enlarged. This "chipping" is continued from the middle of April to the middle of October and even into November when the weather is favourable. The "boxes" as they become filled with the exuding resin are emptied with an iron ladle and the resin is conveyed to depots. With the commencement of the cold season, the flow of turpentine ceases and the "boxes" as well as the spaces above them that have been stripped of bark are freed of the resin adhering to them called "scrapes" that had become hardened in contact with the air. This resin is, however, of little value on account of the impurities with which it is mixed.

The injury done to the trees consists not so much in the withdrawal of the resin itself, as in the unskilful manner in which it is obtained. The large wound is soon covered with fungi and all sorts of putrifying agents which spread rapidly through the trees; they are thus destroyed, or as good as destroyed, even when they escape the greatest of all the scourges of American forests—the forest fires.†

* "Le Pin maritime," par Raymond Brunet, Bibliothèque du Cultivateur.

† Dr. Heinrich Mayr, "Waldungen von Nordamerika," pp. 53, 54. "Of the extravagant methods which prevail in the United States, none certainly exceed in extravagance that under which the turpentine industry is conducted and there is no business connected with the products of the soil which yield so little return in proportion to the destruction of the material involved. The forests of Georgia once represented fabulous wealth; they were not surpassed by those of any other region, and could they have been wisely husbanded, would have made Georgia one of the richest States in the Union. The turpentine farmers take everything they see, and once the resinous surface of the tree is exposed, the fire is almost certain to finish the damage the axe has commenced"—Garden and Forest, Vol. IV. (1891) p. 49.

Among the minor products of coniferous trees derived either directly from the resinous secretions or in combination with them, the following are the most important :—

Tar used in shipbuilding is received chiefly from the north of Europe, of which the Stockholm tar of commerce is considered the best, and from the United States. The distillation of tar both in America and Europe (except in the south of France) was formerly, and probably is still performed in a very rude manner, involving an enormous waste of material. "A funnel-shaped hole is dug in a bank about six or eight feet in diameter at the upper part, and not more than about ten inches at the lower. At the bottom of the hole is placed an iron pan having a long pipe or spout which is made to pass through the bank; the hole is then filled up with billets cut from the roots and branches of Pine trees *(Pinus sylvestris)* which, after being kindled at the top, are covered over incompletely with turf. The wood is then charred from above downwards, and the tar mixed with various other products flows off at the bottom through the spout into a receiver.

Pitch is prepared by melting crude resin in iron pots over a steadily increasing but at first slow fire. The melted resin is at first yellow, then brown, and lastly becomes converted into black pitch. In order to expedite the process and increase the output of pitch, a press is used which fits in the pot and is moved downwards by a kind of screw. The resin, after the pitch has been pressed out, is used for making lamp-black.*

Turpentine Paste and *Pine Oil* are prepared from the crude resin of *Pinus Pinaster*. The former is much used in certain kinds of varnishes, and the latter for lighting purposes; also as an antiseptic for preserving wood in the open air.

Canada Balsam is a transparent straw-coloured resin faintly tinged with green procured from the Canadian Balsam Fir, *Abies balsamea*; it has the consistency of honey, with a pleasant aromatic odour and a slightly bitter flavour. It is chiefly used for mounting objects to be examined under the microscope, for which it is highly suitable, as it remains constantly transparent and uncrystallised.

Coniferine is obtained from the descending sap of the Larch and other trees belonging to the Fir and Pine tribe which by a chemical process can be transformed into Vanilline, the aromatic principle present in the fruit of Vanilla. The preparation of Coniferine is a profitable branch of industry in North Germany.

Abietine is a volatile oil obtained from the resin secreted by some of the Pines of western North America, chiefly *Pinus ponderosa* and *P. Sabiniana*, and recommended for its curative virtues, which, however, have been called into question by the authorities of the Philadelphian College of Pharmacy.†

Amber occurs chiefly in a bed four to five feet thick of glauconite, geologically known as the Amber Beds of Königsberg. It is generally in small pieces, sometimes colourless but usually light yellow; it is susceptible of a good polish, and when rubbed becomes electrical. It melts when heated to 230° C., then it flames and burns with a

* Schlich. Manual of Forestry. Vol. V. p. 169.
† Garden and Forest. Vol. X. 1897 p. 202.

bright flame, and emits a smell by no means disagreeable. It is used for ornamental purposes and for making amber varnish. Amber is the product of coniferous trees which flourished in early Tertiary times, probably of more than one species but which cannot be clearly determined. Pieces of amber have been found in which are preserved entire the bodies of insects that inhabited the primeval forest formed by these trees.

Kauri Gum is a semi-fossilised deposit buried at a depth of five or six feet below the surface of the ground in tracts of open land in the northern island of New Zealand where once grew Kauri forests (*Agathis australis*) which have long since disappeared. It is sometimes found in large lumps but more frequently in fragments varying in size from that of a hen's egg to that of a man's head; it varies also in colour, being sometimes of a rich brown, sometimes bright amber-yellow and occasionally almost colourless and translucent, revealing flies and small beetles that have been enclosed in it for ages. The clearest and most crystalline pieces are most valued: they are carved into ornaments scarcely to be distinguished from amber, but much more brittle: the inferior kinds are manufactured into varnish.*

A few other products only locally utilised are noticed under the species from which they are derived.

DISTRIBUTION AND CENSUS.

THE present distribution of the TAXACEÆ and CONIFERÆ over the globe has resulted from the gradual geological changes that have been effected since the first appearance of a coniferous vegetation in the earlier formations of the Earth's crust: and the existing genera and species are believed to have been developed in the course of ages from others that have long since become extinct. The evidence adduced in support of this belief consists in the fossil remains of plants (and animals) found in the different strata of which the crust of the Earth is composed, and which are proved to have been laid down slowly by the action of water. It is further proved that the distribution of land and water on the surface of the globe has not always been precisely the same as it is now, areas which are now dry land having been at one time covered by the sea, and *vice versa*, and also that the changes in climate have been not less remarkable. Similar formations and consequent changes are still in progress on a vast scale in every region of the Earth, chiefly by the agency of water as is seen by the deposits of layers of mud and silt which are continually accumulating at the mouths of the great rivers, as the Nile, Niger, Ganges, Yang-tse-Kiang, Mississippi, etc., and

* Kirk. Forest Flora of New Zealand, p. 154.

which are brought down by their waters in a state of suspension, forming what are called "Deltas."

From the observed uniformity of Nature's laws and workings, it is reasonable to infer, therefore, that a cause constantly operating in this way at the present time in the case of the above-named and other rivers, has also been operating in the same way from remote antiquity. In the course of these formations, multitudes of plants, including even large trees, have been embedded in the soft deposits of silt and mud, and their remains preserved in the rock which results from the hardening of the mud. The soft and delicate parts could not be perpetuated in this manner, and it is found, in fact, that only the harder parts, such as the wood, bark and fruits are preserved. The softer portions have been more or less quickly decomposed, although under especially favourable conditions there has been some preservation even of these; they have in some instances left *impressions* in the hardening mud, and from which the form and even the species can sometimes be recognised.

Geologists have classified the different beds or strata composing the Earth's crust into five main divisions, and these divisions are further divided into systems, the systems into series, sections or formations, and these again into groups and stages; each group or stage includes two or more zones or horizons which may consist of one or several beds or strata. To all these divisions and sub-divisions they have given technical names. They have also assigned to them a chronological order of formation, not indeed by referring them to a particular year or number of years reckoned from a fixed epoch, but from an examination of the fossil remains and from other data they have ascertained which strata are of earlier formation and which are more recent. The entire series of beds or strata so classified and chronologically arranged forms the Geological Record.

> "The Geological Record is at the best but an imperfect chronicle of the geological history of the Earth. It abounds in gaps, some of which have been caused by the destruction of strata owing to metamorphism, denudation or otherwise. Nevertheless, it is from this record that the progress of the Earth is chiefly traced. It contains the registers of the births and deaths of tribes of plants and animals which have from time to time lived on the Earth. Probably only a small proportion of the total number of species which have appeared in past time have been thus chronicled, yet by collecting the broken fragments of the record, an outline at least of the history of life upon the Earth can be deciphered."*

* Text Book of Geology, by Sir Archibald Geikie, p. 634. "Upon the leaves of that stone book are stamped the characters plainer and surer than those formed by the ink of history, and which carry the mind back into the abysses of past time, compared with which the periods which satisfy the unscientific mind cease to have a visual angle."—*Dr. John Tyndall, in the Belfast Address.*

The oldest vestiges of the Vegetable Kingdom that have been preserved occur in the lower strata of the Primary or Palæozoic (Ancient Life) division of the Geological Record, called the Cambrian system.* They consist only of a few markings on slate or sandstone of marine Algæ (Sea-weeds). In the next higher system, the Silurian, the remains of sea-weeds occur more frequently, and also the earliest traces of a higher vegetation represented by Lycopodiaceæ (club-mosses). In the Devonian period which succeeded the Silurian, a cryptogamic vegetation seems to have covered the land in luxuriant abundance, and with it Conifers and Cycads make their first appearance. Fragments of wood having the structure of living Conifers are found in every state of preservation throughout the entire series of geological formations from the middle Devonian upwards, and they begin to be common everywhere as early as the higher members of the Coal Measures.† These earliest remains of wood appear to belong to primitive Taxads of which silicified specimens of entire stems have been found in the Old Red Sandstone of Canada and New Brunswick; these are the oldest known coniferous remains.

In the Carboniferous system (Coal Measures) vegetation attained a luxuriance equalling, if not surpassing that at present existing. Over five hundred species of plants have been described, which may perhaps be only a fragment of the entire flora of that period but which nevertheless "is marked by a singular monotony of character all over the world from the Equator to the Arctic Circle, the same genera and sometimes even the same species appearing to have ranged over the whole surface of the globe. It consisted almost wholly of vascular cryptogams and pre-eminently of Equisetaceæ, Lycopodiaceæ and Ferns."‡ The coniferous trees of the Coal Measures are doubtfully referred to four genera, the wood of some of them approaching in structure that of the Araucarias; among the fruits, one is much like that of the living Gingko. The supra-carboniferous flora is simpler and less rich than that below; it included a Conifer to which the name of *Walchia piniformis* has been given, and some others. In the succeeding system, the Permian, there is a marked diminution of plant remains; it seems as if the Earth were already exhausted, as one flora after another of the carboniferous vegetation disappears. Fossil fruits of Gingko and of Voltzia, an extinct genus allied to Cunninghamia, are among the very few Conifers that have been detected in this system.

A different vegetation characterises the Secondary or Mesozoic (Intermediate Life) Division. In the Triassic system, the oldest of the series of strata comprising it, Conifers, Equisetums and Ferns, some of them arborescent, were among the ingredients of the forest. Of the Conifers, Voltzia, of which traces have been discovered in the Permian system, became abundant, and another characteristic Conifer was Albertia, whose affinity to living genera has not been clearly made out; but the most distinctive feature of the earlier Mesozoic Ages was the great development of a Cycadaceous vegetation; so typical are these plants that the Mesozoic

*. For the explanation of this and other terms of the like kind the reader is referred to text-books of Geology.

† Solms-Laubach, "Fossil Botany," Garnsey's Translation, p. 80.

‡ Sir A. Geikie, Text Book of Geology, p. 725.

formations have been classed as belonging to the Age of Cycads.* In the succeeding system, the Jurassic, consisting of beds of argillaceous limestones, marls and clays termed Lias and Oolite, the vegetation so far as it is known to us was essentially Gymnospermous. The prevalent trees of the forest were Cycads, but associated with them were primeval forms of Araucaria, Thuia and Pinus. Phyllostrobus found in the Kimeridge Clay of Orbagnoux and Palaeocyparis are, according to Solms-Laubach, the oldest known progenitors of the Cypress tribe. Ancestral forms of Taxaceæ also appear distinctly in the Jurassic period of which the best known is Baiera, a genus allied to Gingko, scarcely exceeding the existing species in size. In the Cretaceous system the earliest known progenitors of the abundant dicotyledonous trees of the present day appear; they were allied to the Oaks, Beeches, Walnuts and Tulip-trees of our flora, and with them were associated numerous Conifers which spread far into the Arctic regions. In the Cenomanian beds appear the earliest forms of Pinus that can be satisfactorily identified as such; an earlier form has been found in the Rhætic beds of the upper Triassic formation, but it is not absolutely free from doubt. All the Pine cones found in the Mesozoic Age belong to the Cembra and Strobus sections of the existing Pines; the scales of the cones are without an apophysis or thickening at their apical end. The most common Conifers of the upper Cretaceous period were the ancestors of the gigantic Sequoias of California; cones of these are abundant and are sometimes attached to their branches with foliage which agrees closely with that of the existing species.

Different phases of plant life appear as we enter upon the Tertiary or Cainozoic (Recent Life) Division. The transition from the later Mesozoic to the earlier Cainozoic formations was marked by great geographical changes in Western Europe which must have occupied a vast period of time. The fossil remains of plants found in the Eocene or lowermost of the Tertiary system of rocks indicate that the age of Lycopods, Ferns and Yew-like Conifers had passed away, and that the threshold of modern types of life had been reached. Ancestral forms of dicotyledonous trees both evergreen and deciduous were taking their place. One of the most striking phenomena of the Tertiary period is the remarkable change in climate which the northern hemisphere of the globe underwent. "At the beginning it was of a tropical or sub-tropical character, even in the centre of Europe and North America. It then gradually became more temperate, but flowering plants and shrubs continued to live even far within the Arctic Circle where then, as now, there must have been six sunless months every year. Growing still milder the climate passed eventually into a phase of extreme cold when snow and ice extended from the Arctic regions into the centre of Europe and North America. Since that time the cold has again diminished until the present thermal distribution has been reached."† Abundant evidences of these climatic changes present themselves in the fossil remains distributed over the great area affected by them. Trees allied to the gigantic Sequoias of California, the Gingko, Thuias and other Cupressineæ flourished in North Greenland; Spruce Firs, Pines and Cypresses in Spitzbergen. In Great Britain during Eocene times, Cypress-like trees allied to the Australian genus Callitris were frequent; remains of a Libocedrus, much like the *L. decurrens* of California, have

* Sir A. Geikie, Text Book of Geology, p. 837. † *Ibid.*, p. 761.

been found in the Thames Valley, and of a true Cypress, *Cupressus taxiformis*, at Bournemouth. Two forms of a Taxodium also occur in the Bournemouth beds, and also others that have been referred to Sequoia; in the London Clay have been preserved fruits of a Taxad closely resembling those of the Gingko; and at Alum Bay in the Isle of Wight as well as in the London Clay have been detected remains of the sub-tropical genus Podocarpus. Remains of the foliage of an Araucaria occur in the Freshwater beds of the Isle of Wight, and in the marine beds at Bournemouth; pine cones in the Thanet beds of Kent, at Bagshot, in the Isle of Wight and County Antrim; and from the basaltic formation in the same county and in the Isle of Mull have been discovered cones of a Tsuga and branchlets of a Cryptomeria.*

In the Oligocene and Miocene systems of the Middle Tertiary period are found large masses of carbon deposited in the earth in the form of beds of "brown coal" or lignite, which are chiefly composed of coniferous remains mixed with those of ancestral forms of Quercus, Magnolia, etc. The coniferous forests of that period did not, therefore, exhibit a dull uniformity as is the case with those of the present time; there was, on the contrary, an abundant and cheerful variety of forms as is seen even now in the forests of Canada and in parts of the southern United States, though not to so great a degree. There must have been enormous quantities of resin exuded by some of these trees, which belonged to genera resembling Thuia, Cupressus, Sequoia and Taxodium; this resin hardened by external conditions is now known as amber.

Towards the close of the Tertiary period, the gradual refrigeration of climate already mentioned, reached its maximum. Under its influence the coniferous trees that had flourished over the north Temperate zone and far beyond the Arctic Circle in the earlier ages, disappeared, "the Alps and Pyrenees were loaded with vast snow-fields from which enormous glaciers descended into the plain, overriding ranges of minor hills on their way. The greater portion of Britain was similarly ice-covered; in North America also, Canada and the eastern States of the Union down to about the 39th parallel of north latitude lay under the northern ice-sheet."† As a natural consequence of this climatic change, the former sub-tropical vegetation of central and northern Europe and of North America was replaced as the ice-sheet receded northwards by an arctic and sub-arctic flora which included but few coniferous species, but they were spread over large areas. As we enter upon the recent and pre-historic formations, the types of vegetation become essentially the same as those now existing, and were spread over the same regions. The paucity of species of coniferous trees in the regions affected by the ice and snow of the Glacial period has remained unchanged except by the agency of Man. The British flora includes only three, the Yew, Juniper and Scots Pine; that of central and northern Europe includes the same three with the addition of the Spruce and Silver Firs, the Larch and the Cembra and Mountain Pines; and if we add to this area all Asia north of the Himalayan and Hindu-Koosh ranges, but excluding China and Japan, only six more species are present of which the

* J. Starkie Gardner, British Eocene Flora, Vol. II. pp. 20—101.

† Sir A. Geikie, Text Book of Geology, p. 884.

specific rank of two is doubtful. In North America, north of the 39th parallel, a similar paucity of species exists, the whole number probably not exceeding a dozen. Whilst the coniferous vegetation of the northern portions of the two continents was thus affected by the Glacial period, the floras of the contiguous regions, as the Mediterranean Basin, China and Japan, North America west of the Rocky Mountains and south of the 39th parallel on the east side were, as they still are, exceptionally rich in coniferous genera and species. Much less is known of the geological changes that have taken place in the south Temperate zone, but whatever may have been their nature, their influence on the vegetation, on account of the restricted land area, would be comparatively small to what has taken place in the north. As regards the existing Coniferae of southern lands, none of the species cover large areas, and the genera and species are much more varied than in the north. In Tasmania the species are so local and present so few individuals, that the island may be crossed from north to south without a single species of the Order being met with.* In New Zealand, on the contrary, the Coniferae attain their maximum of numbers in the southern hemisphere, and, till recently, the fifteen or sixteen species which inhabit the islands covered nearly two-thirds of their area. In southern Chile a considerable part of the slopes of the Andes is covered with a coniferous vegetation represented by nine species distributed among six genera. In the tropical regions of both hemispheres, coniferous trees form but a minute fraction of the entire arborescent vegetation: the few that occur are chiefly Podocarps which nowhere form a continuous forest. Pinus is represented by about half-a-dozen outlying species in the Indo-Malayan region and in Central America; Agathis by nine and the African genus Widdringtonia by five. Some of the Australian Araucarias and Callitrids also occur within the Tropics.

The number of existing genera and species has been variously estimated. The genera admitted in this Manual are Taxaceae eleven and Coniferae twenty-five which with three exceptions in the Coniferae coincide with those admitted by Dr. Maxwell T. Masters in his recent revision of the two Orders. These exceptions are—the Glyptostrobus of Endlicher which, following Bentham, is included in Taxodium, and the Pseudotsuga and Keteleeria of Carrière which are provisionally joined into one genus Abietia. The monotypic Taxad, Pherosphaera and the coniferous genera Tetraclinis, Callitris, Actinostrobus and Widdringtonia as well as all tropical and many sub-tropical species included in other genera are omitted in the body of the work on account of their being unsuited for cultivation in Great Britain. The following enumeration of the species may be accepted as approximately correct so far as our present knowledge extends and subject to such modification as the views of different botanists respecting the limitation of species are accepted. The regions are, to some extent, artificially defined, but the limits assigned to them are such that, with the exception of one or

* Sir J. D. Hooker, Flora of Tasmania, p. 349.

perhaps two Pines and two or three Junipers, the areas inhabited by the species do not overlap.

	Genera.	Species.
I.—Euro-Asiatic Region— North of the Alps, Caucasus, Hindu-Kush and Himalayan ranges and excluding China and Japan - - - - - - -	6	14
II.—Mediterranean Region— Including Asia Minor and the Trans-Caucasian provinces of Russia - - - - - -	7	27
III.—East Asiatic Region— Including China, Japan and the Himalayan zone north of the southern foot hills - -	20	56
IV.—North American Region— East of the Rocky Mountains - - - - -	11	30
V.—North American Region— West of the Rocky Mountains, and including Mexico - - - - - - - - -	13	66
VI.—Tropical Regions of both Hemispheres - -	8	44
VII.—Australian Region— Including Australia and the adjacent islands within the Tropics - - - - - -	6	34
VIII.—South Temperate Region.— Including Tasmania, New Zealand, and southern Chile - - - - - - -	13	39
		310

BOTANICAL RETROSPECT.

The Coniferæ have been studied by many eminent botanists; the enumeration of the most important of their labours in this field is given in the bibliography of the Order at the end of the volume. The following is a brief sketch of the various essays that have preceded and led to the present classification.

The starting point of the nomenclature adopted in this Manual is the *Genera and Species Plantarum* of Linnaeus published in 1753; in this work twenty-five species of Coniferæ are described, which are distributed among five genera all adopted from the older botanists; all the members of the Fir and Pine tribe, of which there are ten, including the Larch, Spruce Fir, and two Silver Firs *(Abies pectinata* and *A. balsamea)*, are ranged under Pinus. The most important work exclusively devoted to the Coniferæ immediately following the latest edition of the *Genera and Species Plantarum* of Linnaeus, is *The Genus Pinus* of Lambert, of which the first volume appeared in 1803,* a remarkable publication for that period, the coloured illustrations still

* The second volume was published in 1821, and an octavo edition of the whole in 1832.

ranking among the best of their kind. Lambert following Linnæus included all the Abietineæ under Pinus, as did Aiton in the *Hortus Kewensis*, the second edition of which was published in 1813. In 1826 was published Louis Claude Richard's *Mémoire sur les Conifères*, edited by his son. This classical work is the earliest that dealt scientifically with the Coniferæ, and in it the foundation of the present systematic arrangement of the Order is laid. Richard arranges the whole Order under three tribes (Sectiones): I. Taxineæ, including Podocarpus, Dacrydium, Phyllocladus, Taxus and Salisburia, and also the Gnetaceous genus Ephedra: II. Cupressineæ, including Juniperus, Thuia (Thuya), Callitris, Cupressus and Taxodium, the last-named founded by himself for the reception of the deciduous Cypress, *Cupressus disticha* of Linnaeus. III. Abietineæ, including Pinus, Larix, Cunninghamia, Agathis and Araucaria; but in the sequel the Cedar, the Larch, the Spruce, Silver and Hemlock Firs are all described under Abies. In the following year Professor Link proposed in the *Journal of the Academy of Science* of Berlin, the separation from Pinus of the Spruce and Silver Firs as distinct genera, the first as Picea and the second as Abies; also Cedrus as distinct from Larix. In 1841 Link again reviewed the Abietineæ in *Linnæa*, Vol. XV., p. 484, and the genera Pinus, Picea, Abies, Cedrus and Larix may be said to have been definitely established, although they were not taken up by many of his successors as he left them.

The TAXACEÆ as an Order distinct from the CONIFERÆ was proposed by Dr. Lindley, following L. C. Richard's Section I. in the second edition of his *Natural System* published in 1836; it was taken up by Loudon two years later in the *Arboretum et Fruticetum Britannicum*, but failed to secure general acceptance notwithstanding the very marked structural differences in the fruits, foliage and wood of the two Orders. By nearly all subsequent authors the Taxads were included in the Coniferæ under the tribes Taxeæ or Taxineæ and Podocarpeæ. In the Abietineæ of Loudon, Link's Abies and Picea are reversed, the former name being applied to the Spruce, and the latter to the Silver Firs in accordance with an unfortunate oversight of Linnæus, who named them *Pinus Abies* and *P. Picea* in contradiction to the classical designation of these trees, and which had been adopted by the older botanists. With Loudon originated that confusion of Abies and Picea which has proved so irksome to horticulturists and foresters, and which was intensified by Gordon through the widely-distributed editions of his *Pinetum*. David Don, who had assisted Lambert in the preparation of the later editions of *The Genus Pinus*, established the tribe Araucarineæ in the *Transactions of the Linnean Society* published in 1841: it included Araucaria and Agathis (Dammara) previously placed in the Abietineæ.

In 1842, Spach, a French botanist of German origin, removed the American White Cedar (*Cupressus thyoides*) from Cupressus, and founded upon it the genus Chamæcyparis* on the ground chiefly that the ovules of each fruit scale are restricted to two, and the fruit is matured the first year instead of in the second as in the true Cypresses. It was afterwards enlarged by the addition of two north-west American species and the Retinisporas of Siebold and Zuccarini. Spach's Chamæcyparis was taken up by most subsequent authors, and

* Histoire des Végétaux Phanérogames. Tome XI. p. 328.

is still retained by continental botanists. By Mr. Bentham the group of Cypresses which it includes was made sectional under Thuia (Thuya),* which, however, has met with no acceptance.

The most eminent contributor to the systematic botany of the Coniferæ immediately after Loudon's death was Stephen Endlicher (Vienna, 1804—1849). In his *Synopsis Coniferarum* published in 1847 the Cupressineæ, Abietineæ, Podocarpeæ and Taxineæ were raised to the rank of Natural Orders and sub-divided into tribes. The Taxodineæ as a tribe was here established; it included Taxodium, Glyptostrobus and Cryptomeria, but curiously enough, Sequoia founded by himself, Athrotaxis and Sciadopitys are placed in the Abietineæ and grouped with Cunninghamia and Agathis, the Araucarias forming a separate tribe. The genus Pinus is retained entire in the Linnæan sense, but sub-divided into sections, one of which (Tsugæ) comprised the Hemlock and Douglas Firs, here separated for the first time from the Spruces. Several generic changes made by Endlicher have been universally adopted, the most noteworthy of which was the separation of the Californian Redwood from Taxodium upon which he founded the genus Sequoia; he also established the genus Libocedrus on Chilian and New Zealand species previously referred to Thuia, and Widdringtonia on a group of South African species allied to Callitris. Endlicher was followed by Carrière, Chef des Pèpinières du Museum d'Histoire Naturelle de Paris, who published a *Traité Général des Conifères* in 1855, of which a second and enlarged edition appeared in 1867; in this work Endlicher's classification is followed in all its essential features, but Pinus is restricted to the true Pines, and Link's Abies, Picea, Cedrus and Larix are kept up, as is also Gordon's Pseudolarix; Endlicher's section Tsuga is raised to generic rank, for the Hemlock Firs and two new genera are broached under the names of Pseudotsuga and Keteleeria respectively, the first for the reception of the Douglas Fir, and the second for the *Abies Fortunei* of Lindley. The second edition of Carrière's *Traité* was immediately followed by the elaboration of the Coniferæ in De Candolle's *Prodromus* by Professor Parlatore of Florence. Parlatore's systematic arrangement is based chiefly on that of Endlicher with the divisional names of a lower rank; in the Abietineæ Pinus is retained in its entirety but divided into two sub-genera, Pinus proper for the Pines, and Sapinus for the remaining species except the Araucarias and Agathis which are also included in the Abietineæ as a sub-tribe. Under the Taxodineæ (Taxodieæ) are included all the genera at present contained in that tribe together with Cunninghamia and Widdringtonia, and the Taxaceæ as a whole are more distinctly separated from the Coniferæ than by previous authors, with the exception of Lindley and Loudon already mentioned.

In 1881 was published the Coniferæ worked out by Mr. Bentham for the *Genera Plantarum*, the most prominent feature of which, as distinguished from all previous elaborations, is the much simpler systematic arrangement of the Order, and which consists only of a primary division into six tribes, with a sectional division of the more extensive genera. The other changes made by Mr. Bentham are chiefly in the circumscription of the genera, thus:—In the Cupressineæ, Widdringtonia (Endl.), Tetraclinis (Vahl.) and Frenela (Mirbel) are merged into Callitris; the first two, however, are restored by Dr. Masters; and Thujopsis

* Genera Plantarum. Vol. III. p. 127.

(Siebold), Biota (Endl.) and Chamæcyparis (Spach.) are merged into Thuia (Thuya), but the last-named is now reunited to Cupressus. A few other changes made by Bentham, such as the merging of Pseudolarix (Gord.) into Larix, and the grouping of Cephalotaxus with the Sequoias of California and the other Taxodineæ are not in harmony with ascertained facts or with more recently acquired information. Mr. Bentham was succeeded by Professor Eichler of Berlin, whose elaboration of the Coniferæ was published two years after his death in Engler and Prantl's *Natürlichen Pflanzenfamilien*, 1887. In this classification the genera are arranged in two primary divisions, Pinoideæ and Taxoideæ, the former including the Conifers proper and the latter the Taxads, thus emphasising the distinction made by Parlatore, but still retaining them in one Natural Order. The Pinoideæ are divided into Abietineæ and Cupressineæ with several tertiary divisions, and the Taxoideæ into Podocarpeæ and Taxeæ; the genera are much the same as in Bentham and Hooker's *Genera Plantarum*, but Chamaecyparis, Thujopsis and Pseudolarix are retained and Pseudotsuga is merged into Tsuga.

In 1892 a "Conifer Conference" was held by the Royal Horticultural Society in their garden at Chiswick, on which occasion was brought together from all parts of Great Britain the most remarkable collection of specimens cut from Taxaceous and Coniferous trees and shrubs ever witnessed. The information gained therefrom, and especially from the papers read and which form the fourteenth volume of the Journal of the Society, prepared the way for a further systematic revision of the Order, which was undertaken by Dr. Maxwell T. Masters, and the result published in 1893 in the thirtieth volume of the Journal of the Linnean Society. The systematic arrangement there elaborated is, with few deviations, adopted in the following pages.

Ginkgo biloba in the Royal Gardens at Kew.
(From the *Gardeners' Chronicle*.

TAXACEÆ.

TREES or shrubs with homomorphic, rarely dimorphic ramification. Leaves persistent, rarely deciduous. Staminate flowers composed of numerous stamens arranged in a globose head or cylindric spike. Ovuliferous flowers composed of few or several imbricated scales that are membraneous or become fleshy, never ligneous. Ovules erect or pendulous surrounded at the base by a fleshy, rarely desiccate arillus which wholly or in part encloses the ripe seed; rarely exarillate. Maturation of fruit annual, rarely biennial.

TRIBE—SALISBURINEÆ.

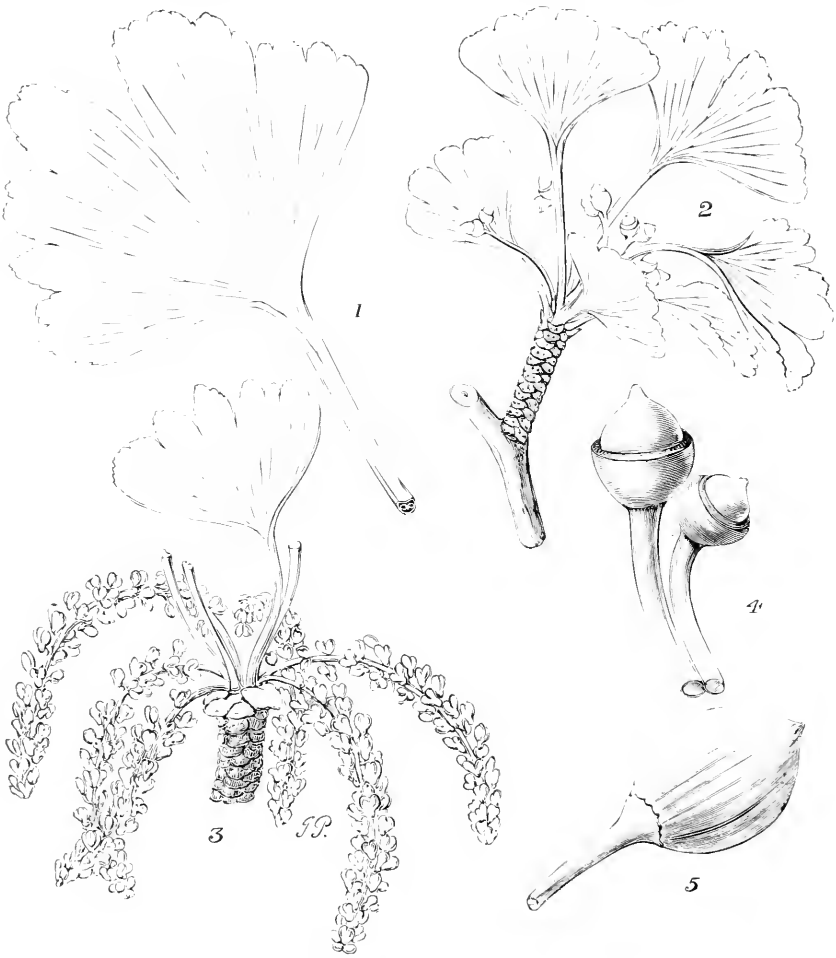
Flowers dioecious, rarely monoecious. Stamens numerous. Ovules erect.

Branchlets dimorphic. Leaves deciduous. Staminate flowers umbellate - - - - 1.—Ginkgo.
Branchlets homomorphic. Leaves persistent.
Staminate flowers crowded; stamens capitate 2.—Cephalotaxus.
Staminate flowers solitary; stamens spicate - 3.—Torreya.

GINKGO.

Linnaeus, Mantissa, II. 313 (1771). Parlatore, D. C. Prodr. XVI. 506 (1868). Bentham and Hooker, Gen. Plant. III. 432 (1880). Eichler in Engler and Prantl, Nat. Pfl. Fam. 108 (1887). Masters in Journ. Linn. Soc. XXX. 3 (1893).

Ginkgo is monotypic. The existing species is the sole survivor of an unknown number of others widely dispersed during geological ages over what is now the temperate and colder parts of the northern hemisphere. Fossil remains of Ginkgo have been discovered in systems that were in course of formation at a remote epoch of the Earth's history and which show conclusively that the genus is of astonishing antiquity and that the first appearance of its ancestral form antedates that of every other existing tree by æons of time. The Ginkgo thus presents to us a glimpse of at least one form of vegetation that flourished on the Earth when it was inhabited by unwieldy Icthyosauri, gigantic toads and monster Deinotheriums ages before Man entered upon his inheritance. If the association of the Ginkgo with the remote Past is of a kind to excite wonder, its recent history is scarcely less a subject for surprise, for the origin of the existing species is shrouded in mystery as obscure as that of its remote ancestors. Its habitat is practically unknown; no naturalist can say that he has seen it in a wild state, and hypothesis alone suggests that it may possibly be found wild in some unexplored district in eastern Mongolia.* For centuries it has been preserved alive by the Chinese and Japanese who by



[Fig. 49. *Ginkgo biloba.* 1, Leaf of sterile branch; 2, of fertile branch; 3, Staminate flowers; 4, Ovuliferous flowers; 5, fruit.

associating it with their religious worship and planting it near their shrines and temples, have invested it with a kind of sanctity that has contributed immensely to its preservation amidst a dense population among whom the struggle for existence has long been of an acute

* A recent communication from the Far East points to the probability of the Ginkgo being endemic in Corea.

kind, and whose resources of fuel and timber have always been extremely restricted. Thus preserved "it stands alone, a perfect stranger, in the midst of recent vegetable forms."

The name Ginkgo was adopted by Linnæus from Kaempfer, the first European naturalist who saw and described the tree; but Sir J. E. Smith altered the name to Salisburia in compliment to R. A. Salisbury, a prominent British botanist of the early part of the nineteenth century, on the ground that it was equally uncouth and barbarous. The alteration was, however, soon afterwards objected to by the elder De Candolle as opening a door to the needless multiplication of names. The original name is now almost universally accepted.

Ginkgo biloba.

A tall tree, 50–100 feet high, with a cylindric or slightly tapering trunk and alternate or scattered horizontal branches; the secondary branches and especially the branchlets usually irregularly disposed. Bark of trunk and primary branches rough, more or less fissured in old trees, dull greyish brown; of branchlets, pale ash-brown and smooth. Leaves deciduous, in fascicles of three–five or more on short alternate "spurs," variable in size; the footstalks 1–3 inches long, terete on the dorsal and furrowed on the ventral side; the lamina a fan-shaped expansion 2–3 inches broad, of leathery texture and dull green colour, with numerous veins of nearly equal size diverging from the top of the petiole and not connected by lateral reticulations; the blade is rendered two-lobed by a cleft in the apical margin which varies much in depth according as the leaves are on sterile or fertile branches, being very shallow or almost obliterated on the latter. Inflorescence diœcious. Staminate flowers sub-pendulous in umbels of three–six on the ends of short arrested branchlets or "spurs," and intermixed with leaves; anther lobes two, pendulous and divergent. Ovuliferous flowers in pairs on the apex of slender footstalks, each flower consisting of a single erect ovule arising from a cup-shaped dilatation of the axis. Fruit drupe-like, the fleshy outer covering of a greenish orange colour enclosing a hard woody mesocarp or shell that contains the seed.*

Ginkgo biloba, Linnæus, Mantissa *loc. cit. supra* (1771). Thunberg, Fl. Jap. 358 (1784). Carrière, Traité Conif. ed. II. 711. Parlatore, D. C. Prodr. XVI. 506. Siebold and Zuccarini, Fl. Jap. II. 72, t. 136. Masters in Journ. Linn. Soc. XVIII. 500; and Journ. R. Hort. Soc. XIV. 219. Beissner, Nadelholzk. 189, with figs.

Salisburia adiantifolia, Smith in Trans. Linn. Soc. III. 330 (1797). Aiton, Hort. Kew. ed. 2. Vol. V. 301 (1813). Loudon, Arb. et Frut. Brit. IV. 2094 (1838), with figs. Endlicher, Synops. Conif. 237 (1847). Gordon, Pinet. ed. II. 373 (1875).

Eng. Maidenhair-tree. Fr. Arbre aux quarante écus.† Germ. Ginkgobaum. Ital. Albero capilvenere. Jap. Icho.

The following varieties are occasionally seen in cultivation:—

macrophylla.—Leaves much larger than in the common form, and often divided into three–five lobes which are occasionally subdivided into smaller lobules.

* The ripe seeds of Ginkgo, Cephalotaxus and Torreya have a close structural resemblance to each other and to Cycas. These genera therefore form one of the links connecting the Cycads with the Taxaceæ.

† The origin of this curious name is related by Loudon in the Arboretum et Fruticetum Britannicum. IV. 2096.

pendula.—Branches more or less pendulous, but sometimes only slightly deflexed. Of slower growth than the common form.

variegata.—Leaves blotched and streaked with pale yellow.

In Japan the Ginkgo attains a very large size and lives to an unknown age: trees fully 100 feet high with massive trunks six to seven feet in diameter are to be seen in the neighbourhood of temples at Tokio. In Europe some of the oldest trees have attained a still greater height, but the trunks are smaller. Both in Europe and North America the Ginkgo has proved quite hardy, often thriving under the most trying conditions of climate, a circumstance which seems to confirm the hypothesis of its northern origin. As a picturesque tree it is unrivalled, whether standing alone or associated for contrast with others of different genera. Its usually straight, erect trunk is furnished with short branches, of which the lower ones spread horizontally: but when from any cause the growth of the principal axis is arrested the primary branches lengthen considerably, and the tree presents a much broader outline. In summer, its curious Maidenhair-like leaves impart to it a light and airy aspect: but it is in autumn, when the foliage takes on a rich golden hue that the beauty of the Ginkgo is most conspicuous, and for that reason alone it should have a place in every garden where space permits: the defoliation is, however, often very rapid especially when the weather is stormy. It is one of the best of trees for planting in crowded towns, its thick leathery leaves covered with a tough resisting skin enabling it to withstand the injurious effects of smoke and other atmospheric impurities.

The secular history of the Ginkgo dates only from the beginning of the eighteenth century. It first became known to Europeans through Engelbert Kaempfer, who visited Japan in 1690 in the capacity of physician to the Dutch Embassy, and who published a figure and description of the tree in his "Amoenitates Exoticæ," which appeared in 1712. Much uncertainty exists as to the precise date of its introduction into Europe: according to London it is believed to have been introduced into Holland some time between 1727—1737, this hypothesis being founded upon the supposed age of a tree in the Botanic Garden at Utrecht. Its introduction into Great Britain is stated by the same authority to have been in 1754 or a year or two earlier, because in that year Mr. John Ellis, F.R.S., a London merchant and correspondent of Linnaeus, informed the latter that there were plants of the Ginkgo in the nursery of Mr. James Gordon at Mile End.* Up to the end of the eighteenth century it continued to be very scarce in Europe: seeds were procurable with extreme difficulty, and propagation was effected chiefly by cuttings and layers. The first tree that was observed to flower in this country was one in the Royal Gardens at Kew in 1795, which had been trained against a wall: the flowers were all staminate, and during

* Arboretum et Fruticetum Britannicum, IV. 2095.

the next twenty years every tree observed to flower in Europe was of the same sex. At length, in 1814, the elder De Candolle detected ovuliferous flowers on a tree near Geneva, and subsequently cuttings from this tree were distributed among the Botanic Gardens of Europe, and in places male trees were grafted with them and they afterwards bore fruit. In the Botanic Garden at Vienna the bud of a female tree was grafted on a small male tree, and a lateral branch was developed from it; at the present time it is a large tree with a number of branches bearing staminate flowers and a large branch bearing ovuliferous flowers. The most notable thing about the tree is, that the grafted branch follows a course of development which is obviously different from that of the stock. Every year in the spring it puts forth foliage about fourteen days later than the male branches, and in the autumn the leaves are still green long after the rest have turned yellow and for the most part fallen off.* In Great Britain the practice of grafting trees of one sex with scions of the other appears to have been generally neglected, and in consequence a Ginkgo tree in fruit in this country is rarely if ever seen.

Not much can be said of the economic value of the Ginkgo. Kæmpfer records in his "Amœnitates" that the nuts were highly esteemed by the Japanese and eaten as a dessert, a practice which has continued down to the present time. The fleshy covering has a rancid and disagreeable odour, and the flavour of the kernel is by no means inviting to the European taste. The timber is not known to be applied to any economic purpose: the wood is yellowish, soft and brittle, and destitute of resin.

CEPHALOTAXUS.

Siebold and Zuccarini. Fl. Jap. Fam. Nat. II. 108 (1842). Endlicher. Synops. Conif. 237 (1847). Parlatore. D. C. Prodr. XVI. 502 (1868). Bentham and Hooker. Gen. Plant. III. 430 (1881). Eichler in Engler and Prantl. Nat. Pfl. Fam. 109 (1887). Masters in Journ. Linn. Soc. XXX. 4 (1893).

Isolated as the Gingko is amidst all existing vegetable forms, traces of its relationship with some of them are not entirely wanting: such traces are found in Cephalotaxus: they are seen in the structure of the fruit which closely resembles that of Gingko in the following characteristics:—

The fruits of both genera are destitute of an aril, its place being taken by the testa of the seed which becomes succulent. The seed or nut which is enclosed in a hard ligneous shell, is covered with a brown membrane the lower half of which is adherent to the shell. There is also a well-marked pollen chamber in the nucellus of the seed.†

Five or six species of Cephalotaxus have been described, but they are not differentiated by very definite characters. Their habitat is confined within a somewhat limited area in eastern Asia including Japan, a part of China and the eastern Himalayan zone where they

* Kerner's "Natural History of Plants," Oliver's Translation. Vol. II. p. 572.

† Masters in Journ. Linn. Soc. XXX. *loc. cit.*

form low evergreen trees or shrubs of Yew-like aspect. The generic characters may be thus formulated:—

Flowers diœcious, in axillary heads. Staminate flowers, subsessile or shortly pedunculate, the peduncle sheathed by imbricating scales, the capitulum consisting of four—six stamens, each enclosed by a broad scale-bract. Anthers three-lobed, pendulous from the apex of the staminal leaf.

Ovuliferous flowers pedunculate, composed of scale-like imbricated bracts that become more or less fleshy at the base and form a cup-shaped cavity which bears two—three ovules.

Fruit drupe-like, ovoid or sub-globose; testa succulent with a leathery skin enclosing an almond-shaped seed with a hard ligneous shell.

The hardy Cephalotaxi are referable to three fairly distinct species connected by intermediate forms that have resulted from hybridity. They should be planted in shade, their foliage then retains its deep lustrous green as well as its persistency; when fully exposed to the sun the leaves often become discoloured and unhealthy and soon fall off. Besides being shaded they should be sheltered from cold winds, and the soil in which they are planted should be moist but sufficiently drained. Under these conditions alone do they appear to thrive in Great Britain.

The generic name Cephalotaxus is derived from κεφαλὴ (head) and τάξος (the Yew), in allusion to the form of the flowers and the Yew-like aspect of the species.

Cephalotaxus drupacea.

A low shrub or bushy tree varying in height from 2—20 or more feet, according to the situation in which it is growing. In British gardens a low spreading bush rarely exceeding 5 feet high. Bark of branches reddish brown marked by narrow, longitudinal out-growths decurrent from the bases of the leaves, the herbaceous shoots yellowish green with the out-growths more prominent. Branchlets distichous and mostly opposite; buds very small, with thick, ovate keeled perulæ. Leaves pseudo-distichous, shortly petiolate, linear, mucronate, scarcely tapering towards the apex, slightly recurved, 0·5—1·25 inch long, grass-green with a median keel above, much paler beneath with darker lines at the margins and midrib. Staminate flowers, shortly stalked, about 0·2 inch in diameter, usually in pairs along the underside of shoots of the preceding year and close to the axils of the leaves. Fruit ellipsoid, contracted at the basal end, 1·5 inch long and 0·75 inch in diameter at the broadest part; chestnut-brown where mature.

Cephalotaxus drupacea, Siebold and Zuccarini, Fl. Jap. II. 66. t. 130, 131. (1842). Endlicher, Synops. Conif. 239. Carrière, Traité Conif. ed. II. 720. Parlatore, D. C. Prodr. XVI. 504. Gordon, Pinet. ed. II. 67. Beissner, Nadelholzk. 183. Masters in Journ. Linn. Soc. XVIII. 499; Gard. Chron. XXI. (1884), p. 113; and in Journ. R. Hort. Soc. XIV. 201.

Cephalotaxus drupacea is widely distributed over the mountains of Japan from southern Hondo to central Yeso, with a vertical range of from 1,000 to 3,000 or more feet, in places forming a part of the undergrowth in woods composed of Maples, Cryptomeria and Cypress. At and near its northern limit it is a low shapeless bush such as it is usually seen in Great Britain; on the Hakone mountains it forms a bushy tree 20 to 25 feet high. It was introduced to the Botanic Garden at Leide (Leyden) about the year 1829 by Dr. Siebold.

Cephalotaxus Fortunei.

In Great Britain, a shrub or low tree not exceeding 20—25 feet high, the trunk usually forked or divided into three or four ascending stems at a short distance from the ground, the outer bark peeling off in flakes exposing a reddish brown inner cortex. Primary branches in pseudo-whorls of three—four, spreading or ascending; branchlets distichous and opposite. Buds ovoid-conic, acute, 0·2 inch long; perulae ovate-lanceolate, keeled and with a mucronate tip. Leaves pseudo-distichous, linear, acuminate, 1·5—3 inches long, falcately curved and recurved at the tip, dark green with a median line above, paler with a narrow keel beneath. Staminate flowers 0·25 inch in diameter, in pairs in the axils of opposite or nearly opposite leaves. Fruit ovoid-elliptic, 1·125 inch long and 0·75 inch in diameter at the broadest with a dull chestnut-brown skin when mature.

Cephalotaxus Fortunei, Hooker, W. in Bot. Mag. t. 4499 (1850). Carrière, Traité Conif. ed. II. 718. Parlatore, D. C. Prodr. XVI. 503. Gordon, Pinet. ed. II. 68. Masters in Gard. Chron. XXI. (1884), p. 114; and in Journ. R. Hort. Soc. XIV. 201. Beissner, Nadelholzk. 183, with fig.

This was introduced in 1849 by Robert Fortune who discovered it in the province of Shan-si in north China while on a mission to that region for the Horticultural Society of London and who stated that the tree grew to a height of from 40 to 60 feet. As seen in the gardens and shrubberies of Great Britain, it is the most distinct of the three species described in these pages, but although it has been in our midst half a century, the height of the oldest specimens scarcely exceed 20 feet, and they have for the most part an unshapely form on account of irregular branching. Younger specimens growing in shade in favourable situations are more ornamental; they take the form of a plumose bush well furnished with bright foliage, and afford a pleasing contrast with their surroundings. *Cephalotaxus Fortunei*, in common with several plants included in other Orders, commemorates one of the most successful botanical and horticultural collectors of his time.

Robert Fortune (1812—1880) was a native of Berwickshire, and was educated at the parish school of Edrom. Showing an early preference for gardening, he served an apprenticeship in private gardens and afterwards in the Botanic Garden at Edinburgh where he remained between three and four years. In 1841 he came to London on being appointed a foreman in the Garden of the Horticultural Society at Chiswick, and two years later he was commissioned by the Society to proceed to China to collect plants. He arrived in China in July 1843 and at once entered upon that career of collecting which afterwards proved so fruitful. He visited Hongkong, Macao and Canton, and thence proceeded northwards to Chusan and Shanghai, and in 1844 he visited the tea-growing district of Ningpo where he remained some time investigating the Tea culture and the process of manufacture. He returned to England with his collections in 1846, and was shortly afterwards appointed to the Curatorship of the Chelsea Botanic Garden which he gave up in 1848 that he might accept an offer of the East India Company to proceed again to China to collect Tea plants and seeds for transmission to India. The mission was eminently successful; in 1851 he brought to Calcutta 2,000 young Tea plants and 17,000 germinating seeds with which he proceeded to the north-west provinces where he may be said to have laid the foundation of the important Tea industry of India. Continuing in the service of the East India Company he revisited China in 1852 and remained in the country three years investigating the Tea and Silk industries and especially the Chinese methods of horticulture, of which he has given some curious and interesting accounts in the "Gardeners' Chronicle." In 1858 he again set out for China, this time in the service of the American Government, and in 1860 he visited Japan whence he returned to England in 1862. During his long and difficult journeyings in the Far East "his adventures were full of romance; whether feasting with Mandarins, enjoying the hospitality of Buddhist priests, battling with the swarming natives, fighting single-handed with pirates, or gaining admission to Loo-Chow in the guise of a Chinaman, he seemed to have exercised equal energy and sagacity." He published an account of his travels in three works entitled "Three Years' Wanderings in the North of China, 1847," "A Residence Among the Chinese, 1857," and "Yeddo and Peking, 1865"; these books are remarkable for the picturesque and natural way in which he describes what he saw. Many of his introductions have found their way into every garden worthy of the name throughout the civilized world and where they are recognized as among the most pleasing ornaments. The principal coniferous trees introduced by him were *Cryptomeria japonica*, *Laricopsis Kæmpferi*, *Cephalotaxus Fortunei*, *Pinus Bungeana*, *Thuia japonica* and *Cupressus funebris*. Amongst flowering shrubs *Pæonia Moutan*, *Viburnum plicatum*, *Jasminum nudiflorum*, *Diervilla (Weigela) rosea*, *Forsythia viridissima* and *Trachelospermum jasminoides* deserve especial mention; and of herbaceous perennials *Anemone japonica*, *Dicentra spectabilis* and *Campanula nobilis* will always retain the high place they now occupy.—*Gardeners' Chronicle*, XIII. (1880), p. 187.

Cephalotaxus pedunculata.

A low tree with a dense head and sub-pendulous branchlets. In Great Britain a spreading, bushy shrub of larger dimensions than *C. drupacea*. Bark of branches reddish brown, smooth, except where marked by the scars of the fallen leaves; bark of branchlets green, ridged and furrowed by cortical out-growths decurrent from the bases of the leaves. Buds conic-cylindric; perulæ ovate, acute, keeled, free at the apex, reddish brown. Leaves subsessile, pseudo-distichous, linear, slightly tapering towards the apex, 1–2 inches long, dark green with a thin median keel above, much paler and marked with darker lines at the midrib and margins below. Staminate flowers distinctly pedunculate, about 0·5 inch long, both peduncle and capitulum sheathed by scale-like, ovate bracts that are gradually larger upwards. Fruit ellipsoid, about an inch long, suspended from a short, deflexed foot-stalk sheathed by a few scarious bracts.

Cephalotaxus pedunculata, Siebold and Zuccarini, Fl. Jap. II. 67, t. 133 (1842). Endlicher, Synops. Conif. 238. Carrière, Traité Conif. ed. II. 716. Parlatore, D. C. Prodr. XVI. 503. Gordon, Pinet. ed. II. 69. Masters in Gard. Chron. XXI. (1884), p. 113; in Journ. Linn. Soc. XVIII. 499; XXII. 201, with fig.; and in Journ. R. Hort. Soc. XIV. 201. Beissner, Nadelholzk. 180.

Taxus Harringtoniana, Forbes, Pinet. Woburn. 217, t. 66.

var.—fastigiata.

A broadly columnar shrub resembling the Irish Yew. Branches erect, more or less appressed to the stem; branchlets also erect and parallel with their primaries. Leaves spreading on all sides of the axis, very leathery and of a darker green than in the spreading form.

C. pedunculata fastigiata. Carrière. Traité Conif. ed. II. 717. Masters in Gard. Chron. XXI. (1884), p. 113, with fig.
Taxus japonica. Hort.
Podocarpus koraiensis. Hort.

Fig. 50. Foliage and fruits of *Cephalotaxus pedunculata*.
(From the *Gardeners' Chronicle*.)

var. — sphæralis.

Branches light chestnut-brown; branchlets glabrous, green. Leaves linear, falcate, sub-acuminate, 1·5—2 inches long. Fruit in clusters near the base of the branchlets, shortly stalked, globose, nearly as broad as long, not ellipsoid.

C. pedunculata sphæralis. Masters in Gard. Chron. XXI. (1884), p. 113 with fig.: and in Journ. Linn. Soc. XXII. 203.

The shrub here described under the name of *Cephalotaxus pedunculata*, as seen in British gardens is distinguished from *C. drupacea* by its pedunculate, staminate flowers, its larger and darker leaves and its larger size. Nevertheless there are forms in cultivation which may with equal right be referred to either: and these forms together with the absence of any definite information respecting the habitat of *C. pedunculata* favour the view of those botanists who recognise but one species of Cephalotaxus endemic in Japan. *C. pedunculata* was introduced to the Botanic Garden at Leide by Dr. Siebold with *C. drupacea*. According to Forbes it was first cultivated in this country in 1837 under the name of *Taxus Harringtoniana*.

The variety *fastigiata* is the best of all the Cephalotaxi for British gardens; it is an analogue of the Irish Yew, curious, ornamental and distinct, and although slow growing, many places may be found for it that no other Taxad or Conifer can so well fill. Only one plant of the variety *sphaeralis* appears to be known: this is (or was) growing in the garden of a clergyman at Steyning in Sussex.

TORREYA.

Arnott, Ann. Nat. Hist. I. 126-130 (1838). Parlatore, D. C. Prodr. XVI. 501 (1868). Bentham and Hooker, Gen. Plant. III. 431 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 111 (1887). Masters in Journ. Linn. Soc. XXX. 5 (1893). Tumion, Rafinesque, Amenities of Nature, 63 (1840), ex Sargent, Silva N. Amer. X. 55 (1896).

A genus of evergreen trees of Yew-like aspect but more formally ramified, and with longer and larger leaves that are rigid and spine-tipped. Three well differentiated species are known* inhabiting regions widely remote from each other: one, the type species, is restricted to a small area in Florida; the second American species has a wider range through the Sierras of western California; and the third occurs on the mountains of central Japan and probably in north China. The existing species are the survivors of an unknown number of others which in Tertiary times were spread over Europe and North America from the Arctic Circle southwards, but which disappeared under the influence of the extreme cold of the Glacial epoch. The Torreyas, therefore, are of much interest in their scientific aspect; they formed part of the arborescent vegetation of the northern regions of the Earth at the time when Taxodium and the Sequoias were a prominent ingredient of the forest, with which they are still associated in North America, and doubtless attained their greatest development during the same geological period. The race appears to be passing away, although the species may be preserved indefinitely by the hand of Man.

The essential characters of Torreya are—Flowers diœcious, rarely monœcious, axillary and sessile on shoots of the preceding year

* Our knowledge of *Torreya grandis* introduced by Fortune from North China in 1847 is still very imperfect, and the little that is known of it tends to the conclusion that it is not specifically distinct from the Japanese *T. nucifera*.

Staminate flowers in globose-cylindric heads, covered with ovate, closely imbricated, spirally arranged scales, and subtended at the base by a few scale-like bracts, larger than the antheriferous scales. Stamens in six—eight whorls, attached to the axis by a short, flattened filament bearing four deflexed anthers.

Ovuliferous flowers, composed of one or more fleshy scales surrounded at the base by a few scale-like imbricated bracts in decussate pairs; ovule solitary, erect, seated in the centre of a fleshy aril which partially closes over it, and becomes confluent with the testa of the seed.

Fruit ovoid or ellipsoid, consisting of a single seed enclosed in a ligneous shell covered with a fibrous fleshy envelope (aril) and thin leathery integument of a greenish brown colour when ripe.

The young foliage of the Torreyas when bruised emit a disagreeable rue-like odour, whence in America they are called fetid Yews. The genus commemorates Dr. John Torrey, "the Nestor of American Botany," the originator and author of a portion of the "Flora of North America," and the contributor of many valuable papers on subjects connected with American Botany.*

The Torreyas do not thrive in Great Britain. *T. taxifolia* is a subtropical tree which, if introduced, would probably succumb to the first severe winter it would have to endure; *T. californica* has proved disappointing except in the case of a very few specimens growing in the south-west of England and in parts of Ireland; and the same must be said of the Japanese *T. nucifera*. In a few places the two last-named species are growing into moderate-sized bushes, but more frequently their growth is very slow, and the habit they assume offers little that is attractive and is quite different from the handsome trees they often become in their native countries.

Torreya californica.

A tree 50—70 or more feet high, with a trunk 1—2 feet in diameter covered with grey-brown bark with a reddish tinge and fissured longitudinally into narrow ridges. Branches spreading and ramified distichously, the branchlets mostly opposite; bark of branches smooth, red-brown, much paler and striated with grey on the younger shoots, and green on branchlets of the current year's growth. Buds usually three at the apex of the axial growths, solitary or in pairs on the lateral shoots, ovoid-conic, acute, four-angled with about eight ovate, acute, light brown, closely imbricated perulæ in decussate pairs. Leaves persistent five—six years, sub-spirally arranged and spreading distichously, linear-lanceolate, spine-tipped, 1·5—2·5 inches long, falcately curved or straight, thickened along the middle, dark lustrous green above, paler with two depressed whitish stomatiferous lines beneath. Staminate flowers in dense globose heads about 0·35 inch in diameter, in the axils

* The name Torreya, after fifty years of continuous use for this remarkable group of trees, is now discarded by the American botanists in favour of Rafinesque's Tumion, on the ground that the name had been previously taken up by Sprengel for a Verbenaceous plant which has been merged in Clerodendron by Bentham and Hooker. "Genera Plantarum." II. 1156.

of the leaves of the terminal shoots. Fruit solitary, ellipsoid or obovoid, 1—1·5 inch long, the fleshy envelope green more or less striated with purple, thin and resinous, the inner woody seed-coat strongly furrowed.

Torreya californica. Torrey in New York Journ. Pharm. III. 49 (1854). Parlatore, D. C. Prodr. XVI. 506 (1868). Hoopes, Evergreens, 385. Gordon Pinet. ed. II. 410. Hooker fil. in Gard. Chron. XXIV. (1885), p. 553 with fig. Masters in Gard. Chron. V. s. 3 (1889), p. 800, with figs.; and in Journ. R. Hort. Soc. XIV. 254. Brewer and Watson. Bot. Califor. II. 110. Beissner, Nadelholzk. 188. Sargent, Forest Trees of N. Amer. 10th Census U.S. IX. 186.

T. myristica. Hooker, W. Bot. Mag. t. 4780 (1854). Van Houtte, Fl. des Serres, IX. t. 925 (copied from Bot. Mag.). Carrière, Traité Conif. ed. II. 727. Kent in Veitch's Manual, ed. 1. 311.

Tumion californicum. Greene, Pittonia. II. 195 (1891). Lemmon, West Amer. Cone-bearers, 83. Sargent. Silva N. Amer. X. 57, t. 513.

Eng. and Amer. Californian Nutmeg. Germ. Muskatnuss-Torreye. Fr. Torreya de Californie.

"The Californian Nutmeg inhabits the borders of mountain streams, and is nowhere common: it is widely distributed in California from Mendocino county to the Santa Cruz mountains in Santa Clara county in the coast region, where, especially near its northern limit, it grows to its largest size and is most abundant; it also occurs along the western slopes of the Sierra Nevada from Eldorado to Tulare County at elevations of from 3,000 to 5,000 feet above sea-level."*

On its native mountains *Torreya californica* during its best period is a handsome pyramidal tree, in old age a round-headed compact tree with drooping branches and lax foliage. In its adult state it is not, however, always an attractive object as we learn from the sketch of a scraggy tree by Sir J. D. Hooker published in the "Gardeners' Chronicle" of October 31st, 1885; this tree was growing in the Yosemite valley and was the best specimen observed. It is not certainly known who was the original discoverer of the Californian Nutmeg; the materials from which Dr. Torrey first described the tree as *Torreya californica* in the New York "Journal of Pharmacy" in 1854 were communicated by a Mr. Shelton. Shortly afterwards it was figured and described in the "Botanical Magazine" by Sir William Hooker under the name of *Torreya myristica* from specimens supplied by Mr. James Veitch, Senr. which had been gathered by William Lobb. As Torrey's name has priority the latter must sink as a synonym of it. The wood is said to be light and close-grained but not strong, durable in contact with the soil and susceptible of a high polish: it is not much used.

Although introduced into British gardens in 1851, handsome specimens of *Torreya californica* are but rarely seen.† It has occasionally produced its plum-like fruits in this country, and young plants have been raised from the seeds.‡

* Sargent. Silva of North America, *loc. cit. supra.*

† The best specimen known to the author is at Tortworth Court in Gloucestershire, the seat of the Earl of Ducie.

‡ At Orton Hall, near Peterborough, the seat of the Marquis of Huntly, by Mr. Harding, the Gardener. The tree which produced the seeds is monoecious.

Torreya nucifera.

An under-shrub or small tree 20—30 feet high but in favourable situations attaining the dimensions of a large tree upwards of 80 feet high with a trunk 4—5 feet in diameter covered with red bark. Primary branches spreading, in old trees sometimes sub-pendulous; branchlets distichous and opposite; bark of young shoots green changing to reddish brown the second year. Terminal buds in threes of which the axial one is the largest, spindle-shaped, sheathed by three—four decussate pairs of light brown membraneous perular scales. Leaves persistent three—four years, linear-lanceolate, acute, 0·75—1·25 inch long, terminating in a sharp spine, spirally arranged around the axis but rendered pseudo-distichous by a half twist of the short petiole, very coriaceous and rigid, dark lustrous green above, paler beneath with a shallow channel on each side of the midrib. Staminate flowers oblong-ellipsoid, about 0·5 inch long. Fruit ovoid-elliptic, less than an inch long.

Torreya nucifera, Siebold and Zuccarini, Fl. Jap. II. 61, t. 129 (1842). Endlicher, Synops. Conif. 240 (1847). Carrière, Traité Conif. ed. II. 721 (1867). Parlatore, D. C. Prodr. XVI. 505. Hoopes, Evergreens, 386. Gordon, Pinet. ed. II. 411. Beissner, Nadelholzk. 186. Masters in Journ. Linn. Soc. XVIII. 500; and in Journ. R. Hort. Soc. XIV. 254.

Taxus nucifera, Linnæus, Sp. Plant. ed. I. 1040 (1753), and ed. II. 1472 (1764). Thunberg, Fl. Jap. 275 (1784). L. C. Richard, Mém. sur les Conif. 21 (1826).

Eng. Japanese Torreya. Fr. Porte-noix Torréya. Germ. Nusstragende Torreye. Ital. Torreya giapponese. Jap. Kaya.

Torreya nucifera occurs in the southern islands of Japan and in the forests of southern and central Hondo, attaining its greatest development on the banks of the river Kisagawa, "rising to a height of 80 feet, and forming a tree unequalled in the massiveness of its appearance and in the beauty of its bright red bark and lustrous dark green, almost black foliage."* On the south-west coast of Hondo where it is associated with Camellias, *Diospyros Kaki* and other garden favourites it is somewhat different from the inland tree: the head is more dense and with a rounded top not unlike that of some of the older Yews in this country; the leaves too are shorter, narrower and more pointed. The wood is strong and straight-grained; it is much valued for building and cabinet-making.

The Japanese Torreya first became known to science through Kæmpfer, who figured and described it in his "Amœnitates," published in 1712. According to Aiton, it was cultivated in England in 1764 by Captain Thomas Cornwall under the Linnæan name of *Taxus nucifera*† but was subsequently lost; it was re-introduced into European gardens by Dr. Siebold about the year 1840 or a little earlier.

Torreya taxifolia.

A tree occasionally 40 feet in height with a short trunk 1—2 feet in diameter, producing when cut, many vigorous shoots from the stump and roots and whorls of spreading or slightly pendulous branches,

* Sargent, Silva of North America, X. 56.

† Hortus Kewensis, ed. II. Vol. V. p. 416.

which form a rather open pyramidal head tapering from a broad base. Bark of trunk brown faintly tinted with orange-red, irregularly fissured into wide ridges and disclosing a yellow inner bark. Branchlets slender, green for two or three years, then gradually changing to dark orange-red. Buds 0·5–0·75 inch long, covered with loosely imbricated scales. Leaves slightly falcate, 1·5 inch long, tipped with an elongate callous point, lustrous dark green above, paler beneath with broad shallow grooves. Staminate flowers 0·25 inch long with pale yellow anthers. Ovuliferous flowers broadly ovate, abruptly narrowed at the apex, enclosed at the base by broad thin rounded scales. Fruit slightly obovate, dark purple, 1–1·25 inch long and 0·75 inch broad.—Sargent, *Silva of North America*, X. 57, t. 515.

Torreya taxifolia. Arnott. Ann. Nat. Hist. I. 130 (1838). Endlicher. Synops. Conif. 241 (1847). Nuttall. Sylva. ed. II. Vol. II. 153. t. 109 (1865). Carrière, Traité Conif. ed. II. 726. Parlatore. D. C. Prodr. XVI. 505. Hoopes. Evergreens. 387. with fig. Gordon. Pinet. ed. II. 412. Beissner. Nadelholzk. 186. with fig. Masters in Journ. R. Hort. Soc. XIV. 251.

Tumion taxifolium. Greene. Pittonia. II. 194 (1891). Sargent. Silva. *loc. cit. supra.*

The species on which the genus was founded by Arnott; it was discovered in 1833 by Mr. Hardy B. Croom, a planter and amateur botanist of North Carolina, on the bluffs of the Appalachicola river opposite the town of Aspalaga in north-west Florida, where it is confined to a narrow strip extending about forty miles on the eastern bank of the river. Although it is said to be hardy as far north as eastern Massachusetts, it is still virtually unknown in British gardens, and from its geographical position it cannot be expected to withstand the severe winters that occur at intervals in this country.

TRIBE—TAXINEÆ.

Flowers monœcious or diœcious. Seed enclosed in a dry testa with or without a fleshy arillus.

SUB-TRIBE I.—TAXEÆ.

Ovules erect or ultimately becoming so.
Ovuliferous flowers perulate.
  Branchlets leaf-like, entire or lobed. Leaves on adult plant squamiform, deciduous - 4.—Phyllocladus.
  Branchlets terete. Leaves homomorphic, persistent - - - - - - - - 5.—Taxus.
Ovuliferous flowers without perulæ.
  Branchlets terete, often much sub-divided.
    Leaves heteromorphic - - - - - - 6.—Dacrydium.

SUB-TRIBE II.—PODOCARPEÆ.

Ovules inverted or ultimately becoming so.
Peduncle and bracts concrescent and fleshy.
  Leaves heteromorphic - - - - - - 7.—Podocarpus.
Peduncle ligneous.
  Fruits solitary or loosely spicate. Leaves linear 8.—Prumnopitys.
  Fruits aggregated.
    Flowers monœcious. Leaves linear and spirally arranged - - - - - - - - 9.—Saxegothaea.
    Flowers diœcious. Leaves squamiform, four-ranked - - - - - - - - 10.—Microcachrys.

PHYLLOCLADUS.

L. C. Richard, Synops. Conif. 129. t. 3 (1826). Endlicher, Synops. Conif. 234 (1847). Parlatore, D. C. Prodr. XVI. 498 (1868). Bentham and Hooker, Gen. Plant. III. 432 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 108 (1887). Masters in Journ. Linn. Soc. XXX. 7 (1893).

A singular genus of Taxads in which the functions of foliation are performed by metamorphosed branchlets termed "phylloclades" (phyllodes of some authors, cladodes of others) which are leaf-like expansions usually arranged in a distichous manner along the axial growths from which they are produced. The phylloclades assume different forms in different species and even in the same species as rhombic, fan-shaped, etc., and are either entire, lobed or pinnate: they are leathery in texture and usually with a well-defined median nerve and numerous smaller nerves branching obliquely from it. True leaves of linear form or some modification of it are produced in the young state of the plant, but they usually disappear at the end of the third or fourth year: in the adult state, the true leaves appear only in the form of minute scales at the tip of the branches and at the base of the phylloclades.

Flowers monœcious or diœcious. Staminate flowers crowded or solitary on the tips of axial growths, and surrounded with scale-like bracts at the base. Stamens in a dense cylindric spike and closely imbricated: anthers two-celled with an acute or oblong connective.

Ovuliferous flowers few and either taking the place of, or produced on the margin of greatly reduced phylloclades. They are composed of boat-shaped scales spirally arranged around an axis. Ovules solitary, at first inverted but ultimately becoming erect and surrounded by a coriaceous aril.

The genus includes five species, of which three are endemic in New Zealand, one in Tasmania and one in Borneo. The New

Zealand species are occasionally seen in cultivation in a young state in European Botanic Gardens; the Tasmanian species has been in cultivation in the open ground for many years in the Pinetum of the Hon. Mark Rolle, at Bicton, in South Devon; the Bornean species is known in this country only as an herbarium specimen.

The Phyllocladi are the survivors of a race of trees whose ancestry can be traced back to Mesozoic times, species of which were once widely dispersed over the northern hemisphere. The generic name is derived from φύλλον (a leaf), and κλάδος (a branch), in allusion to the leaf-like branchlets.

Phyllocladus alpinus.

A monœcious shrub or small tree 5—25 feet high with numerous short stout branches. Phylloclades crowded, cuneate, narrowly rhombic or linear-oblong, 0·5—1·5 inch long, with erose margin and apiculate teeth, glaucous and very coriaceous. Staminate flowers, short, in terminal fascicles of two to six, sessile or shortly pedunculate. Oyuliferous flowers on the margins of reduced phylloclades or at the base of others forming small cones each consisting of two or three naked ovules in a fleshy cup. Fruits crimson with two—three seeds, each with a membraneous envelope at its base.—Kirk, *Forest Flora of New Zealand*, p. 199, t. 100.

Phyllocladus alpinus. Hooker fil. Fl. Nov. Zeal. I. 235, t. 53 (1854); and Handb. 260 (1867). Endlicher. Synops. Conif. 214. Carrière. Traité Conif. ed. II. 708. Gordon. Pinet. ed. II. 193.

P. trichomanoides var. alpina. Parlatore, D. C. Prodr. XVI. 498.

Eng. Celery Pine. Mountain Toatoa. N. Zeal. vernacular, Tanekaha, Toatoa.

Phyllocladus alpinus inhabits the mountain districts of the North Island of New Zealand, rarely descending below 2,000 feet elevation; its northern limit is on the summit of Cape Colville. In the South Island it is abundant from Nelson to Southland; on the eastern side it is restricted to high elevations, but on the western it forms a considerable ingredient of the forest at low elevations where it attains its greatest development.

Sir J. D. Hooker remarks that *Phyllocladus alpinus* is perhaps only a form of *P. trichomanoides* but a very distinct one. Mr. Kirk considered it more nearly allied to the Tasmanian *P. rhomboidalis*. Be that as it may, it is highly probable that it would prove hardy in Great Britain in those places where other New Zealand plants thrive, and that the introduction of this remarkable plant would add a novel feature to the British Arboretum.

Phyllocladus glaucus.

A diœcious tree 20—40 feet high with a trunk 12—18 inches in diameter, furnished with short branches that are sometimes whorled. Leaves on young plant linear, obtuse or acute; scale-like leaves of adult plant similar but smaller and recurved. Phylloclades distichous and alternate on modified rachides or branchlets 5—12 inches long, rhomboidal or obliquely ovate-cuneate narrowed below into a short footstalk, lobed or toothed, 0·75—2 inches long, very coriaceous, glaucous green. Staminate flowers in clusters of ten—twenty on rather stout peduncles with one or two minute bracts at the base of each. Oviliferous flowers three—six on each side of the rachis and taking the place of the lower phylloclades, shortly pedunculate, ovoid, or globose-ovoid, 0·5 inch long: ovules seated on a coriaceous cup-shaped disk, of which there are ten—twenty in each flower. Fruit about the size of a small hazel nut, the seeds projecting beyond the aril to about one-half of their length.—Kirk, *Forest Flora of New Zealand*, p. 195. tt. 98, 99.

Phyllocladus glaucus, Carrière, Traité Conif. ed. I. 502 (1855) ; and ed. II. 707.
P. trichomanoides var. glauca, Parlatore, D. C. Prodr. XVI. 498. Gordon, Pinet. ed. II. 195.
N. Zeal. vernacular, Toatoa, Tanekaha.

Phyllocladus glaucus is considered by those who have seen it in its native home, to be the handsomest of all the New Zealand Taxads: it has a restricted habitat in the northern part of the North Island, in places ascending the mountains to nearly 3,000 feet. "The wood is white, remarkably straight in grain and of great strength, but as the tree occurs only in situations difficult of access, it has not been utilised except for temporary purposes."

Phyllocladus rhomboidalis.

A tree 35—60 feet high with a trunk 1—2 feet in diameter. Branches scattered or sub-verticillate, spreading or ascending, the basal part bare of branchlets; bark dark brown with shallow keels decurrent from the base of each branchlet; branchlets numerous, each bearing three—nine phylloclades. Phylloclades shortly stalked, rhomboidal, the longer axis 1—2 inches long, the shorter 0·5—0·75 inch long, the larger lower ones deeply cut into oblong lobes, the smaller terminal ones with the basal margin entire, and the apical one toothed. Flowers monœcious, terminal on the phylloclades and surrounded at the base by imbricated bracts. Fruits containing two or three seeds enclosed to half their length by a fleshy aril.

Phyllocladus rhomboidalis, L. C. Richard, Synops. Conif 130, t. 3 ; and Mém. sur les Conif. 23 (1826). Endlicher, Synops. Conif. 235. Hooker fil. Fl. Tasm. I. 359. Carrière, Traité Conif. ed. II. 706. Parlatore, D. C. Prodr. XVI. 499. Gordon, Pinet. ed. II. 194.
P. asplenifolius, Hooker fil. in Lond. Journ Bot. IV. 151 (1845).
Tasm. vernacular, Celery-topped Pine, Adventure Bay Pine.

The type species on which the genus was founded by the excellent French botanist, L. C. Richard; it is common in the damp forests of Tasmania, especially on the mountains and in the southern parts of the island where it is known by the somewhat inappropriate name of "Celery-topped Pine." The trunk is usually too slender to afford useful timber, but it has been often used for the small masts of sailing vessels. The bark is used for tanning leather.

Phyllocladus trichomanoides.

A tall tree with a trunk 60—70 feet high and 2—3 feet in diameter covered with smooth dark grey or blackish bark. Branches sub-verticillate; branchlets slender. Phylloclades fan-shaped or obliquely rhomboidal, lobed or toothed. Leaves on the young plants narrowly linear, crowded, about 0·4 inch long. Staminate flowers in terminal clusters of five—ten, shortly pedunculate. Ovuliferous flowers solitary on the margins of the phylloclades, consisting of two fleshy scales united in the form of a cup in which is seated the ovule.—Kirk, *Forest Flora of New Zealand*, p. 9, t. 7.

Phyllocladus trichomanoides, Don in Lambert's Genus Pinus, ed. II. Vol. II. App. (1828). Endlicher, Synops. Conif. 235. Hooker fil, Handb. N. Zeal. Fl. 260. Carrière, Traité Conif. ed. II. 705. Parlatore, D. C. Prodr. XVI. 498. Gordon, Pinet. ed. II. 195.

N. Zeal. vernacular, Tanekaha, Celery-topped Pine.

Phyllocladus trichomanoides was originally discovered in New Zealand by Banks and Solander during Captain Cook's first voyage round the globe; it is restricted to the Auckland and Hawke's Bay district in the North Island, and to Nelson and Marlborough in the South Island; it is most abundant, and attains its greatest development in the forests north of Waikuto. The wood is of great strength, dense and heavy, and is used for piles, railway ties, mine props, and occasionally for building purposes. The bark is highly prized for dyeing and tanning; it is one of the best vegetable dyes for yellow and pink, and on that account large quantities are sent from New Zealand to Europe every year.

TAXUS.

Linnaeus, Sp. Plant. II. 1040 (1753). Endlicher, Synops. Conif. 242 (1847). Parlatore, D. C. Prodr. XVI. 499 (1868). Bentham and Hooker, Gen. Plant. III. 431 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 112 (1887). Masters in Journ. Linn. Soc. XXX. 7 (1893).

Taxus, the classical name of the Yew,* is applied to a genus of trees and shrubs of very variable habit, but of slow growth and long-lived, characterised by their close-grained, durable wood, their dark green persistent foliage, their highly coloured berry-like fruits, and especially by their flowers, the structure of which essentially distinguishes the genus from every other in the Order. The floral characters of the Yew may be technically formulated thus—

Flowers diœcious, rarely monœcious, solitary and axillary, sometimes terminal.†

Staminate flowers with a short stalk or stipes bearing a globose head (capitulum) of from four to eight stamens, each bearing three—eight anther cells attached to a peltate connective.

* ". . . piceæ tantum *taxique* nocentes
Interdum, aut hederæ pandunt vestigia nigræ."—Virgil, Georg. II. 257.

† The flowers of the Yew have been already described in page 30.

Ovuliferous flowers sessile, composed of numerous imbricated scales of which the upper one only bears an erect ovule.

Fruit a brownish oval nut enveloped in a glutinous aril open at the apex and maturing the first season.

More than one eminent botanist has expressed his opinion that Taxus is a monotypic genus and that the local forms occurring in Florida and Japan, and the more widely distributed ones in Canada and north-west America are but geographical varieties of the common Yew which have in the course of ages, under the influence of climate and environment, become differentiated in habit and foliage from the European type. It is, however, more convenient to describe these geographical offshoots separately as sub-species. A fifth geographical form has been described by Schlechtendal* under the name of *Taxus globosa* from specimens gathered by Ehrenberg in south Mexico; but as nothing more is known of it, it is here purposely omitted.

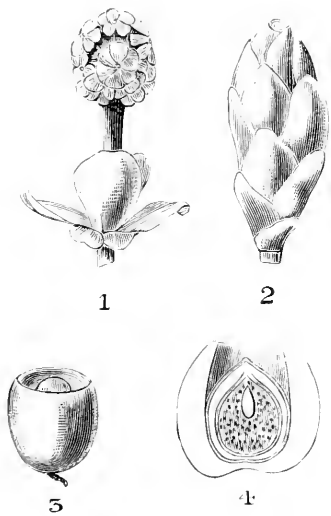


Fig. 51. Fructification of the common Yew. 1, Staminate. 2, Ovuliferous flower. 3, Ripe fruit. 4, Longitudinal section of the seed showing the position of the embryo.

With the exception of the Mexican form the Yew is not met with in a wild state beyond the limits of the temperate zone of the northern hemisphere. Preferring elevated situations it nowhere forms a continuous forest, and even where plentiful it is mixed with other trees. On the continent of Europe it is more or less common in all the mountainous and hilly districts from the Mediterranean to Sweden and Norway, as far as 61° north latitude, ascending to 3,500—4,000 feet on the Alps and Apennines, 4,000—5,000 feet on the Pyrenees, and 5,000—6,000 feet on the mountains in the south of Spain. It is also found in Algeria on the Atlas range, on the Cilician Taurus in Asia Minor, in Armenia, Persia and as far eastwards as the Amur region. On the Himalaya its vertical limits are 6,000—11,000 feet and it spreads eastwards from Kafiristan and Kashmir to Assam and the Khasia Hills.

The Yew is of geological antiquity; it first appeared in early Tertiary times, and in the Miocene period it formed an ingredient of the forests of Great Britain, and has continued to inhabit these islands ever since. It is found among the buried trees on the Norfolk coast near Cromer; it also crops up in another forest now in part buried beneath the Bristol Channel in which, if there be any truth in bones, the elephant, rhinoceros and beaver once roamed.†

* Linnaea, XII. 496.
† Ramsay, Physical Geology of Great Britain, 134.

Taxus baccata.

A medium-sized or low tree very variable in habit and dimensions, attaining a height of 30—50 or more feet according to situation and environment.* Trunk straight, erect, and when the tree is isolated, sending out numerous spreading branches at a short distance from the ground, but when crowded with other trees often free of branches for 20—25 or more feet of its height; the trunk is then more or less lobed or has broad, rounded, longitudinal ridges. Usually, whether solitary or associated with other trees, the trunk divides at a few feet from the ground into two—five or even more secondary trunks which frequently divide in like manner at a greater or less distance from their base. Bark roughish, peeling off in longitudinal shreds or small flakes exposing a smooth reddish brown inner cortex; in old trees very rugged and irregularly fissured. Primary branches irregularly disposed and often of very unequal development, spreading for the most part horizontally and ramified laterally. Branchlets distichous, opposite or alternate, covered with reddish brown smooth bark. Buds small, globose, dark chestnut-brown, the terminal ones closely sheathed by young foliage leaves. Leaves persistent three—four years, sub-spirally arranged around their axis, spreading from all sides on erect shoots, bifarious on horizontal branchlets, linear or linear falcate, acute, 0·75—1·25 inch long, dark lustrous green above, paler with a thickened midrib beneath. Flowers and fruit as described above.

Taxus baccata, Linnæus, Sp. Plant. ed. I. Vol. II. 1040 (1753). L. C. Richard, Mém. sur les Conif. 19 (1826). Loudon, Arb. et Frut. Brit. IV. 2066, with figs. (1838). Endlicher, Synops. Conif. 242. Carrière, Traité Conif. ed. I. 517; and ed. II. 730. Hoopes, Evergreens, 376. Parlatore, D. C. Prodr. XVI. 500. Sowerby, Eng. Bot. VIII. 277. t. 884. Brandis, Forest Fl. Ind. 539. Gordon, Pinet. ed. II. 338. Willkomm, Forstl. Fl. ed. II. 270. Boissier, Fl. orient. V. 711. Hooker fil, Fl. Brit. Islands, ed. III. 380; and Fl. Brit. Ind. V. 648. Beissner, Nadelholzk. 166, with figs. Masters in Journ. R. Hort. Soc. XIV. 249. And many others.

Eng. Yew. Old Eng. Eu. Ew. Eugh. Yeugh. Yewe and others. Fr. If. Germ. Eibe, Eibenbaum. Ital. Tasso. Span. Tejo. Texo. Gr. τάξος, μίλος. Mod. Gr. μαυρέλατος.

var.—adpressa.

A low tree or shrub rarely exceeding 12 feet high with long spreading branches much and irregularly ramified; branchlets short, spreading or ascending. Leaves shorter than in the common form, narrowly ovate-oblong, obtuse, about 0·5 inch long, bifarious in two ranks, slightly inclined upwards and forwards. Aril of fruit usually shorter than the seed. **adpressa stricta** has the branches erect or more or less ascending; **adpressa variegata** has the tips of many of the branchlets cream-white.

T. baccata adpressa, Carrière, Traité Conif. ed. I. 520; ed. II. 731. T. adpressa, Gordon, Pinet. ed. II. 387. T. tardiva, Parlatore, D. C. Prodr. XVI. 502 (in part).

var.—aurea.

A dense shrub or low tree with bright golden yellow leaves, the colour most developed at the tips and margins. **aurea elegantissima** has the leaves striped with straw-yellow and sometimes whitish.

T. baccata aurea, Carrière, Traité Conif. ed. II. 734. T. baccata Elvastonensis, Beissner, Nadelholzk. 176.

* In the Himalaya 100 feet high and 15 feet in girth.—Brandis.

var.—brevifolia

A shrub or low tree of irregular outline. Branchlets numerous and unevenly disposed. Leaves scattered or sub-spirally arranged on the erect shoots, pseudo-distichous on the lateral spreading ones, 0·3—0·75 inch long, dark green above, much paler below.

T. baccata brevifolia, *supra*. T. brevifolia, Hort. not Nuttall.

var.—Cheshuntensis.

A seedling from the Irish Yew and intermediate between it and the common form both in habit and foliage. Branches erect or ascending. Leaves close-set, spreading on all sides from their axis, mucronate, dark green above, glaucescent below.

T. baccata Cheshuntensis, Gordon, Pinet. ed. II. 389.

var.—Dovastonii.

A low tree with long spreading branches and lax pendulous branchlets clothed with leaves somewhat longer than those of the common form, deeper in colour and frequently falcately curved.

T. baccata Dovastonii, Loudon, Arb. et Frut. Brit. IV. 2082, with fig. Westfelton Yew.

var.—ericoides.

A dwarf shrub with close-set slender branches and short erect branchlets. Leaves much smaller than in the common form and more pointed at the tip, heath-like and crowded.

T. baccata ericoides, Carrière, Traité Conif. ed. II. 736. T. ericoides, Hort. T. epacrioides, Hort.

var.—fastigiata.

The most distinct of all the abnormal forms of the common Yew. Habit strictly fastigiate. Branches stout, erect and closely appressed; branchlets mostly short and erect like their primaries. Leaves sub-spirally arranged around their axis and spreading from all sides of it, dark lustrous green. **fastigiata argentea** has the tips of many of the branchlets cream-white: **fastigiata aurea** has the young growths golden yellow.

T. baccata fastigiata, Loudon, Arb. et Frut. Brit. IV. 2086, with figs. T. fastigiata, Hort. T. hibernica, Hort. Irish Yew, Florence Court Yew.

var.—fructu-luteo.

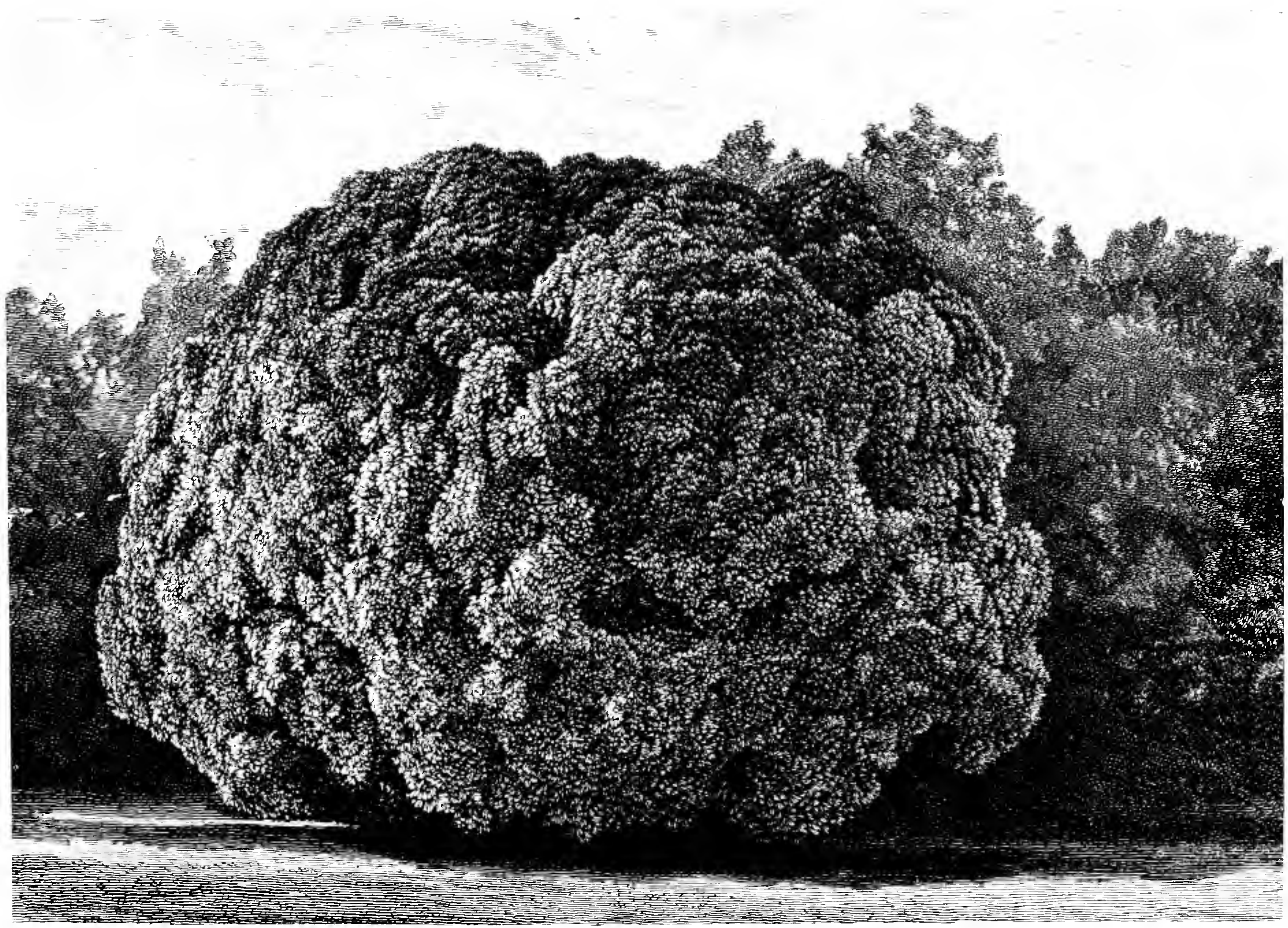
Differs from the common Yew in the aril of the fruits being yellow instead of red. Habit spreading. Leaves somewhat shorter and paler in colour than in the common form, and occasionally recurved.

T. baccata fructu-luteo, Loudon, Arb. et Frut. Brit. IV. 2068. Yellow-berried Yew.*

var.—glauca

A vigorous-growing much-branched shrub resembling in habit var. *Cheshuntensis* but of larger dimensions. Leaves longer and narrower than in the common Yew, which on the lateral branchlets are often

* The yellow-berried Yew is of Irish origin. It appears to have been discovered about the year 1817 growing on the lands of the Bishop of Kildare, near Glasnevin; but it seems to have been neglected till 1833 when it was noticed in the grounds of Clontarf Castle, whence cuttings were distributed. Loudon, *loc. cit.*



Yew at Cherkley Court, Leatherhead, Surrey

From the *Gardeners' Chronicle.*

falcately curved upwards, dark green above with a glaucous bluish tint below.

T. baccata glauca. Carrière. Traité Conif. ed. II. 735. T. baccata nigra. Hort. Blue John.

var.—pendula.

Primary branches sub-pendulous. Leaves somewhat paler in colour and more or less incurved. Of slow growth and attaining but limited dimensions. **gracilis pendula** has the sub-pendulous branches and their appendages more slender and more elongated. A larger shrub than the var. *pendula*.

T. baccata pendula. Hort. T. baccata Jacksonii. Hort. Weeping Yew.

var.—procumbens.

A prostrate shrub. Branches much elongated and much ramified, scarcely rising from the ground. Quite distinct from *T. canadensis* in its ramification and foliage.

T. baccata procumbens. Loudon. Arb. et Frut. Brit. IV. 2067. T. baccata expansa. Carrière. Traité Conif. ed. II. 738.

var.—Washingtonii.

A rather vigorous-growing variety with longer leaves, having their tips and part of the upper surface of a bright golden yellow.

T. baccata Washingtonii. Hort. T. canadensis Washingtonii. Hort.

Other deviations from the common type have been named *columnaris*, *compressa*, *erecta*, *horizontalis*, *microcarpa*, *nana*, *pyramidalis*, *recurvata*, *sparsifolia*, etc., names sufficiently indicative of their most obvious characteristics; but it is doubtful whether these characteristics have proved sufficiently constant in most of these varieties to justify the retention of the names, or whether they are still to be found in cultivation.*

The Yew in one or other of its numerous protean forms is seen everywhere throughout Great Britain, but almost everywhere planted by the hand of Man, so numerous and so useful are the purposes for which it is required. The Yew also grows wild in this country, as everyone knows, and trees that have sprung up spontaneously are to be seen in most of the hilly districts, and also in the copses and hedgerows in the plains especially on the chalk formation, but they are relatively few in number not only to what they were in Saxon and Norman times, but also to those that have been raised and planted by human agency; indeed, it is not exceeding the truth to affirm that for every hundred seedling Yews that spring up spontaneously, many thousands are raised by the forester and nurseryman. Many causes have contributed to the extermination of the Yew in the wild state, amongst which the clearing of the

* Beissner (Nadelholzkunde, pp. 169—176) describes forty-one varieties of the common Yew, including *Taxus cuspidata* (Sieb. et Zucc.). Many of them are coloured forms of recognised varieties, and others are believed to be identical, or nearly so, with varieties of older introduction.

land for cultivation and the long and continuous demand for the wood for Yew bows and the better kinds of household furniture have been the most potential. On the chalk downs of Surrey and Sussex where the Yew occurs wild in considerable numbers, it is sometimes seen solitary forming a conspicuous object from afar; occasionally it occurs in scattered groups, in places forming small groves unmixed with other trees.

One of the most remarkable of Yew groves of Nature's own formation occurs on Mickleham Downs near Leatherhead, on the estate of Abraham Dixon, Esq., of Cherkley Court. Here an extensive area is covered with Yews, almost unmixed with other trees and shrubs, except a few Junipers scattered here and there through the grove. The aspect of some of these Yews is peculiar and even beautiful. Groups of from five to a dozen may be seen with their trunks in close proximity to each other, forming a dense copse or clump, and each tree being thickly furnished with branches from the ground on the side freely exposed to the air, the groups has the appearance of being one tree of gigantic dimensions. In one part of the grove a considerable space is completely covered with Yews, all of which, except the outside trees, have lost their lower branches, those remaining on the trees being confined to the tops only, and with their foliage forming a dense canopy impervious to the sun's rays, the interior being lighted only at distant intervals by small openings in the thick foliage. On entering the thicket the aspect is weird and sombre, and when in winter the tops of the trees are covered with a thick coating of snow, and the diminished light takes a hazy yellowish hue, the appearance of the interior causes an indescribable feeling of depression and gloom.

In Norbury Park, not far from Cherkley Court, is another remarkable group of Yews called the Druid's Grove. All the trees are of very great age, the largest measuring from 18 to 22 feet in girth at a short distance from the ground. There is a famous clump of Yews at Kingsley Vale, on the South Downs, near Chichester, and another on the North Downs, in a slight hollow of the hill, near Guildford. Numerous great Yews here stand in a natural park or wood opening, among Hawthorns and several indigenous shrubs, Holly, Furze, Blackthorn and Crab, with Butcher's Broom beneath. This retired covert, forming part of the primeval forest, is blameless at present of a foreign tree.

Scarcely surpassed in interest and antiquity by any other group in the kingdom are the famous Borrowdale Yews which stand on the left of the mountain track over the Sty Pass to Wastdale. They are the remains of a grove of Yews that were reduced to four, known almost throughout the nineteenth century as the poet Wordsworth's "Fraternal Four," a brotherhood of venerable trees which remained uninjured till one of them was uprooted by the great gale of December, 1883; the others were also more or less injured by the breakage of branches. The illustration represents their present aspect and condition.

Many individual trees have become celebrated either on account of their great age or by reason of their association with historical

Photo by Green Booth

Wordsworth's "Fraternal Yews," Borrowdale, Cumberland

From the *Gardeners' Magazine*.

events, or with places of worship; only a few of the most remarkable of these can be noticed here.*

The Fortingal Yew in Perthshire is supposed to be the oldest in Great Britain; it is now a mere shell, the only parts remaining being the outermost portion of the old trunk which is 56 feet in girth near the ground.

In the shrubbery at Kyrle Park, Worcestershire, stands a very old tree split into two parts; the upright part is 24 feet in girth at five feet from the ground, and the area overspread by its branches is over 70 feet in diameter; the slanting portion is hollow; the total diameter of umbrage is 65 feet.†

At Trentham, Staffordshire, are some venerable Yews of almost hoary antiquity. There are twenty-three trees, all of them with two exceptions, still in health and vigour; the circumference of the trunks at six feet from the ground ranges from 16 to 19 feet. There is a local tradition that there was formerly an ancient Saxon church in close proximity to the trees.

At Ormiston Hall, in East Lothian, is one of the most beautiful Yews in Scotland. The trunk is nearly 20 feet in circumference at three feet from the ground, and the area overspread by its branches is over 70 feet in diameter.‡

The largest Yew in Ireland is near the College at Maynooth on the estate of the Duke of Leinster; its massive trunk is 20 feet in circumference at three feet from the ground; the height of the tree is about 50 feet, and the length of the longest branches upwards of 40 feet. This grand old Yew is still in robust health.§

Other very aged trees are, or were quite recently standing in Albury Park near Guildford; The Vineyard, Hatfield House; at Cliveden near Maidenhead; in Penrhyn Park, Bangor; around Tintern in Monmouthshire; at Craigends, Renfrewshire; Yewdale, Coniston; Brockenhurst, Hants; Dryburgh Abbey, Berwickshire; Whittinghame, East Lothian, etc.

The association of the Yew with religion and places of worship is of very ancient date. Yew boughs were formerly carried in procession on Palm Sunday, and in parts of Ireland Yew trees are sometimes called Palms; it is still the custom for the peasants to wear in their hats or button-holes, sprays of Yew from Palm Sunday until Easter Day. Many hypotheses have been brought forward explanatory of the cause of the selection of this tree for planting in proximity to churches and abbeys, or, perhaps, it would be more correct to say, the building of churches and abbeys in proximity to large and full-grown Yews; for it is indisputable that the finest and most venerable trees at present existing in Britain are to be found in churchyards and in the vicinity of old priories and abbeys, but it is by no means certain whether in all cases, or even in the majority of them, the Yews were planted subsequent to the building of the edifice, or the edifice erected near the spot where the

* For further particulars, the elaborate work on the subject by Dr. John Lowe, entitled "The Yew Trees of Great Britain and Ireland," may be consulted.

† The Yew Trees of Great Britain, p. 225.

‡ Id. 240. "Here Wishart the martyr preached to an audience composed of the Laird of Ormiston, his dependents and neighbours, and in desponding strains in harmony with the solemn and funereal aspect of the old yew-tree, addressed his last and parting words to those friends from whom he was so soon to be severed for ever."—(A.D., 1545.)

§ For an opportunity of inspecting this and other superb trees in the grounds at Carton I am indebted to the kindness of Lord Frederick Fitzgerald.

Yews were already standing.* The true cause of the association, in this country at least, is not, we think, difficult to be found—this is in the character and habit of the tree itself. There is no other native evergreen tree at all to be compared with the Yew as regards its foliage, its massive sombre aspect, and its longevity, and hence the Yew would be naturally selected to represent the feelings, the sentiments and the hopes associated with burial-grounds and in connection with places of worship where sentiments and feelings are most likely to seek expression by visible representatives or enduring monuments. The feeling of Hope lives in its evergreen foliage; Sorrow is remembered in its dark and sombre shade, and Veneration is awakened in its aged aspect. It may be safely assumed from the known antiquity of many Yews still standing in churchyards and the like places, that the association of the Yew with religion must be of very ancient origin; and the probability is very great that it took its rise at an epoch anterior to the introduction of Christianity into Britain.

Among the ancient Yews still existing that are, or have been associated with sacred edifices, the following are celebrated:—

In the churchyard of Buckland near Dover is a Yew of great antiquity, the trunk of which was split by lightning about the middle of the eighteenth century during a storm which destroyed the steeple of the church. It has a special interest apart from its antiquity from the fact that in 1880 it was removed to another part of the churchyard sixty yards distant, and the horizontal position assumed by the trunk after the injury was restored to a comparatively erect one.

In the churchyard of Church Preen in Shropshire stands one of the finest Yews in Great Britain; it is 50 feet high and has a girth of 21¾ feet at four feet from the ground; the trunk is hollow and will hold twenty-one men standing upright. The tree is, to all appearances, still healthy.†

The Crowhurst (Surrey) Yew ranks among the largest in the country. The trunk has a girth of 32 feet near the ground and is hollow inside; the cavity has been fitted up with a table and benches around, on which sixteen persons may sit. The top was blown off in 1845.

In the churchyard of Darley in Derbyshire is a venerable tree 31 feet in girth. The trunk which is hollow is only regular and straight to about ten feet from the ground where it divides into several large limbs, two of which are erect and the others spreading. It is a fruit-bearing tree and believed to be over one thousand years old.

The Fountains Abbey Yews near Boroughbridge in Yorkshire are, after the Fortingal Yew, supposed to be the oldest in Great Britain. There were originally seven, and in Evelyn's time six were still standing, but in 1891 Dr. Lowe found but five, and of these two were dead and uprooted.

In Gresford churchyard near Wrexham in Denbighshire is one of the oldest and still one of the largest Yews. The circumference of the trunk at five feet from the ground is over 30 feet and its height exceeds 50 feet.

* "There was a very ancient Yew in the churchyard of Kirkheating, near Huddersfield. The inhabitants of the village have a tradition that the church (which dates before 1245) was built to the tree, and not the tree planted to the church. It was living in 1864, but is now dead."—*G. Roberts, in "Science Gossip,"* 1875, p. 70.

† The Yew Trees of Great Britain, p. 197.

The Old Yew in Buckland Churchyard after Transplanting.
(From the *Gardeners' Magazine*.)

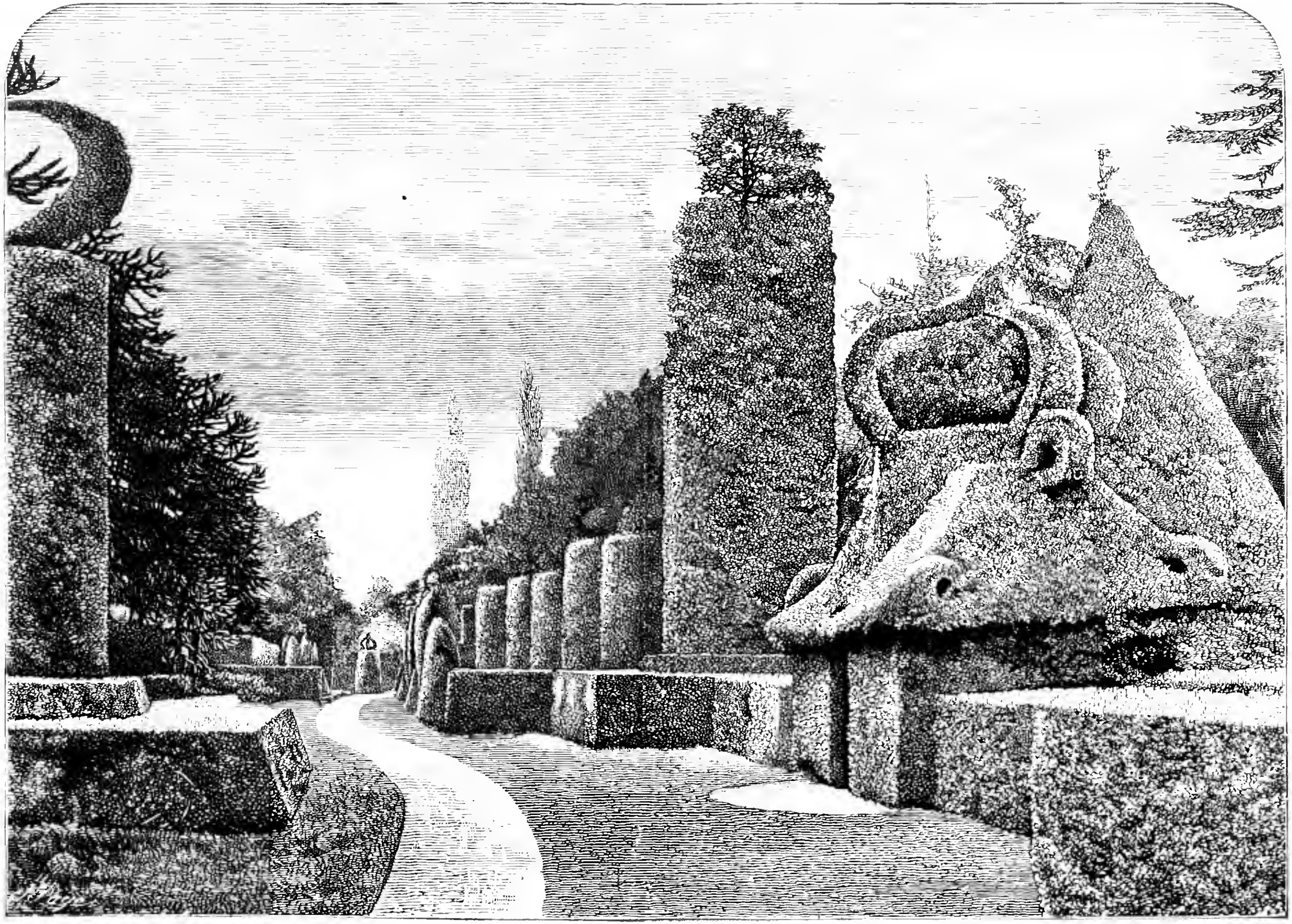
In the churchyard of Tisbury in Wiltshire is an enormous Yew over 30 feet in circumference with large limbs 20 to 25 feet long. The trunk is now hollow and is entered by means of a rustic gate. The tree is believed to be over one thousand years old.

Other venerable Yews associated with places of worship are standing in the churchyards of Boughton in Kent, Crowhurst near Battle, Hambledon near Godalming, Hurstmonceux in Sussex, Iffley near Oxford, Loose near Maidstone, Manhilad near Pont-y-pool, Tandridge in Surrey, and other places.

The association of the Yew with early English history is varied and important. Venerable trees still mark the spots where great events have taken place, and others are associated with the names of historic personages. The Ankerwyke Yew, near Staines, witnessed the conference between King John and the English Barons in 1215, and in sight of which Magna Charta was signed. It is $30\frac{3}{4}$ feet in circumference at three feet from the ground, and most probably its age exceeds one thousand years. Under the Loudon Yew, in Ayrshire, it is said that Bruce bestowed the ancient castle and estate on the Loudon family, and on the same spot, some centuries afterwards, John, Earl of Loudon, signed the Act of Union between England and Scotland. This tree is over 40 feet high, with a trunk $4\frac{1}{2}$ feet in diameter at twelve feet from the ground.

In a much wider bearing the Yew played a prominent part in our early history as supplying the wood of which the bows of the archers were made* and on that account it was the subject of many statutes of our early kings, and afterwards of Parliament up to the time of Elizabeth which made provision for the preservation and planting of Yews for the supply of Yew-wood, regulating the export and import of it, etc., so great had been the destruction of the trees in England during Norman and Plantagenet times. Every student of English history can point to great events in which the Yew bow played a foremost part. It was essentially the Saxon weapon both for warfare and the chase; and during the earlier part of the Norman supremacy was often used with deadly effect by the oppressed natives to rid themselves of their tyrannical masters. Deeds of daring were performed, attesting the extraordinary prowess and skill of the Saxon archers; deeds that were long kept in remembrance by tradition, celebrated in song and verse, or preserved in legends which afterwards supplied subjects for modern romance. The Yew bow was fatal to several English Kings, to Harold at Hastings, to William Rufus in the New Forest, and to Richard Cœur de Lion at Chaloux, in France. It was the skill of the English archers that enabled Henry II. to gain a footing in Ireland, and the name of Strongbow, borne by the leader of the expedition, attests the high repute in which the weapon was held. Cressy, Poictiers and Agincourt were won chiefly by the Yew bow; it was the most popular weapon through the long civil strife between the rival houses of York and Lancaster; and both in warfare as well as in the chase, it was held in estimation long after the invention of gunpowder had prepared the way to a complete change in the system and science of war.

* The bow continued for ages to be the favourite national weapon of the Saxons. They practised archery incessantly in their amusements and regained by its importance on the field of battle their due weight in the government of the country.—Alison's History of Europe, ed. IX. Vol. I. p. 31.



Topiary work at Elvaston Castle, near Derby.

The association of the Yew with gardening in England began early in the sixteenth century. It was brought into prominent notice towards the end of the century by Evelyn, who claims the "merit" of being the first to introduce the fashion of clipping it into artificial shapes which became general during the next century. It was first used in the formation of hedges for purposes of utility, but the dense growth it assumes when pruned, its apparently unlimited duration, and the readiness with which it may be cut into many shapes without impairing its vitality, soon led to its being extensively used in topiary work, which had been previously confined chiefly to the Box and Juniper. The dark dense foliage of the Yew, and its more robust and taller growth than the Box or Juniper, offered facilities for the introduction into gardens, by artificial means, of many varieties of form, and the fashion of clipping Yews into geometric figures, and also into the figures of birds, beasts, and even the human shape, became for a time a very prevalent practice, which reached its height towards the close of the seventeenth and during the early part of the eighteenth century. The popularity of the Yew as an ornamental garden plant during this period may be partly accounted for by the paucity of evergreen trees and shrubs at that time available,* and the desire for variety created by the taste for gardening which began to be general among all classes. The practice gradually fell into disuse as the introduction of exotic hardy trees and shrubs became more frequent, and supplied a more natural and pleasing variety than the uncouth figures which one kind of tree was made to take, but into which Nature never intended it to grow. Many evidences of the old topiary work are still to be met with, and not a few old Yews are made to retain the figures into which they were originally cut and trimmed. Some of the most remarkable of these are to be seen at Levens Hall, Westmoreland, where the topiary foible of our horticultural predecessors is still maintained in all its quaint antagonism to Nature.†

Not less striking but more modern, and, if we may use the expression, more rational, is the topiary work at Elvaston Castle, near Derby, the seat of the Earl of Harrington. A large portion of this consists of ornamental hedges of the common Yew, either dividing parts of the grounds from each other, or enclosing spaces devoted to special subjects; and of single specimens, both of the common Yew and its golden variety, cut into conical pyramids of uniform size and height, and of such there are upwards of one thousand. There are comparatively few representations of birds and animals: the bolder work represents the walls and bastions of a Norman castle, archways,

* The number of native evergreen trees and shrubs may be counted on the fingers, thus—Yew, Scots Pine, Juniper, Holly, Privet, Ivy, Butcher's Broom, Spurge Laurel and Mistletoe (the Box is a doubtful native), and up to the close of the seventeenth century the number of exotic evergreen trees introduced was not much greater, and some of them were very rare. The best known were the Spruce Fir, Silver Fir, Stone Pine, Pinaster, Red Cedar, Savin, Arbor Vitæ, Evergreen Oak, Sweet Bay, Laurustine, Portugal Laurel, Phillyrea and Arbutus.

† See the "Gardeners' Chronicle" for 1874, p. 264, where an account of the topiary work at Levens Hall is given, illustrated with woodcuts of some of the most remarkable groups which include figures of the British Lion; Queen Elizabeth and ladies; the Judge's Wig, a number of Yews planted in a half circle, so as to form an arbour by bringing the branches over the top in a hood or wig-like fashion; and many others. These figures were first formed early in the eighteenth century, so that for upwards of one hundred and eighty years these Yews must have had their young growth cut off to keep the figures within the prescribed shape and size, a proof of the astonishing tenacity of life possessed by the Yew.

alcoves, arbours, etc. The great extent of the topiary work at Elvaston is calculated to excite surprise rather than admiration, at the same time its extreme formality is greatly relieved by the noble Conifers of the Fir and Pine tribe which have been planted beside and around it with no sparing hand, and by the beautiful view afforded by the river Derwent, in its winding course through the grounds.

Avenues of Yew trees were formed as early as the Stuart period and more frequently in the early Hanoverian times; but the comparatively slow growth of the trees and especially the dark and gloomy aspect produced by them when full grown and standing in close proximity to each other, caused the planting of Yew avenues to fall into disuse. Among the most noteworthy still remaining are those at Cleish Castle in Kinross, Candover near Alresford, Overton-on-Dee near Ellesmere, and Aberglasney in Carnarvonshire.* In Ireland where the humidity of the climate induces a more rapid growth and a more verdant aspect of the foliage, Yew avenues are scarcely so sombre as in Great Britain: mention may be made of those at Glencormas near Bray, Oldcastle in Co. Meath, Clonfert in King's County and in the Royal Botanic Gardens at Glasnevin. At Dungamstown in Co. Wicklow is a row or colonnade of Yew trees remarkable for uniformity of growth so unusual in the Yew and the consequent impressive effect produced by it. The trees, fifteen in number, have straight undivided trunks to the greater part of their height which exceeds forty feet and have an average girth of eight feet at three feet from the ground: the distance between them varies from eight to sixteen feet: the branching begins at about eight feet from the ground and continues regularly upwards forming a close mass of dark foliage to the summit.†

For the formation of hedges, the Yew has long been recognised as one of the best plants that can be selected, especially where space can be allowed for it to attain the width necessary to render it an efficient protective screen. A Yew hedge is also an ornamental adjunct to the flower garden and pleasure grounds for which it not only forms an efficient screen but it often produces a picturesque effect. Very old and massive Yew hedges are to be seen at Pewsey in Wiltshire, Melbourne in Derbyshire, Holme Lacey near Hereford, Hadham in Hertfordshire, Albury Park near Guildford, and other places.

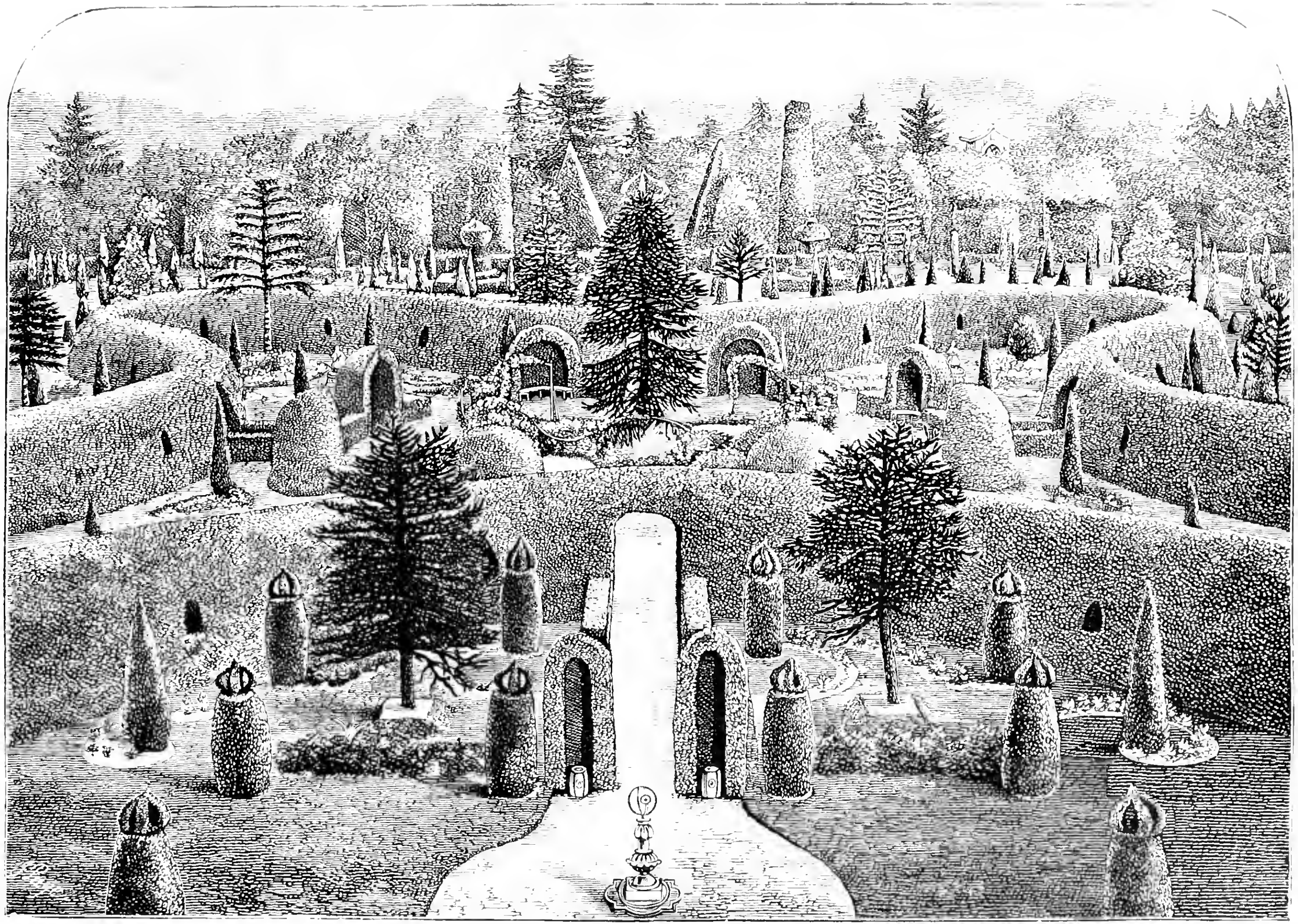
The Yew sports into many varieties and sub-varieties, of which those described in the preceding pages are distinct and ornamental, and include some valuable additions to the resources of the gardener and landscape planter, notably the varieties *adpressa*, *Dorastoni* and *fastigiata* (The Irish Yew).‡

The following account of the origin of the variety *adpressa* was communicated to "The Garden" by the late Mr. Francis Dickson of Chester: "This Yew was discovered by my father Mr. Francis Dickson about the year 1838 growing in a bed of seedlings of the common Yew. Being of slow growth it was necessarily slow of propagation, and it took

* Others are mentioned by Dr. Lowe in "The Yew Trees of Great Britain," pp. 14–16.

† For an opportunity of inspecting this singular arboreal phenomenon I am indebted to the kindness of Mr. Thomas Acton, the genial proprietor of Kilmacurragh.

‡ It is worthy of note that the most striking deviations from the common type are fruit-bearing (female) plants, for such are *adpressa*, *Dorastoni*, *fastigiata* and *fructu luteo*. The vars. *aurea*, *glauca* (Blue John) and *ericoides* are said to be males.



Topiary work at Elvaston Castle. The Yew Garden.

many years to get up a stock upon the grounds of the then firm of F. and J. Dickson, of which my father was the head. I well remember the value he set upon this plant and the vexation when, on his return home after a few days' absence, he learned that a representative of the firm of Knight and Perry of Chelsea had purchased and taken away with him some half-dozen good-sized plants as the result of negotiation with an inexperienced salesman who was presumably ignorant of their value. This enabled the Chelsea firm to propagate it and eventually to distribute it, which they did under the name of *adpressa*, but my father always adhered to the name he had originally given it—*brevifolia*."* The name *adpressa* is here retained, as *brevifolia* has been applied to two other Yews quite distinct from the Chester seedling.

The origin of the Dovaston or Westfelton Yew is thus stated by Loudon:—"The Westfelton Yew stands in the grounds of Mr. J. F. M. Dovaston, of Westfelton, near Shrewsbury, and the following account of it has been sent to us by that gentleman: 'About sixty years ago (now over a hundred) my father, John Dovaston, a man without education but of unwearied industry and ingenuity, had, with his own hands, sunk a well and constructed and placed a pump in it, and the soil being light and sandy, it constantly fell in. He secured it with wooden boards, but perceiving their speedy decay, he planted near the well a Yew tree, which he bought of a cobbler for sixpence, rightly judging that the fibrous and matting tendency of the Yew roots would hold up the soil. They did so, and independently of its utility, the Yew grew into a tree of extraordinary and striking beauty, spreading horizontally all round, with a single aspiring leader to a great height, each branch in every direction dangling in tressy verdure downwards, the lowest ones to the very ground, pendulous and playful as the most graceful birch or willow, and visibly obedient to the feeblest breath of air.'"† This beautiful tree is still flourishing; at the present time (1900) the girth of the trunk at 4½ feet from the ground is nearly 9 feet and the height is 37 feet.‡

The Irish Yew originated from a plant accidentally found on the mountains of Fermanagh, near Florence Court, more than a century ago. The original tree is a female, so that the thousands of plants propagated from it are berry-bearing, a circumstance that greatly enhances the ornamental qualities of this shrub during the autumn months.

The following account of the origin of the Irish Yew is taken from the "Gardeners' Chronicle" for 1873, p. 1336, where it is reprinted from the "People's Journal," as it appeared in one of a series of chapters entitled "A Visit to the Eastern Necropolis" (at Dundee), by a writer under the *nom de plume* of "Norval," dating from Rossie Priory. It will be seen that the account contains an apt illustration of one of the purposes for which the Irish Yew is much planted:—

"Near by our place is a grave marked by a small and solitary Irish Yew, and nothing more. I know not who had been laid under it.

* The Garden, XXIX (1886) p. 221. In the same volume, p. 268, is a further communication on this subject from Messrs. James Dickson and Sons of Chester, who state that the original *Taxus adpressa* was found in a bed of Thorn seedlings ten years earlier than the date given above. In Knight and Perry's "Synopsis of Coniferous Plants" it is entered as *Taxus tardiva* (Endlicher) with the synonyms *T. adpressa* (Hort.) and *T. brevifolia* (Hort.).

† Arboretum et Fruticetum Britannicum, IV. 2082.

‡ Mr. J. F. E. Dovaston, the present owner *in lit.*

That dark green 'mournful Yew,' however, serves a purpose in some hearts. Here and there in the Necropolis are to be seen similar monuments breaking the monotony of the grassy ranges. Each of them seems to have a sad story in its custody. The dark Yew has long been adopted as a favourite tree for shading the ground of our dead. The

Fig. 52. The original Irish Yew at Florence Court.

Irish Yew, or Florence Court variety of the Yew, has in a special manner become the most prominent and distinguished of the family. The history of the Irish Yew may be of interest to many. Here it is, and I quote from the MS. in possession of Lord Kinnaird 'Above one hundred years ago, Mr. Willis, farmer, of Aghenteroark, in the parish of Killesher, county of Fermanagh, found upon his farm on the mountains above Florence Court, two plants of this tree. These he dug up, and planted one in his own garden. He took the other down to his landlord at Mount Florence, where it was planted. The tree that was planted in his own garden remained there till the year 1865, when it died. The other is still alive at Florence Court, and is the one from which the millions of plants now distributed in all parts have sprung. The first cuttings were given by my father, the Earl of Enniskillen, to Messrs. Lee and Kennedy, then the largest nurserymen about London.' Signed, Enniskillen, Rossie Priory, September 8th, 1867."

The illustration, from a photograph sent to Messrs. Veitch by the late Earl of Enniskillen, represents the original Irish Yew at Florence Court as seen about twenty-five years ago; at the present time it has a more open, straggling habit and also a somewhat unhealthy appearance believed to have been caused by some laurels being allowed to grow too freely around it but which have since been cut away.

The wood of the Yew is exceedingly hard and close-grained, of a beautiful reddish brown colour, susceptible of a high polish, and very durable, tough and elastic. It was also formerly much used in the manufacture of articles of domestic furniture, many antique and curious specimens of which are still preserved in museums, etc. The spray and foliage of the Yew are poisonous to cattle. The berries are glutinous, and have a sweet taste; they are often eaten by children without being followed by harmful consequences. The kernel, too, is edible, and has a bitter flavour not unlike that of the seeds of the Stone Pine *(Pinus pinea)*.

Taxus brevifolia.

"A tree usually 40—50 but occasionally 70—80 feet in height with a straight trunk 1—2 feet thick, rarely more, frequently unsymmetrical and irregularly lobed, and with long, slender, horizontal or slightly pendulous branches. Bark of trunk about 0·25 inch thick, covered with small, thick, dark red-purple scales which on falling expose a bright red-purple inner bark. Branchlets slender; buds small with loosely imbricated yellow-green scales. Leaves 0·5—0·625 inch long, dark yellow-green above, paler below with stout midribs and slender petioles, persistent four—five years." Fructification as in the common Yew. Sargent, *Silva of North America*, X. 65, t. 514.

Taxus brevifolia, Nuttall, Sylva, III. 86, t. 108 (1849). Carrière, Traité Conif. ed. II. 742. Hoopes, Evergreens, 383. Parlatore, D. C. Prodr. XVI. 501. Brewer and Watson, Bot. Califor. II. 110. Macoun, Cat. Canad. Plants, 463. Gordon, Pinet. ed. II 392. Beissner, Nadelholzk. 177. Masters in Journ. R. Hort. Soc. XIV. 249.

T. Boursieri, Carrière, Rev. Hort. 1854, p. 228, with fig.; and Traité Conif. ed. II. 739.

T. Lindleyana, Murray in Edinb. New Phil. Journ. I. 294 (1855.

Eng. Californian Yew. Amer. Western Yew. Fr. If de Californie. Germ. Kurzblätteriger Eibenbaum.

Taxus brevifolia is widely distributed over the Pacific region of north-west America from Queen Charlotte's Island to south California, but nowhere very abundant: it ascends the Selkirk mountains in British Columbia to 4,000 feet, and the western slopes of the Sierra

Nevada to 8,000 feet, preferring the banks of streams and deep ravines, and usually growing under larger coniferous trees: its eastern limit occurs on the Rocky mountains of Montana. It is a smaller and more slender tree than the European Yew, with shorter thinner leaves that abruptly terminate in a bristle-like mucro.

The Californian Yew was discovered by David Douglas during his first mission to north-west America in 1825. It was introduced by William Murray in 1854, but it is still exceedingly rare in British gardens.*

Taxus canadensis.

A prostrate shrub seldom rising more than 2—3 feet above the ground. Branches spreading, elongated, stoutish, much ramified and covered with reddish brown bark. Branchlets slender, spreading or more or less pendent: buds small, globose, with reddish brown perulae. Leaves shortly petiolate, crowded, pseudo-distichous in two ranks, shorter and narrower than in the common Yew, and with revolute margins.

Taxus canadensis. Wildenow. Sp. Plant. IV. 856 (1805). London. Arb. et Frut. Brit. IV. 2093. Endlicher. Synops. Conif. 243. Carrière. Traité Conif. ed. II. 739. Parlatore. D. C. Prodr. XVI. 501. Gordon. Pinet. ed. II. 393. Beissner. Nadelholzk. 176. Masters in Journ. R. Hort. Soc. XIV. 249.

T. baccata var. canadensis. Gray. Manual. ed. II. 425. Macoun. Cat. Canad. Plants. 463.

T. baccata. Hooker. W. Flor. Bor. Amer. II. 167 (in part).

Eng. Canadian Yew. Fr. If du Canada. Germ. Kanadischer Eibenbaum. Ital. Tasso del Canada.

The Canadian Yew is common in damp woods in many parts of the forest country extending from Anticosti, Newfoundland, and Nova Scotia through Canada to the northern shore of Lake Superior and to Lake Winnipeg.† South of the Dominion boundary it spreads through the northern States from New Jersey to Minnesota. It was introduced early in the nineteenth century; it is now but seldom seen in British gardens, being far surpassed as a decorative plant by varieties of the common Yew.

Taxus cuspidata.

A tree 40—50 feet high with a trunk 2 feet in diameter covered with bright red bark;‡ under cultivation a much smaller tree. In Great Britain, the oldest specimens are mostly shrubs with two—three or more ascending much-branched stems. Branches spreading or ascending, ramification distichous; bark reddish brown marked with outgrowths decurrent from the bases of the leaves. Branchlets numerous, short and close-set. Leaves on the lateral shoots pseudo-distichous, often turned upwards and inwards; on the erect shoots spirally arranged around them and spreading, 0·5—1 inch long, shortly petiolate and mucronate, dark

* The Yew usually met with in cultivation under the name of *Taxus brevifolia* is the short-leaved variety of *T. baccata* described in page 127

† Macoun. Catalogue of Canadian Plants, *loc. cit.*

‡ Sargent. Forest Flora of Japan. 76.

lustrous green above, fulvous green below, the midrib marked by a shallow keel on both sides. Fructification as in the common Yew.

Taxus cuspidata. Siebold and Zuccarini. Fl. Jap. II. 61, t. 128 (1842). Endlicher. Synops. Conif. 243. Parlatore. D. C. Prodr. XVI. 502. Franchet et Savetier. Enum. Plant. Jap. I. 472. Gordon. Pinet. ed. II. 394. Masters in Journ. Linn. Soc. XVIII. 499; and in Journ. R. Hort. Soc. XIV. 299.

T. baccata. Thunberg. Fl. Jap. 275 (1784).

T. baccata var. cuspidata. Carrière. Traité Conif. ed. II. 733. Beissner. Nadelholzk. 173.

Eng. Japanese Yew. Fr. If du Japon. Germ. Japanischer Eibenbaum. Ital. Tasso giapponese. Jap. Ichii. Momi-noki.

Taxus cuspidata has been cultivated throughout Japan from time immemorial but is known to be endemic only in the northern island, Yeso, where it attains its greatest development. The wood, like that of the common Yew, is tough, close-grained, and beautifully coloured and is used by the wealthier inhabitants for cabinet-work and indoor decoration, and by the Ainos, the aboriginal inhabitants of Yeso, for making bows. As distinguished from the European type, the leaves are broader, more abruptly pointed, more leathery in texture and lighter in colour.

Taxus floridana.

A bushy tree rarely 25 feet high with a short trunk about a foot in diameter, and numerous short, spreading branches; more often shrubby in habit, 12–15 feet high. Bark thin, purple-brown, smooth, occasionally separating into large, irregular, plate-like scales. Branches slender; buds small with loosely imbricated pale yellow perulæ. Leaves usually conspicuously falcate, 0·75 to 1 inch in length, dark green above and paler below with rather obscure midribs and slender petioles. Sargent, *Silva of North America*, X. 67, t. 515.

Taxus floridana. Chapman. Fl. 436 (1860). Carrière. Traité Conif. ed. II. 741. Hoopes. Evergreens. 384. Sargent. Forest Trees of N. America, 10th Census, IX. U.S.A., 186.

Taxus floridana is restricted to a narrow area in western Florida extending about thirty miles along the eastern bank of the river Appalachicola. It was discovered in 1833 by Mr. Hardy B. Croom; it received, however, but little notice from botanists till it was described by Chapman in his "Flora of the Southern States," published in 1860. Except in habit, it is not easily distinguishable from the Canadian Yew; it has probably not yet been introduced into British gardens.

DACRYDIUM.

Solander in Forster's Plant. esculent. 80 (1786). Endlicher. Synops. Conif. 224 (1847). Parlatore. D. C. Prodr. XVI. 493 (1868). Bentham and Hooker. Gen. Plant. III. 433 (1881). Eichler in Engler and Prantl. Nat. Pfl. Fam. 106 (1887). Masters in Journ. Linn. Soc. XXX. 8 (1893).

A genus of trees and shrubs with heteromorphic foliage including about twelve species, of which seven are natives of New Zealand, one is endemic in Tasmania and one in Chile (the *Lepidothamnus*

Fonki of some authors); the others are distributed through New Caledonia, the Fiji Islands, the Malay Peninsula and Borneo. The essential characters of the genus are chiefly these:—

Flowers diœcious. Staminate flowers small, solitary and terminal, surrounded at the base by a few involucral bracts. Anthers sessile, crowded, spirally arranged around a central axis, two-celled, with an elongated peltate connective.

Ovuliferous flowers terminal, solitary or in lax spikes, composed of one three or more thickened scales of which one, rarely two, bear an ovule, at first horizontal, but after fertilisation becoming erect and surrounded at the base by a fleshy aril.

Fruit, a nut, usually of ovoid shape, seated on a fleshy or dry receptacle which is green or otherwise coloured, requiring (New Zealand species) more than a year to attain maturity.

Two of the species are of great importance in their native countries on account of their valuable timber, viz., the Rimu or Red Pine of New Zealand, *Dacrydium cupressinum*, and the Huon Pine of Tasmania, *D. Franklinii*, both of which are cultivated in Great Britain. Compared with these, the other species are of little value or interest; mention may, however, be made of *D. laxifolium*, one of the smallest of Taxads, a weak straggling shrub common in the mountain districts of New Zealand, and which is rarely found more than a foot high; and of *D. Kirkii*, the tallest of the New Zealand species and the most local; its habitat is restricted to the extreme northern portion of the North Island.

The generic name is derived from δακρύδιον (diminutive of δάκρυ, a tear), in allusion to the weeping habit of the species.

Dacrydium cupressinum.

A tall or medium-sized tree with a trunk varying in height from 40 to 80 feet, and in diameter from 2 to 4 feet, covered with dark brown or grey-brown bark which falls away in thick scale-like plates like those of the Scots Pine. Branches more or less pendulous with distichous ramification, but becoming more spreading in old age. Branchlets slender, elongated, alternate or opposite, and drooping like their primaries, in old age shorter and recurved at the tip. Leaves persistent four five or more years; on young plants close-set and spirally arranged around their axes, awl-shaped with a rather broad decurrent base 0·25 – 0·5 inch long, spreading, dark green; on old trees much smaller, scale-like, trigonous and imbricated. Staminate flowers green and inconspicuous on the tips of the erect or upturned branchlets. Ovuliferous flowers solitary, terminal. Seeds about one-eighth of an inch long.

Dacrydium cupressinum, Solander in Forster's Plant. esculent. 80 (1786). L. C. Richard, Mém. sur les Conif. 16, t. 2. fig. 3 (1826). Endlicher, Synops. Conif. 225 (1847). Carrière, Traité Conif. ed. II. 691. Parlatore, D. C. Prodr. XVI. 494. Hooker fil. Handb. N. Zeal. Fl. 258. Gordon, Pinet. ed. II. 104. Kirk, Forest Fl. N. Zeal. 29, tt. 18, 19, 20, 21, 22. Masters in Journ. R. Hort. Soc. XIV. 209.

N. Zeal. vernacular, Rimu, Red Pine.

This remarkable tree was discovered during Captain Cook's first voyage to the South Pacific Ocean 1768—1771, and Dr. Solander who accompanied the expedition as botanist founded upon it the genus Dacrydium. The following particulars respecting it are taken from Kirk's "Forest Flora of New Zealand":—

> *Dacrydium cupressinum* occupies a larger area of the New Zealand forests than any other native tree; when growing in an open situation it is extremely beautiful with its pendulous branches and conical outline, but when surrounded with other trees it forms a comparatively small round head with drooping branches; its drooping habit is unique amongst New Zealand Conifers. Its wood is adapted to a larger number of important uses than that of any other tree in the colony, but its intrinsic value is less than that of the Kauri Pine, *Agathis australis*, or the Totara, *Podocarpus Totara*. It supplies the chief timber employed for general building purposes over two-thirds of the colony; it is also extensively used for fencing and railway ties but not with very satisfactory results as it is not durable in contact with the ground. The wood is of a dark red colour with light red or yellow streaks, and takes a high polish, it is thence much in request by cabinet-makers in the manufacture of household furniture; it is also used for panelling both in public and private buildings. The bark is often used by the tanner, but the amount of tannin contained in it is small, being only about 4·3 per cent.

In Great Britain *Dacrydium cupressinum* is occasionally used as a decorative plant in its young state for the conservatory on account of its gracefully pendulous habit.

Dacrydium Franklinii.

A tall pyramidal tree 80—100 feet high with a trunk 3—5 feet in diameter at the base. Primary branches spreading or slightly depressed; branchlets slender, pendulous with tetrastichous ramification, the herbaceous shoots short, close-set and often much divided. Leaves bright green in decussate pairs; on the axial growths lanceolate-rhomboidal, acute, sharply keeled, imbricated, free at the apex; on the lateral shoots much smaller, ovoid-rhomboidal and concrescent. Staminate flowers small, terminal or short recurved lateral branchlets, cylindric, composed of fifteen—twenty anthers with a deltoid connective. Ovuliferous flowers in a curved terminal spike composed of "four — eight adherent scales on each of which is seated a sessile ovule whose outer integument is abbreviated and the apex of the inner is exserted and points to the peduncle of the spike."

Dacrydium Franklinii, Hooker fil in Lond. Journ. Bot. IV. 152, t. 6 (1845); and Fl. Tasman I. 357, t. 100 A (1860). Endlicher, Synops. Conif. 227. Carrière, Traité Conif. ed. II. 695. Parlatore, D. C. Prodr. XVI. 495. Gordon, Pinet. ed. II. 106. Masters in Journ. R. Hort. Soc. XIV. 209.
Huon Pine of Tasmania.

The Huon Pine, the most valuable timber tree of Tasmania, is restricted to the south-west part of the island. It was formerly abundant around Macquarie Harbour and along the Huon river, but in consequence of the continuous demand for its timber, especially for ship and boat building, it has greatly diminished in numbers since its first discovery by Allan Cunningham in 1817. The wood is close-grained, easily worked, burns briskly, giving out a pleasant aromatic fragrance, and is used for every purpose for which coniferous timber is in request.

Dacrydium Franklinii is described by those who have seen it in its native country as a noble tree of broadly pyramidal outline, with drooping branchlets clothed with foliage of the brightest green. It was introduced into British gardens many years ago and has proved to be fairly hardy in the south and south-west of England and Ireland, but always forming a shrub of irregular habit of which the primary branches are covered with light red-brown bark, and the branchlets slender, sometimes much elongated, drooping or quite pendulous. The tree was named in compliment to Sir John Franklin, Governor of Tasmania at the time of Captain Ross' Antarctic expedition "for his zealous co-operation in all the objects of the expedition, and for his unwearied zeal in forwarding the cause of science in that colony."

PODOCARPUS.

L'Héritier. MS. (1788) nov. gen. ex typo. Taxi elongatæ, ex L. C. Richard Mém. sur les Conif. 13, t. 1 (1826). Endlicher, Synops. Conif. 206 (1847). Parlatore, D. C. Prodr. XVI. 507 (1868). Bentham and Hooker, Gen. Plant. III. 434 (1881). Eichler in Engler and Prantl. Nat. Pfl. Fam. 104 (1887). Masters in Journ. Linn. Soc. XXX. 9 (1893).

A genus of evergreen trees and shrubs dispersed over the tropical and sub-tropical regions of both hemispheres including Japan and New Zealand, the last named group of islands numbering seven species in its flora, but absent from the Mediterranean region and sub-tropical North America. The essential characters may be thus formulated :—

Flowers monœcious or diœcious, axillary or sub-terminal. Staminate flowers solitary or fascicled on a common peduncle, surrounded at the base by a few imbricated bracts. Stamens spirally crowded. Anthers two lobed.

Ovuliferous flowers pedunculate, solitary or in pairs, surrounded at the base by a few bracts which together with the raphe of the ovule, the peduncle and the outer coat of the seed become fleshy. Ovule solitary and anatropous.

Fruit small, globose or ovoid with a fleshy pericarp seated on a fleshy receptacle.

Leaves variable in shape and attachment, opposite, alternate or scattered ; linear or oblong with a single median nerve or with parallel veins as in *Podocarpus Nageia* ; sometimes dimorphic on the same branch.

Upwards of seventy species of Podocarpus have been described by different authors, but more than one-third of them are but very imperfectly known, owing doubtless to the remoteness of their habitats and the difficulty of obtaining satisfactory specimens, especially of the flowers and fruits, for critical examination and comparison; it is thence probable that many of these imperfectly known forms may hereafter be reduced to varieties or even to synonyms of the authentic types.

The Podocarps occupy but a subordinate place in the British Pinetum. Of the introduced species, not more than four or five can be cultivated in the open ground in any part of Great Britain, but the number might be increased by the addition of two shrubby alpine species (*P. nivalis* and *P. acutifolius*) that inhabit the mountains of the South Island of New Zealand. The hardy species are described in the following pages with the addition of three others that are highly valued for their timber in their native country.

The generic name Podocarpus is derived from ποῦς, ποδός (a foot) and καρπὸς (fruit), in reference to the swollen peduncle of the fruit.

Podocarpus alpinus.

A prostrate straggling bush, but sometimes arborescent, attaining a height of 12—15 feet. Branches spreading, often much elongated; branchlets slender, opposite or in pseudo-whorls, with pale green bark furrowed longitudinally. Leaves inserted all round the stem or obscurely two-ranked, often recurved, linear or linear-oblong, obtuse, 0·25 — 0·5 inch long, tapering to a very short petiole, dark green above, glaucous beneath with thickened margins and midrib. "Staminate flowers cylindric, scarcely so long as the leaves, sessile, solitary or fascicled. Fruit small, elliptic, seated on or towards the apex of one fork of a bifid, fleshy, scarlet, sub-cylindric peduncle which is larger than the fruit, and consists of several fleshy bracts adnate to the swollen peduncle."*

Podocarpus alpinus. R. Brown ex Mirbel in Mém. Mus. d'Hist. Nat. XIII. 75 (1825). Hooker fil in Lond. Journ. Bot. IV. 151; and Fl. Tasm. I. 356. Endlicher, Synops. Conif. 214. Parlatore, D. C. Prodr. XVI. 520. Gordon. Pinet. ed. II. 351. Beissner, Nadelholzk. 194. Masters in Journ. R. Hort. Soc. XIV. 242.
P. Totara alpina. Carrière. Traité Conif. ed. II. 652.

Podocarpus alpinus inhabits the mountains of Victoria and Tasmania at 3,000 to 4,000 feet elevation; in the first-named colony it occurs on Mounts Buller and Hotham, in the latter on Mounts Wellington and Marlborough. It has long been in cultivation in British gardens, and has proved to be one of the hardiest of the genus. The date of introduction does not appear to have been recorded.

Podocarpus chilinus.

A much-branched tree 40—50 feet high. Branches scattered, close-set, spreading and much ramified. In Great Britain, usually a low dense shrub rarely a medium-size tree. Branchlets with smooth brown bark, opposite or in pseudo-whorls of three—five, but sometimes

* Flora of Tasmania, *loc. cit.*

solitary. Leaves scattered or with an obscurely spiral arrangement, 1·5 — 3·75 inches long, linear-lanceolate, acuminate, sessile, or narrowed at the base into a very short petiole, straight or falcately curved, dark lustrous green with a thickened midrib above, much paler and obscurely keeled beneath. Fruits pedunculate, solitary or in pairs, the peduncles axillary, one-third as long as the leaves and bearing at their summit a fleshy receptacle on which is seated an ellipsoid fruit.

Podocarpus chilinus. L. C. Richard in Ann. Mus. Paris, XVI. 297 (1810); and Mém. sur les Conif. 11 (1826). Loudon, Arb. et Frut. Brit. IV. 2101 (1838). Endlicher, Synops. Conif. 212 (1847). Gay, Fl. Chil. V. 402. Carrière, Traité Conif. ed. II. 649. Parlatore, D. C. Prodr. XVI. 511. Gordon, Pinet. ed. II. 329. Masters in Journ. R. Hort. Soc. XIV. 242.
P. salignus, Hort.

Podocarpus chilinus has an extensive range in the sub-alpine Andean region of Chile from the province of Maule southwards to Valdivia. It was discovered by Dombey, a French botanist who accompanied Ruiz and Pavon during their mission to Peru and Chile (1777—1787), and from Dombey's herbarium specimens it was figured and described by the elder Richard in the publications quoted above. It was introduced into British gardens about the year 1849; it is hardy in the south of England and Ireland.*

Podocarpus dacrydioides.

A lofty tree 80 — 150 feet high with a trunk 4 — 5 feet in diameter covered with thin greyish brown bark, and usually free of branches to the greater part of the height. Branches and branchlets slender, the latter much and repeatedly ramified. Leaves dimorphic; on young trees linear, flat, about 0·25 inch long, bifarious with upturned tips and of a deep bronzy green; on adult trees smaller, scale-like, in decussate pairs, subulate, imbricated or concrescent, dark green. Inflorescence diœcious; staminate flowers small, solitary and terminal, the anthers with a deltoid connective; ovuliferous flowers terminal and sessile, "consisting of three—four rarely two—five carpellary leaves bent like a sickle and usually carrying a single ovule on the face. Fruit a shining black nut seated on a crimson pulpy receptacle developed from the carpellary leaf."

Podocarpus dacrydioides, A. Richard, Fl. Nov. Zeal. 358, t. 39 (1832). Endlicher, Synops. Conif. 223. Carrière, Traité Conif. ed. II. 678. Parlatore, D. C. Prodr. XVI. 520. Hooker fil. Handb. N. Zeal. Fl. 258. Gordon, Pinet. ed. II. 357. Kirk, Forest Fl. N. Zeal. 11, t. 31, 32.
N. Zeal. vernacular, Kahikatea. White Pine.

Podocarpus dacrydioides is distributed throughout New Zealand either scattered amongst other trees or forming extensive forests in low grounds by river sides or in swampy situations; it was originally discovered by Captain Cook in the great forest between the Thames and Piako rivers. It is one of the most valuable timber trees of the

* The finest specimen known to the author is at Panjerrick, near Falmouth, which is upwards of 40 feet high. There is a beautiful tree of smaller dimensions at Kilmacurragh, Co. Wicklow, and another at Fota Island, near Cork.

colony; the wood is white, firm, strong, straight in grain and of fairly even texture but not durable when in contact with the ground; it is extensively used in house-building, framing and weather-boarding, and it is especially suitable for conversion into pulp for the manufacture of paper.

The late Mr. Kirk described a virgin forest of Kahikatea trees as one of the most striking sights in New Zealand scenery.—"Straight unbranched trunks rise one after the other in endless series and in such close proximity that at a short distance no trace of foliage is visible except overhead or in the immediate vicinity of the observer; the naked symmetrical shafts tapering almost imperceptibly, appear to form dense walls which completely shut out every glimpse of the outer world."—*Forest Flora of New Zealand.*

Podocarpus ferrugineus.

A tall round-topped tree 50—80 feet high with a trunk 1—3 feet in diameter covered with dark greyish bark deeply furrowed or cast off in large flat flakes. Leaves distichous, narrowly linear, acute, 0·5—0·75 inch long, with thickened midrib and often falcately curved. Inflorescence diœcious; staminate flowers solitary, axillary, sessile, as long as the leaves; ovuliferous flowers axillary, consisting of a single ovule borne on a short stalk clothed with minute scale-like leaves. Fruit about 0·75 inch long with a bright red pericarp covered with a glaucous bloom and enclosing a hard nut containing a single seed.*—Kirk, *Forest Flora of New Zealand*, 163, t. 84.

Podocarpus ferrugineus. Don in Lambert's Genus Pinus, ed. II. Vol. II. App. (1832). Hooker, W. Icon. Pl. 542 (1843). Endlicher, Synops. Conif. 220. Hooker fil. Handb. N. Zeal. Fl. 253. Carrière, Traité Conif. ed. II. 674. Parlatore, D. C. Prodr. XVI. 519. Gordon, Pinet. ed. II. 352.

N. Zeal. vernacular. The Miro.

"*Podocarpus ferrugineus* is generally distributed throughout New Zealand but is less plentiful in the North than in the South Island. It occurs in great abundance in the southern part of the South Island and forms a large proportion of the forest on Stewart Island." Miro timber exceeds that of all other New Zealand Taxads in strength; it is straight and even in grain, hard and elastic, but not durable in contact with the ground.

Podocarpus macrophyllus.

A low or medium-sized tree 25—40 feet high with a straight erect trunk covered with ash-brown bark and with a diffuse or spreading crown. Branches crowded and much ramified; branchlets (of plants in British gardens) stoutish, short, close-set and angulate. Leaves scattered or sub-spirally arranged around their axis, shortly petiolate, narrowly lanceolate, sub-acuminate, 2·5—5 inches long, straight or slightly falcately curved, dark green with a narrow keel along the midrib above,

* It is probable that this species may be hereafter referred to Prumnopitys if that genus should be retained.

much paler and keeled beneath. Inflorescence not seen; as represented by Siebold and Zuccarini's figures:—staminate flowers in axillary clusters, cylindric, about an inch long; ovuliferous flowers solitary, rarely in pairs, pedunculate and bibracteate. Fruit roundish, about the size of a large pea, seated in a sub-cylindric, fleshy receptacle as large again as itself.

Podocarpus macrophyllus, Don in Lambert's Genus Pinus, ed. I. Vol. II. 22 (1824), not Wallich. Siebold and Zuccarini, Fl. Jap. II. 70, tt. 133, 134. Endlicher, Synops. Conif. 216. Carrière, Traité Conif. ed. II. 644. Parlatore, D. C. Prodr. XVI. 517. Gordon, Pinet. ed. II. 340. Franchet et Savatier, Enum. Plant. Jap. I. 475. Beissner, Nadelholzk. 194. Masters in Journ. R. Hort. Soc. XIV. 243. Sargent. Forest Fl. Jap. 77.

Taxus macrophylla, Thunberg, Fl. Jap. 276 (1784). Aiton, Hort. Kew. ed. II. Vol. V. 416 (1813).

Jap. vernacular, Maki.

vars.—argenteo-variegatus and aureo-variegatus.

Branchlets shorter and the leaves more crowded than in the common form, the leaves of the first named with a broad cream-white, and of the second with a broad yellow margin; in both varieties many of the young leaves when first developed are wholly white in the one and wholly yellow in the other.

P. macrophyllus argenteo- and aureo-variegatus, *supra*. P. chinensis argentea and aurea, Gordon, Pinet. ed. II. 331.

Podocarpus macrophyllus first became known to science in the early part of the eighteenth century through Kaempfer.* It was also seen by Thunberg during his brief stay in Japan in 1777, and who described it in his "Flora Japonica" under the name of *Taxus macrophylla*. Fifty years later it was gathered by Siebold whose figures of it are among the best yet published; it is common in cultivation throughout Japan but not known to be endemic. Several varieties are known to Japanese horticulturists, and among them the two variegated forms described above which were first sent to this country by Mr. Fortune in 1861 and re-introduced by Mr. James H. Veitch in 1892. Around Tokio the common form is much used as a hedge plant and is often cut into fantastic shapes, whilst the variegated forms are preferred for pot culture and dwarfing.

Podocarpus Nageia.

A medium-sized tree with an erect trunk covered, when old, with smooth purplish bark. Branches spreading or sub-pendulous with distichous ramification; branchlets opposite or alternate, sub-angulate, green. Leaves in decussate pairs, rarely alternate, somewhat distant, elliptic-lanceolate or lanceolate-oblong, acute, 2—3 inches long and 0·75—1 inch broad, narrowed at the base into a short petiole, many-nerved, leathery in texture, dull green. Flowers monoecious (?), axillary, bracteate. Staminate flowers in fascicles of three—five, cylindric, about an inch long. Ovuliferous flowers solitary or in pairs, shortly pedunculate, the receptacle scarcely thicker than the peduncle. Fruit about

* Amoenitates Exoticae, p. 780, published in 1712.

the size of a small cherry with a dark purplish pericarp enclosing a small seed with a bony testa.

Podocarpus Nageia. R. Brown. ex. Mirbel in Mém. du Musée Paris. XIII. 75 (1825). Siebold and Zuccarini. Fl. Jap. II. 71. t. 135 (1842). Endlicher. Synops. Conif. 207 (1847). Parlatore. D. C. Prodr. XVI. 508. Franchet et Savetier, Enum. Pl. Jap. I. 474. Masters in Journ. R. Hort. Soc. XIV. 243. Sargent, Forest Fl. Jap. 77.

Nageia japonica. Gaertner. Carpol. I. 191. t. 39 (1788). Carrière. Traité Conif. ed. II. 635 (1867). Gordon. Pinet. ed. II. 180.

Jap. vernacular. Nagi.

Podocarpus Nageia, like the preceding species, is of Japanese origin and first became known to science through Kaempfer who accurately described and figured it in his "Amœnitates" under the name of *Laurus julifera*. In 1788 the German botanist, Gaertner, gave it generic rank as *Nageia japonica*, in which he is followed by Carrière and others, the character chiefly relied on being its broad leaves arranged in pairs, certainly a very distinct one but which it possesses in common with three or four other species of Malayan origin. By Endlicher all these were made sectional under Podocarpus to which the organs of fructification sufficiently conform.

Podocarpus Nageia has been assiduously cultivated by the Japanese from time immemorial with whom it is a great favourite, especially a variety in which the leaves are marked with broad white stripes, and this they use for dwarfing and pot culture. Professor Sargent remarks that "the real beauty of the tree is only seen when it has become large and old and the trunk covered with its peculiar smooth purple bark. A grove of these trees on the hill behind the Shinto temple at Nara is one of the most interesting spots in Japan."* According to Carrière, it was introduced into European gardens in 1840; it is now but seldom seen, and in Great Britain it is always more or less injured if not killed by severe winter frosts, a fact indicative of a sub-tropical origin.

Podocarpus neriifolius.

A much-branched shrub or small tree with the branchlets ridged and furrowed by cortical outgrowths decurrent from the bases of the leaves. "Leaves scattered, approximate, narrowly lanceolate, acute, coriaceous, dark green above, pale and slightly glaucous beneath, tapering below into a very short petiole. Staminate flowers axillary, sessile, solitary, cylindric, an inch long, arising from a cup-shaped scaly involucre; anthers numerous, imbricated, two-celled. Ovuliferous flowers solitary, axillary, pedunculate. Receptacle of the fruit oblong, fleshy, with an oblong depression at the top becoming deep purple, and slightly glaucous when mature. Seed obovate, glaucous green before maturity."—*Botanical Magazine*, t. 4655.

Podocarpus neriifolius. Don in Lambert's Genus Pinus. ed. II. Vol. II. p. 22 (1828). Endlicher. Synops. Conif. 215. Hooker. W. in Bot. Mag. *loc. cit.* Carrière. Traité Conif. ed. II. 661. Parlatore. D. C. Prodr. XVI. 514. Brandis. Forest Fl. Ind. 541. Hooker fil. Fl. Brit. Ind. V. 649.

Eng. Oleander-leaved Podocarp.

* Forest Flora of Japan. *loc. cit. supra.*

A beautiful evergreen tree inhabiting the temperate Himalayas of Nepal and Sikkim: it also occurs on the Khasia Hills and in the forests of Burmah, whence it spreads southwards into the Malay peninsula and the Andaman Islands. It was introduced to the Royal Gardens at Kew in the early part of the nineteenth century, and is still cultivated in the great Temperate House.

Podocarpus nubigenus.

A tree of Yew-like aspect of variable dimensions according to the situation in which it is growing. Leaves linear, or elongated oval-elliptic, 1–2 inches long, sessile or attenuated at the base into a very short footstalk, sub-acuminate with a thickened mid-nerve, dark lustrous green above with two glaucous stomatiferous bands beneath. Inflorescence not seen. Fruit as described by the author of the specific name "pedunculis solitariis, receptaculo oblique bilobo, obovato, brevioribus; fructibus oblongis, oblique obtuse apiculatis."

Podocarpus nubigenus, Lindley in Journ. Hort. Soc. Lond. VI. 264 (1851): and Paxton's Flower Garden, II. 162, with fig. Carrière, Traité Conif. ed. II. 650. Parlatore, D. C. Prodr. XVI. 513. Gay, Fl. Chil. V. 404. Gordon, Pinet. ed. II. 341. Masters in Journ. R. Hort. Soc. XIV. 243.

Discovered by William Lobb in southern Chile in 1846, and introduced by him in the following year to the Veitchian nursery at Exeter. It was found associated with and growing under the same conditions as *Saxegothaea conspicua* and which are stated under that species Although fairly hardy in the south-west of England and in Ireland, the climate of this country, so different in many respects from that of Southern Chile, is apparently unsuitable for it, and like the Saxegothaea, it has proved disappointing.

Podocarpus Totara.

A tree varying in height from 40–80 and in places even to 100 or more feet, with a trunk 2–6 feet in diameter. Bark on old trees often 3 inches thick, deeply furrowed; on younger trees fibrous, reddish brown and thrown off in ribbon-like shreds. Branches spreading, with distichous ramification; branchlets opposite, rigid, with dull green channelled bark. Leaves spirally inserted but rendered pseudo-distichous by a twist of the short petiole, linear or linear-lanceolate, mucronate, 0·5–1·25 inch long, dull, dark green and channelled above, paler and obscurely keeled beneath. Inflorescence dioecious. Staminate flowers axillary on shoots of the preceding year, solitary or in twos and threes, cylindric, sessile or shortly stalked, 0·5–0·75 inch long, with four minute involucral bracts at the base; anthers numerous with a small, obtuse, toothed connective. Ovuliferous flowers axillary, shortly stalked, consisting of two connate scales, one, rarely both, of which bears an ovule near the apex. Fruit about the size of a cherry, with a pulpy pericarp enclosing a nut rounded or slightly narrowed at the apex.

Podocarpus Totara, Don in Lambert's Genus Pinus, ed. II. Vol. II. App, 189 excl. syns. (1832). Hooker W. in Lond. Journ. Bot. I. 572, t. 19. Endlicher, Synops. Conif. 212. Carrière, Traité Conif. ed. II. 652. Parlatore, D. C. Prodr. XVI. 514. Hooker fil. Handb. N. Zeal. Fl. 258. Gordon, Pinet. ed. II. 350. Kirk, Forest Fl. N. Zeal. 227. t. 115. Masters in Journ. R. Hort. Soc. XIV. 243.
N. Zeal. vernacular, Totara.

The following account of the Totara is taken from Kirk's "Forest Flora of New Zealand":—

"With the exception of the Kauri, *Agathis australis*, the Totara affords the most valuable timber in New Zealand, but unlike the Kauri it is found almost throughout the colony. It sometimes forms large groves and even forests, but it is usually mixed with other trees. The wood is of a deep red colour, varying considerably in depth of tint; it is straight in the grain, compact and of great durability; it does not warp or twist, and is easily worked; it is an excellent timber for general building purposes; it is of great value for bridges, wharves and constructive works where large spans are not required, also for railway ties, telegraph posts, palings and shingles, and for marine piles it is invaluable on account of its great power in resisting the attacks of the teredo."

The Totara was introduced into British gardens many years ago; a tree in the Temperate House in the Royal Gardens at Kew is over 35 feet high with a trunk somewhat slender in proportion to height. In the open ground it grows slowly, and unless planted in a warm sheltered spot, it is liable to be killed by winter frosts.

PRUMNOPITYS.

Philippi in Linnaea. XXX. 731 (1859–60). Carrière. Traité Conif. ed. II. 682 (1867). Stachycarpus. Masters in Journ. Linn. Soc. XXX. 9 (1893). Podocarpus, sect. Stachycarpus, Endlicher. Synops. Conif. 218 (1847). Bentham and Hooker, Gen. Plant. III. 435.

Fig. 53. *Prumnopitys elegans*. Branchlets with staminate flowers. Communicated by the Earl of Ducie, from Tortworth Court.

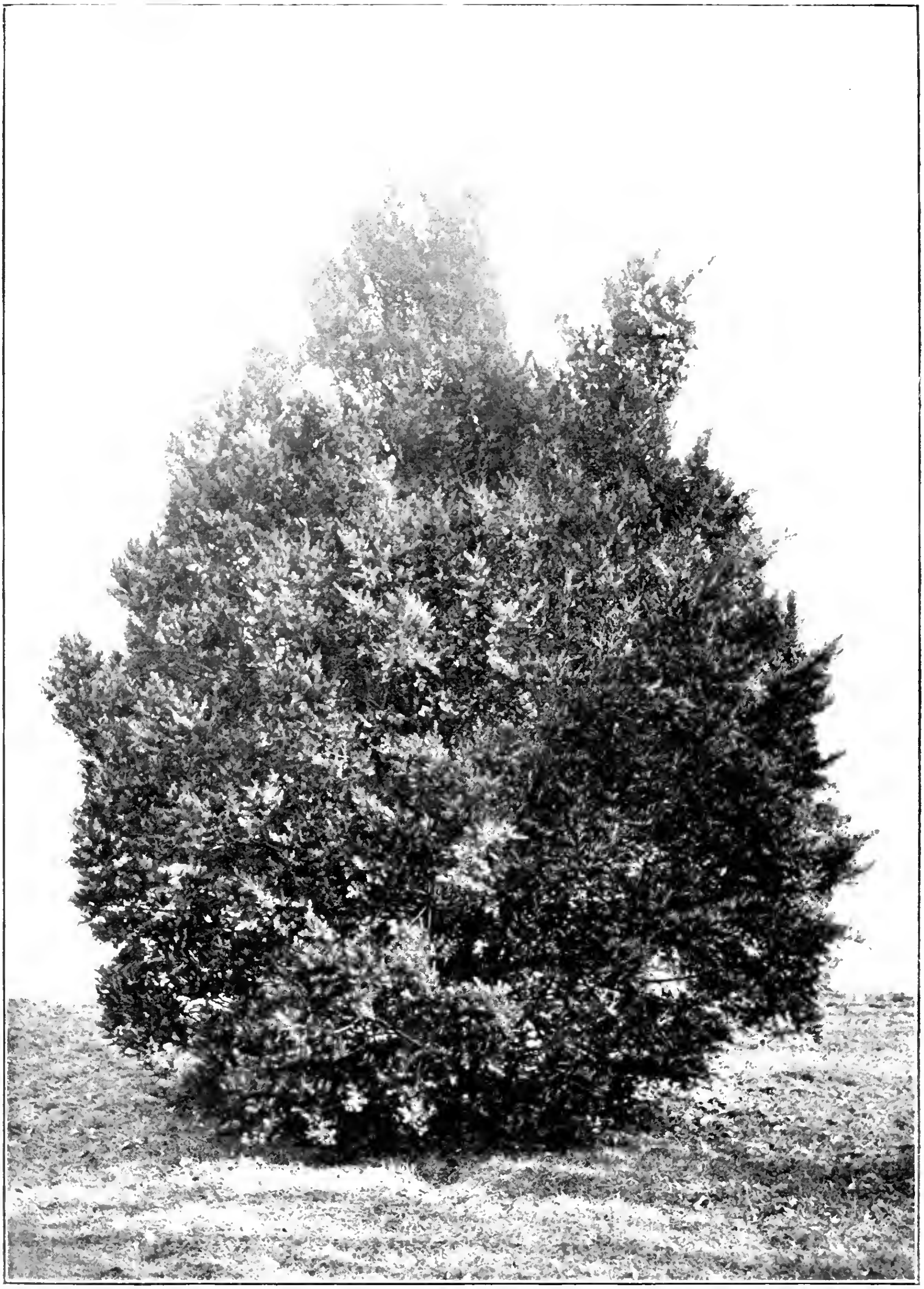
In all the true Podocarps the peduncle and ovule-bearing scale of the seminiferous flowers become fleshy when the fruit is mature, forming the *receptaculum* of many botanists, a characteristic on which much stress has been placed as it chiefly distinguishes Podocarpus from the allied genera. In two of the species included by most authors in Podocarpus, and probably in others not yet sufficiently known, the peduncle and fruit-scale do not become fleshy; in *Podocarpus andinus* (Pöppig), inhabiting southern Chile, on which Professor Philippi of Santiago founded the genus Prumnopitys, and in *P. spicata*, a native of New Zealand, the fruits are pseudo-terminal or sessile on a common rachis. These two species with three others were made sectional by Endlicher under the name of Stachycarpus: this section is adopted by Bentham and Hooker in the "Genera Plantarum" who include in it only the two species above named, and the same course is followed by Eichler in Engler and Prantl's "Natürlichen Pflanzenfamilien": Dr. Maxwell Masters has, however, given the section generic rank as Stachycarpus in the "Journal of the Linnean Society," but in the Kew Hand-List, Prumnopitys is retained for the Chilian species and for others in which the "receptaculum" is wanting.

As Prumnopitys differs from Podocarpus only in the absence of the so-called "receptaculum" further diagnosis is unnecessary; the name is derived from προῦμνος (the wild plum) and πίτυς (the pine tree).

Prumnopitys elegans.

A diœcious tree 40—50 feet high, but frequently much less especially at its highest vertical limit, the trunk covered with dark brown bark and much branched from the base upwards. In Great Britain usually a dense, much-branched shrub of pyramidal or broadly columnar outline. Branches slender, spreading or ascending and much ramified. Branchlets close-set, often pseudo-distichous, opposite, with smooth green bark that changes to brown after the fall of the leaves. Leaves persistent three—five years, spirally crowded around the branchlets, sub-distichous on horizontal growths, spreading on all sides in the ascending or erect shoots, linear, mucronate, 0·5—1 inch long, straight or falcately curved, dark green above, with the midrib indicated by a shallow channel on the older leaves; paler with thickened midrib and margins and with two glaucous stomatiferous bands beneath. Staminate flowers in terminal and axillary racemes, cylindric, obtuse, subtended by a pale green subulate bract; stamens numerous, spirally and close-set around the axis, sulphur-yellow. Fruit about the size of that of the wild Damson *(Prunus insititia)* which it much resembles in shape and colour, solitary and sessile or pseudo-terminal on short slender branchlets (rachides) on which the leaves are reduced to small acute scales. Seed enclosed in a

Fig. 54. *Prumnopitys elegans.* Fruiting branchlet and fruits, nat. size. Communicated by Mr. Coleman, from Eastnor.



Prumnopitys elegans. Fruit-bearing tree at Eastnor Castle, Ledbury.

hard bony shell surrounded with a viscous pericarp covered by a tough pergameneous skin.

Prumnopitys elegans, Philippi in Linnaea, XXX. 731 (1859–60). Lindley in Gard. Chron. 1863, p. 6. Carrière, Traité Conif. ed. II. 682. Kent in Veitch's Manual, ed. I. 316. Masters in Journ. R. Hort. Soc. XIV. 244. Kew Hand-List. 25.
Podocarpus andinus, Poppig. Nov. Gen. et Sp. III. 18 ex Endlicher, Synops. Conif. 219 (1847). Gay, Fl. Chil. V. 403 (1849). Parlatore, D. C. Prodr. XVI. 519. Gordon, Pinet. ed. II. 351. Beissner, Nadelholzk. 195.
Stachycarpus andinus.* Van Tieghem in Bull. Soc. Fr. 1891 (*fide* Masters).

Prumnopitys elegans inhabits the Andes of southern Chile where it has a vertical range of from 4,500 to 6,000 feet elevation; the limits of its distribution are not known. It was introduced from Valdivia by the Veitchian firm in 1860 through Richard Pearce and has proved hardy over the greater part of Great Britain, but it grows most freely in the south-western counties of England and in Ireland wherever it has been planted.†

Prumnopitys spicata.

A tall tree attaining a maximum height of 80 feet, frequently much less, with a trunk rarely exceeding 3 feet in diameter covered with bluish black bark. Primary branches of young trees slender, pendulous and much ramified; of adult trees erect or ascending with numerous short, close-set branchlets. Leaves pseudo-distichous, narrowly linear, mucronate, straight or falcately curved, about 0·5 inch long, green above, glaucous beneath. Flowers diœcious in short spikes; the staminate flowers ovoid, cylindric, composed of numerous anthers with a cordate connective; the ovuliferous flowers three—six on a spike, sessile and distant. Fruits globose, 0·5 inch in diameter with a fleshy pericarp. Cotyledons two.—Kirk, *Forest Flora of New Zealand*, 5, tt. 4, 5.

Prumnopitys spicata, Masters in Kew Hand-List of Coniferae, 25 (1896).
Podocarpus spicatus, R. Brown in Horsfield's Plant. Jav. rar. 40. Hooker, W. Icon. Pl. 543 (1843). Endlicher, Synops. Conif. 221. Carrière, Traité Conif. ed. II. 676. Hooker fil. Handb. N. Zeal. Fl. 258. Parlatore, D. C. Prodr. XVI. 519. Gordon, Pinet. ed. II. 354.
N. Zeal. vernacular, Black Pine, Matai.

The species described above was originally discovered by Banks and Solander in New Zealand during the memorable voyage of the *Endeavour* under the command of Captain Cook, 1768—71. It is distributed in greater or less abundance throughout the colony, including Stewart Island in the extreme south. Of its habit and aspect in its native country Mr. Kirk remarks:—

There is a singular difference between the early and mature stages of growth of this tree. Young trees from 10 to 20 feet high exhibit crowded, slender, pendulous branches ramifying into innumerable branchlets, the small narrow leaves, which are of a bronzed tint, being

* By the rule of priority this should be the accepted name. Stachycarpus is the sectional name proposed by Endlicher in 1847 for the group of species here included in Prumnopitys, and the specific name *andinus* (Poppig) is of still earlier date.

† Fine specimens of *Prumnopitys elegans* are growing at Eastnor Castle (both sexes); at Tortworth Court (both sexes); Menabilly, Cornwall; Kilmacurragh, Co. Wicklow; at Fota Island and Lakelands, Co. Cork.

confined to the extremities: in this stage it is a weeping tree of most remarkable appearance and differs so widely from the mature state that it has been taken both by natives and settlers for a different tree. In the mature state it forms a round-headed tree with erect branches ultimately developing a vast number of short, strict, close-set branchlets. The Matai affords timber of great value on account of its smooth even texture, strength and durability; it is heavy and close-grained but easily worked.

Prumnopitys spicata has been in cultivation under glass in Botanic gardens for many years past, but no date of introduction appears to have been recorded. As it grows wild in Stewart Island it is not improbable that seedlings might be raised sufficiently hardy for the climate of the south-western counties of England and Ireland.

SAXEGOTHÆA.

Lindley in Journ. Hort. Soc. Lond. VI. 258 (1851). Parlatore, D. C. Prodr. XVI. 497 (1868). Bentham and Hooker, Gen. Plant. III. 434 (1881). Eichler in Engler and Prantl. Nat. Pfl. Fam. 103 (1887). Masters in Journ. Linn. Soc. XXX. 10 (1893).

As shown under Phyllocladus and Dacrydium, the Taxads and Conifers of the southern hemisphere present some remarkable deviations from all northern types in the structure of their reproductive organs as well as in their general morphology, and in none of them is this peculiarity more marked than in Saxegothæa. With some hyperbole, Lindley characterised it as "having the male flowers of a Podocarp, the female cone of a Dammara (Agathis), the fruit of a Juniper, the seed of a Dacrydium and the habit of a Yew." In a scientific sense, Saxegothæa therefore possesses considerable interest as being a connecting link between the Taxaceæ and Coniferæ, but with a preponderance of characters pertaining to the former; it is a monotypic genus named in compliment to Prince Albert of Saxe-Gotha, the much lamented Consort of Her Majesty the Queen. Its essential characters will be gathered from the subjoined figures and description of the species.

Saxegothæa conspicua.

On its native mountains where it attains its greatest development, a tree of Yew-like aspect 20–30 feet high, at its highest vertical limit a low dense shrub; in Great Britain mostly a much-branched dense shrub or low tree of irregular outline.* Bark of branches yellowish brown, of the youngest shoots dull pale green. Buds, when formed, intermediate between the true winter buds of Taxus and the leafy terminal envelopes of the Cupressineæ, minute, enclosed by leaf-like scales that afterwards develop into foliage leaves. Leaves persistent

* At Strete Ralegh, near Exeter, the residence of Mr. H. M. Imbert Terry, is an arborescent form over 20 feet high with a trunk a foot in diameter near the base and covered with reddish brown bark. The tree has a spreading habit with a dark Yew-like aspect; it was raised from the seed originally collected by William Lobb in southern Chile.

four—five years, linear, mucronate, 0·5—0·75 inch long, spirally arranged with a bifarious tendency on the horizontal shoots, spreading on all sides on the erect ones, dark green above with the midrib slightly raised, with two pale stomatiferous lines beneath. Staminate flowers cylindric, whitish brown on a short axillary stalk with a few involucral bracts at the base; anthers two-celled, dehiscing longitudinally. Ovuliferous flowers terminal, small, roundish, with a short footstalk and distant leafy scales that graduate into lanceolate, imbricated,

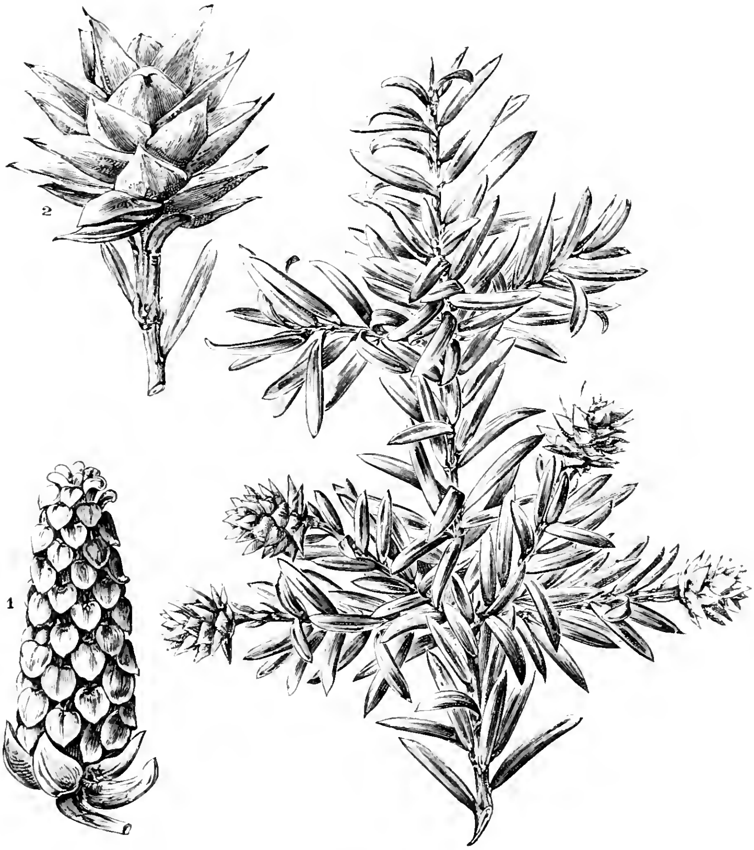


Fig. 55. A fruiting branchlet of *Saxegothæa conspicua*, natural size. 1. Staminate. 2. Ovuliferous flower enlarged.
Communicated by Mr. H. M. Imbert Terry from Strete Ralegh, near Exeter.

mucronate ovuliferous scales each bearing a solitary inverted ovule. Fruit a fleshy globose body less than an inch in diameter formed by the coalescence of the fertilised scales, the individuality of which is indicated by the projecting apex.

Saxegothæa conspicua, Lindley in Journ. Hort. Soc. Lond. *loc. cit.*; and Paxton's Flower Garden, I. 111, with figs. Gay, Fl. Chile, V. 411. Carrière. Traité Conif. ed. II. 683. Parlatore, D. C. Prodr. XVI. 497. Gordon, Pinet. ed. II. 372. Beissner, Nadelholzk. 195. Masters in Gard. Chron. II. ser. 3 (1887) p. 684; V. ser. 3 (1889), p. 782; with figs.; and in Journ. R. Hort. Soc. XIV. 70.

This remarkable Taxad was discovered by William Lobb in 1846 while collecting for the Veitchian firm in southern Chile, and introduced by him in the following year. Lobb sent to Mr. James Veitch, Senr., the following account of the locality in which he found it:—

> The whole of southern Chile, from the Andes to the ocean, is formed of a succession of ridges of mountains gradually rising from the sea to the central ridge; the whole is thickly wooded from the base to the snow line. Ascending the Andes of Comau, I observed from the water to a considerable elevation, the forest to be composed of a variety of trees, and of a sort of cane so thickly matted together that it formed almost an impenetrable jungle. Further up, amongst the melting snows, vegetation became so much stunted in growth that trees seen below 100 feet high and 8 feet in diameter, only attain the height of a few inches.
>
> On reaching the summit no vegetation exists, nothing but barren rocks which appear to rise among the snow that is many feet in depth and frozen so hard that in walking over it the foot makes but little impression. A little below the scenery is singular and grand. Rocky precipices stand like perpendicular walls 200–300 feet in height, over which roll the waters from the melting snows which appear like lines of silver. Sometimes these waters rush down with such force that boulders many tons in weight are hurled from their lofty stations to a depth of many hundred feet. In this wild region the Saxegothæa has its home associated with *Podocarpus nubigenus*, *Fitzroya patagonica*, *Libocedrus tetragona*, evergreen Beeches and other trees.

It is not surprising that the introduction of this remarkable plant should have attracted much interest at the time, and that hopes should have been entertained of its proving a distinct addition to the British Arboretum. Such hopes, however, have not been realised; the Saxegothæa is now but rarely seen, and when seen is scarcely noticed by the general observer. Although it has been in our midst more than half a century very few of the plants originally raised from Lobb's collection are now in existence. The cause of this is climatic, not so much in regard to temperature as to aerial and hygrometric conditions; for whilst the average yearly temperature of southern Chile is nearly the same as that of Great Britain, the annual rainfall is three times as much as that of this country.

MICROCACHRYS.

Hooker fil. in Lond. Journ. Bot. IV. 149 (1845). Endlicher, Synops. Conif. 227 (1847). Bentham and Hooker, Gen. Plant. III. 433 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 103 (1887). Masters in Journ. Linn. Soc. XXX. 10 (1893).

A monotypic genus founded on a Tasmanian shrub in 1845 by Sir Joseph Hooker who, adverting to the distribution of Taxads and Conifers in that island, observes "that it contains a greater number of species in proportion to its area, and these of more peculiar form than any other country; that whilst in the south temperate zone generally none of the species cover large areas, in Tasmania the individual species are so local that the island may be crossed from north to south without a single indigenous species being met with."* The species here described is one of the rarest and one of the most peculiar of them, particularly in the scales of the young cones assuming a pulpy texture and bright colour, a character probably unique in the Order. Like the Saxegothaea, it forms a direct transition from the Taxads to the Coniferae with imbricated leaves. The generic name is formed from *μικρὸς* (small) and *κάχρυς* (a cone).

Microcachrys tetragona.

A low straggling shrub with much elongated slender branches covered with dark reddish brown bark. Ramification tetrastichous (four-ranked); branchlets short, four-angled, similarly ramified and falling off the third or fourth year. Leaves in decussate pairs, ovate-rhomboid, sub-acute; on the young shoots, concrescent or closely imbricated; on the axial shoots longer, keeled and free at the acute tips, dark green, becoming effete the third year. Flowers diœcious and terminal. Staminate flowers small, ovoid or sub-cylindric, pale yellow, composed of numerous stipitate two-lobed anthers, each with a triangular connective. Ovuliferous flowers ovoid or globose, 0·25 inch long, bright red; scales spirally imbricated, each bearing an inverted ovule and ultimately becoming succulent.

Microcachrys tetragona, Hooker fil in Lond. Journ. Bot. *loc. cit. supra*. Fl Tasman. I. 358, with fig.; and Bot. Mag. t. 5576. Carrière, Traité Conif. ed. II. 688. Gordon, Pinet. ed. II. 184. Masters in Journ. R. Hort. Soc. XIV. 219.
Dacrydium tetragonum, Parlatore, D. C. Prodr. XVI. 496.

Microcachrys tetragona occurs only on the highest summits of the Western Range and Mount Lapeyrouse in Tasmania. It was introduced to the Royal Gardens at Kew about the year 1857 by Mr. William Archer on whose property it grew. Although of great interest in a botanical sense, its only value as a garden plant is for conservatory decoration for which the elegant habit it can be made to assume under pot culture, its neat foliage and bright red fruits render it highly suitable.

* Flora of Tasmania, 349.

1 2 4 5 6 7

Group of Cupressineæ at Westonbirt, Gloucestershire.

and 2. *Thuya gigantea.* 3. *Cupressus Lawsoniana.* 4. *C. obtusa.* 5 and 6. *Libocedrus decurrens.* 7. *Cupressus pisifera squarrosa.*

CONIFERÆ.

Trees or shrubs with resinous secretions and homomorphic rarely dimorphic ramification. Leaves persistent, occasionally deciduous. Staminate flowers composed of numerous stamens arranged in close-set spirals around a common axis. Seminiferous flowers composed of a central axis on which the ovuliferous scales are inserted spirally or in decussate pairs, rarely in whorls of three; scales made up of two parts, the bract which is free adnate at the base, or concrescent, and the seminiferous ligneous, rarely fleshy, lamina bearing two or more erect or pendulous ovules. Seeds 2—9, winged or without wings and destitute of an arillus.

TRIBE CUPRESSINEÆ.

Flowers monœcious, rarely diœcious. Stamens in decussate pairs or in whorls of three. Scales of the mature strobiles (fruits) opposite or whorled, rarely sub-spirally arranged, consisting of two parts although apparently simple, the bract being concrescent with the scale except at the apex. Ovules erect, 1—9 in one—two series.

SUB-TRIBE I.—JUNIPERINÆ.

Scales of strobiles (galbuli) concrescent and becoming fleshy.
Leaves homo- or dimorphic in whorls of three or in decussate pairs Staminate flowers axillary or terminal - - - - - - - - 1.—Juniperus.

SUB-TRIBE II.—THUINÆ.

Scales of strobiles ligneous in decussate pairs. Branchlets flattened or angulate. Foliage dimorphic; primordial leaves free and spreading: adult leaves squamiform, appressed or more or less concrescent. Scales of strobiles in decussate pairs or sub-spirally arranged.

Flowers diœcious, uppermost scales only of the strobiles fertile - - - - - - 2.—Fitzroya.

Flowers monœcious, scales of strobiles thickened.
Scales of strobiles horizontal at the base with a peltate expansion and bearing two or more seeds - - - - - - - - - - 3.—Cupressus.

Scales of strobiles ascending, oblong or broadly clavate.

Scales 8—12, more or less imbricated; seeds winged or wingless - - - - - 4.—Thuia.

Scales 4—6, valvate, the middle or largest pair only fertile; seeds with an oblique wing at the apex - - - - - - - 5.—Libocedrus.

JUNIPERUS.

Linnaeus, Sp. Plant. II. 1038 (1753). Endlicher, Synops. Conif. 7 (1847). Parlatore. D. C. Prodr. XVI. 475 (1868). Bentham and Hooker, Gen. Plant III. 427 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 101 (1887) Masters in Journ. Linn. Soc. XXX. 12 (1892).

The Junipers are evergreen, medium-sized, or low trees of pyramidal or fastigiate habit, but in old age often with rounded or flattened tops and irregular in outline; or bushy shrubs of spreading habit, occasionally quite prostrate. Their habit is greatly modified by climate and locality, and in mountainous regions by altitude and aspect, so that the same species which are arborescent in the warmer and more favoured districts are reduced to prostrate shrubs at their northern limit or highest vertical range; instances of these extreme forms in habit occur in *Juniperus communis*, *J. excelsa*, *J. recurva*, *J. virginiana* and others. The foliage is dimorphic, consisting either of pungent acicular or awl-shaped leaves in whorls of three, or of small scale-like leaves closely imbricated or concrescent in decussate pairs. In some species as *J. communis* the acicular foliage is constant; in others, as *J. excelsa*, *J. virginiana*, it prevails up to ten—twelve or more years when it gradually gives place to the smaller scale-like leaves; in others again, as *J. chinensis*, both forms of leaves are present from a very early age; in the typical *J. Sabina*, at least in Great Britain and in a few other species, the scale-like leaves only are present.

The essential characters of the genus may be technically expressed thus :—

Flowers monœcious or diœcious, the latter predominating, axillary or terminal on short lateral branchlets of the preceding year.

Staminate flowers solitary, rarely clustered, on short footstalks sheathed by a few minute involucral bracts, light yellow. Stamens numerous in decussate pairs or whorls of three, the scale-like connective bearing on the inner surface two—six anther cells.

Ovuliferous flowers composed of two—three series of scales in opposite pairs or whorls of three, and bearing at the base of the inner side, one—two erect ovules.

Fruits (galbuli) maturing the second year, or later, composed of mucronate, concrescent fleshy scales that are smooth or tuberculose, bluish black or brown in colour, and bearing two—five seeds.

The most obvious distinguishing character of the Junipers consists in the fruit being succulent, consolidated and slightly reduced in the number of its parts. A subordinate distinguishing character is seen in the ternate arrangement of the acicular leaves.

The number of species has been variously estimated according to the views of the authors who have described or enumerated them, thus—Carrière describes forty including several but doubtfully admitted, Parlatore twenty-seven, Gordon thirty-six, and in the "Genera Plantarum" Mr. Bentham estimated the number to be about twenty-five.* But whatever may be the number of species, they are all reducible to a series of types comparatively few in number, around which the species may be grouped, but the species themselves or the forms recognised as such are in several cases separated from each other by little else than geographical position. The genus admits of a division into two well-marked sections thus distinguished:—

OXYCEDRI. Leaves homomorphic, acicular or awl-shaped, more or less spreading and arranged in whorls of three. Flowers mostly diœcious, solitary and axillary. Fruits relatively large and containing three seeds or fewer by abortion.

SABINÆ. Leaves dimorphic, acicular or scale-like, the latter always arranged in decussate pairs on fertile branches and on adult plants. Flowers terminal on short lateral branches of the preceding year. Fruits relatively small and containing for the most part a single seed.

Endlicher constituted the Syrian Juniper, *J. drupacea*, a distinct section under the name of Caryocedrus on account chiefly of the seeds being coalescent in the centre of the fruit.† Practically this species may be included in the Oxycedri.

The Junipers inhabit both the eastern and western continents from the Arctic regions to the verge of the Torrid zone; in Asia including China and Japan in the east and Persia and Asia Minor in the west; in Africa, part of the Mediterranean littoral, the Canary Islands, and an outlying species in Abyssinia (*J. procera*); in America spreading southwards far into Mexico and into the West India Islands. In places they cover large areas unmixed with other vegetation, as in the arid region between the Rocky Mountains and the Sierra Nevada and on the north-west Himalaya at the highest vertical limit of arborescent vegetation up to 15,000 feet above sea-level.

The economic value of the Junipers is not very great. Where they attain a timber-like size, the wood is light, fragrant, close-grained and of a reddish brown colour as that of *J. virginiana* and *J. bermudiana*

* Traité Général des Conifères, ed II. (1867). De Candolle's Prodromus, Vol. XVI. (1868). The Pinetum, ed. II. (1875). Genera Plantarum, Vol. III (1881). No genus in the Coniferæ stands in more urgent need of revision than Juniperus; the task, however, is an exceedingly difficult one in the absence of living fruiting specimens of many of the species which, owing chiefly to climatic causes, cannot be cultivated in the open ground in this country.

† Synopsis Coniferarum, p. 8. As no fruits of *Juniperus drupacea* are produced in this country, the author has not had an opportunity of verifying this.

which is much used in the manufacture of "cedar pencils" and domestic furniture, and that of *J. recurva* and *J. excelsa*, the latter of which is used for all kinds of constructive purposes in the mountainous region of north-west India.* The fruits of the Savin were formerly used as a diuretic in medicine, and those of the common Juniper are still employed in large quantities for flavouring gin. In horticulture, some of the arborescent species of the temperate zone, as *J. chinensis*, *J. virginiana* and the fastigiate form of *J. communis* are much used in ornamental planting; the shrubby species for the most part occupy but a subordinate place although several handsome forms of prostrate habit are to be found among them. An essential condition for the successful cultivation of the Junipers is free exposure to sun and air.

Juniperus is the Latin name of the Juniper, and appears to have been applied indiscriminately to most of the species common in southern Europe in the same way as the Greeks applied the names *κέδρος* and *ἄρκευθος*.

Juniperus bermudiana.

A monœcious tree attaining a height of 50—60 feet with a broadly conical crown, the trunk often 2—3 feet in diameter near the base, and covered with dark brown bark which in the younger trees peels off in shreds, but in the older ones becomes hard, rugged and irregularly fissured. Branches spreading or ascending; branchlets much ramified, ramification tetrastichous (four-ranked), the youngest branchlet system ramified in the same way. Leaves dimorphic; on young trees and on the older shoots of those more advanced in age, in whorls of three, acicular, concave with two stomatiferous lines above, convex beneath, becoming effete on the axial growths the second or third year; on the younger lateral shoots and on adult trees scale-like, ovate, acute, imbricated and bright green. Staminate flowers with eight—ten anthers. Fruits (galbuli) solitary or in twos and threes in and near the axils of the youngest branchlet systems, 0·3—0·5 inch in diameter, smooth, not glaucous, reddish brown with a purplish tinge when mature.†

Juniperus bermudiana, Linnaeus, Sp. Plant II. 1039 (1753). Endlicher, Synops. Conif. 29. Hooker W. in Lond. Journ Bot. II. 141, t. 1. Carrière, Traité Conif. ed. II. 49 Parlatore, D. C. Prodr. XVI. 490. Hemsley in Gard. Chron. XIX. (1883), p. 656, with figs. Sargent in Garden and Forest, IV. (1891), 289, with figs And many others.

The Bermuda Juniper still forms the most prominent feature of the flora of the little ocean-girt group of islets from which it derives its specific name, although the woodcutter's axe has long since removed most of the serviceable trees for the use of the shipbuilder and for the manufacture of "cedar" pencils for which the wood was at one time much in request, but now superseded by that of the cheaper and more accessible *Juniperus virginiana.* Nevertheless a few old trees standing in cemeteries and other particular spots afford ample evidence of what a picturesque and even beautiful object

* Aitchison in Journal of the Linnean Society, XVIII. 97.

† Fruiting sprays were communicated by the late M. Charles Naudin from the Villa Thuret Botanic garden, Antibes.

this Juniper is where other trees are scarce.* It grows well-nigh everywhere on the islands, in the most diverse situations from the low brackish swamps along the sea-shore to the dry limestone hills inland. A letter written by Sir Hans Sloane to Mr. Ray, the eminent naturalist, contains evidence that the Bermuda Juniper was cultivated in this country in 1684,† and according to London, also in the following century by Philip Miller at Chelsea, but it is too tender for the open ground; it has long been a denizen of the Temperate House in the Royal Gardens at Kew.

Juniperus bermudiana affords an instructive instance of the manner in which an insular flora originates. Its nearest affinity is the Red Cedar, *J. virginiana*, from which it is chiefly distinguished by its stouter branchlets, its longer and more obtuse glandular leaves, its larger staminate flowers with more scales and its larger differently coloured fruits. The Red Cedar is abundant all over the eastern portion of the North American continent from Canada to Florida; its fruits are devoured by birds which void the hard seeds without injury, and by them *J. virginiana* has been widely dispersed over the American continent and the adjacent islands, and hypothetically by the same agency transplanted to the Bermudas at a remote epoch, for pieces of "cedar" wood were found at a depth of 50 feet below low-water mark during the dredging operations undertaken by the British naval authorities for the construction of a dock. Thus during the course of ages under the influence of the insular climate the Bermuda Juniper has gradually diverged from the parent stock to such a degree as to be recognised as specifically distinct. Analogous instances occur in the Azores and the Canary Islands which are inhabited by Junipers that are undoubted offshoots of *J. Oxycedrus* widely distributed over the Mediterranean region.

Juniperus californica.

A tree occasionally 40 feet in height with a straight large-lobed, unsymmetrical trunk 1–2 feet in diameter; more often shrubby with numerous stout, often contorted branches which form a broad open head. Branchlets stout, at first light yellow-green changing to bright red-brown in their third or fourth season, and at the end of four or five years after the leaves have fallen, covered with thin grey-brown scaly bark. Leaves usually in threes, closely appressed, slightly keeled and glandular pitted at the base, distinctly fringed on the margin, light yellow-green, about 0·125 inch long and becoming effete in the third year; on vigorous shoots and young plants, linear-lanceolate, rigid, pungent, 0·25–0·4 inch long, whitish on the upper surface. Staminate flowers about 0·2 inch in length with eighteen twenty-four stamens. Fruits globose, somewhat more than 0·25 inch in diameter, reddish brown with a thick glaucous bloom. Sargent, *Silva of North America*, X. 79, t. 517.

* Excellent illustrations of this are given in Garden and Forest, Vol. IV. (1891), pp. 294, 295.

† Hemsley in Gardeners' Chronicle, XIX. (1883), p. 656.

Juniperus californica, Carrière. Revue Hort. (1854), p. 352, with fig.; and Traité Conif. ed. II. 41. Engelmann in Trans. Acad. St. Louis, III. 558. Brewer and Watson, Bot. Califor. II. 113. Beissner, Nadelholzk. 113. Masters in Journ. R. Hort. Soc. XIV. 211.

J. occidentalis, Hoopes, Evergreens, 299 (in part). Parlatore, D. C. Prodr. XVI. 489 (in part). And others.

J. pyriformis, Lindley in Gard. Chron. (1855), p. 420.

The species described above was for a long time confounded with *Juniperus occidentalis*, from which it is not easily distinguishable in herbarium specimens, however distinct in habit and aspect the two may appear in their native country. It has a restricted range on the lower slopes and lowlands of California from the valley of the Sacramento southwards into Lower California: it also occurs on the western slopes of the Sierra Nevada as far north as Kernville.

Juniperus californica was introduced to the Veitchian nursery at Exeter about the same time as the Wellingtonia (1853) by William Lobb, who had gathered seeds on the San Bernardino mountains in south California. Plants were subsequently distributed under Dr. Lindley's name of *J. pyriformis*, but their unsuitableness for the British climate soon became apparent; the very few plants of *J. californica* still living in this country are referred to *J. occidentalis*.

Two closely allied forms or climatic variations of *Juniperus californica* may be here noticed.

Juniperus mexicana.

Schlechtendal in Linnaea, V. 97 (1830); and XII. 494 (1838). Endlicher, Synops. Conif. 28. Parlatore, D. C. Prodr. XVI. 491. Carrière, Traité Conif. ed. II. 47. And others.

A tree ranging from 20 to 30 feet high, in some places attaining greater dimensions, but at its highest vertical range reduced to a low straggling shrub. It is spread over the mountains and high plateau of Mexico from the Sierra Madre southwards at elevations ranging from 6,000 to 10,000 feet above sea-level. Carrière states that it was introduced into European gardens in 1841.

Juniperus utahensis.

Lemmon. Report California State Board of Forestry. III. 183. t. 28 (1890), ex Sargent, Silva of N. Amer. X. 81, t. 518. J. californica var. utahensis, Engelmann, Trans. Acad. St. Louis, III. 588.

This takes the place of *Juniperus californica* in the arid region lying between the Sierra Nevada of California and the Rocky Mountains where it is very abundant, in places forming stunted forests above 5,000 up to 8,000 feet elevation. It differs from *J. californica* in its more slender branches and usually glandless leaves, and in its smaller and generally one-seeded fruits. It is geographically separated from that species by the Mohave desert. It affords the cheapest and most accessible fuel in the desert region which it inhabits, but is rapidly disappearing to supply the wants of miners and others.* *J. utahensis* is probably not in cultivation in Great Britain.

* Silva of North America, *loc. cit. supra.*

Juniperus chinensis.

A diœcious tree of elongated conical or columnar outline attaining in China and Japan a height of 60—70 feet, but much less at high altitudes where it is reduced to a low tree or dense shrub. In Great Britain usually a slender medium-sized tree of columnar but occasionally pyramidal outline. Primary branches of male trees short, stoutish, close-set, spreading or ascending and much ramified; of female trees longer, more slender, spreading and less densely ramified. Branchlets with dark chestnut-brown bark that is paler on the younger growths; ramification mostly tetrastichous, that of the herbaceous shoots pinnate and very slender. Leaves dimorphic: on young plants and on the sterile branchlets of older ones, in whorls of three, subulate, pungent, spreading, 0·25—0·5 inch long; concave, greyish white with green median and marginal lines on the ventral side; convex, wholly green and sometimes with a narrow gland on the dorsal side; in the fertile branches and youngest shoots in decussate pairs, scale-like, ovate, obtuse, concrescent or closely imbricated, bright green. Staminate flowers very numerous, fusiform-cylindric, composed of eight—twelve stamens, light yellow. Fruits somewhat variable in form and size, spherical or top-shaped, 0·25—0·4 inch in diameter, blackish blue with a glaucous bloom when mature.

Juniperus chinensis, Linnæus, Mantissa, 127 (1771). Siebold and Zuccarini. Fl. Jap. II. 58, tt. 126. 127. Loudon, Arb. et Frut. Brit. IV. 2505, with figs. Forbes, Pinet. Woburn, 208, t. 65. Endlicher, Synops. Conif. 20. Carrière, Traité Conif. ed. II. 29. Parlatore, D. C. Prodr. 487 (excl. Indian habitat). Gordon, Pinet. ed. II. 158. Beissner, Nadelholzk. 118, with figs. Masters in Journ. R. Hort. Soc. XIV. 221.

J. flagelliformis, Hort. J. neaborensis, Hort.

Eng. Chinese Juniper. Fr. Genévrier de Chine. Germ. Chinesischer Sadebaum. Ital. Ginepro chinese.

var.—albo-variegata.

Of dwarfer, denser habit than the common form and mostly with acicular foliage that is more glaucous and with many of the branchlets and terminal shoots cream-white.

J. chinensis albo-variegata, Hort. J. chinensis variegata Gordon, Pinet. ed. II. 159. J. chinensis procumbens albo-variegata, Hort. J. japonica albo-variegata, Hort.

var.—aurea.

This has the whole of the current year's growth suffused with golden yellow which is heightened by full exposure to the sun and which gradually changes to the normal green colour in the following season.

J. chinensis aurea, Hort.

var.—procumbens.

A dwarf shrub with robust spreading often procumbent elongated branches and short branchlets. Leaves on young plants acicular, marked with two silvery lines above and bright green beneath; in old plants and in the variegated forms scale-like in decussate pairs. **procumbens aurea** has the growth of the current season tinged with golden yellow which changes to light green in the following year. **procumbens aureo-variegata** has many of the branchlets and terminal growths deep golden yellow.

J. chinensis procumbens, Endlicher, Synops. Conif. 21. Beissner, Nadelholzk. 121. J. procumbens, Siebold and Zuccarini, Fl. Jap. II. 59, t. 127, fig 3. J. japonica, Carrière, Traité Conif. ed. II. 31. Gordon, Pinet ed. II. 160.

Other varieties are known as *Jacobiana*, *pendula*, *pendula aurea* and *pyramidalis*.

Although long recognised as one of the most ornamental of Junipers for the lawn and flower-garden very little is known respecting the habitat and distribution of *Juniperus chinensis*. Specimens of undoubted Chinese origin are preserved in the national Herbaria but these are mostly from cultivated plants, and no record is found of its having been seen growing wild in any locality in China accessible to Europeans; a circumstance easily accounted for by the presence everywhere of a dense population.* It appears to grow spontaneously on the mountains of central Japan, and there is ample evidence of its having been for centuries past cultivated by the Japanese.†

Juniperus chinensis was introduced into British gardens in 1804 along with other Chinese plants by William Kerr, a young gardener employed in the Royal Gardens at Kew who was sent on a botanical mission to the Far East in 1803.‡ Its remarkable adaptability to a wide range of temperature is shown by its endurance of our severest winters without injury, and by its vigorous and healthy growth in the sub-tropical Botanic Gardens of Sydney and Adelaide in Australia. Of the varieties cultivated in Great Britain *aurea* is by far the most ornamental that has originated in European gardens; the others described above were introduced from Japan by the late Mr. John Gould Veitch and Mr. Robert Fortune with the exception of a vigorous form of *procumbens* which was distributed from an English nursery.

Juniperus communis.

In Great Britain usually a shrub with spreading sometimes prostrate branches which turn upwards at the end, and which with their appendages form a more or less dense bush several feet through but not more than 3 to 5 feet high; less frequently a low tree 15—20 or more feet high with relatively short spreading or ascending branches covered with smooth reddish brown bark, and much ramified at the distal end. Branchlets slender, from which numerous herbaceous shoots are produced at short intervals in a four-ranked arrangement, but which is often much obscured. Leaves in whorls of three, subulate, rigid, pungent or spine-tipped, spreading nearly at a right angle to the shoot, 0·25—0·5 inch long, silvery white with green margins above, grass-green and obscurely keeled

* An herbarium specimen gathered by Sir Joseph Hooker in Tibetian territory north of Sikkim is, without doubt, indigenous and affords evidence of the presence of the Chinese Juniper in a locality very remote from that from which it was originally introduced.

† Two venerable Junipers 70 to 80 feet high with hollow trunks more than six feet in diameter standing in front of a Buddhist temple in Nangano, Japan, and which must be several centuries old, are referred to *Juniperus chinensis* by Professor Sargent. Forest Flora of Japan, p. 78.

‡ His name is commemorated by the genus Kerria. Among other beautiful plants introduced by him was the grand old Tiger Lily, *Lilium tigrinum*.

beneath. Staminate flowers very small, axillary composed of fifteen eighteen stamens in five six whorls. Ovuliferous flowers consisting of three divergent ovuliferous scales, and three minute fleshy scales alternating with them below and adnate to them at the base. Fruits numerous, solitary in the axils of the leaves, on short footstalks clothed with minute triangular imbricated scales, ripening in the second year, at first green, changing to blackish violet with glaucous bloom, about one-fifth of an inch in diameter and containing three seeds.

Juniperus communis, Linnaeus, Sp. Plant. II. 1040 (1753). Pallas, Fl. ross. I. 12, t. 4 (1784). L. C. Richard, Mem. sur les Conif. 33 (1826). Loudon, Arb. et Frut. Brit. IV. 2489, with figs. Endlicher, Synops. Conif. 15. Carrière, Traité Conif. ed. II. 17. Parlatore, D. C. Prodr. XVI. 471. Brandis, Forest Fl. Ind. 535. Gordon, Pinet. ed. II. 131. Brewer and Watson, Bot. Califor. II. 113. Willkomm, Forstl. Fl. ed. II. 261, with fig. Boissier, Fl. orient. V. 707. Beissner, Nadelholzk. 133, with figs. Sowerby, Eng. Bot. VIII. 273, t. 882. Hooker fil. Fl. Brit. Ind. V. 646. Masters in Journ. R. Hort. Soc. XIV. 212. Sargent, Silva N. Amer. X. 75. t. 516. And many others.

J. canadensis, Gordon, Pinet. ed. II. 129.

Eng. Juniper. Amer. Ground Cedar. Fr. Genévrier commun. Germ. Wachholder, Machholder, Kranawett, and others. Ital. Ginepro ordinario. Span. Enebro. Port. Zimbro.

var.—aureo-variegata.

All or nearly all the terminal growths of the current year golden yellow which changes in the following season to the normal colour of the species. The golden variegation occurs in two distinct forms, the one arborescent or spreading, the other dwarf or procumbent.

J. communis aureo-variegata, Hort. ex Beissner, Nadelholzk. 138. J. communis aurea, Hort. J. canadensis aurea, Hort.

var.—cracovica.

An arborescent form with spreading branches and long, slender, somewhat distant, sub-pendulous branchlets which are at first yellowish and furnished with longer leaves than in the common Juniper.

J. communis cracovica,* Loddiges, ex Loudon, Arb. et Frut. Brit. IV. 2490 (cracovia). Gordon, Pinet ed. II. 132. Beissner, Nadelholzk. 136.

var.—fastigiata.

An erect low tree 12–15 or more feet high, of slender columnar habit; the branches and their ramifications erect, rigid and closely appressed to the principal stems and to each other; the youngest branchlets short and furnished with close-set leaves that are smaller and usually more brightly coloured than in the common form. The variety cultivated in gardens under the name of **compressa** is a diminutive form of *fastigiata*.

J. communis fastigiata, Parlatore, D. C. Prodr. XVI 197. J. communis suecica, Loudon, Arb et. Frut. Brit. IV. 2487. Carrière, Traité Conif ed II. 18. J. communis hibernica, Gordon, Pinet. ed. II 132. Beissner, Nadelholzk 136. J. communis arborescens, Endlicher, Synops. Conif. 16. J. hibernica compressa, Hort. Swedish Juniper.

var.—hemisphærica.

A small cæspitose bush usually of hemispheric form with short, much ramified branches and branchlets, the latter clothed with leaves

* This variety is said to have originated in the neighbourhood of Cracow; it may be so since the common Juniper is abundant on the Carpathian Mountains.

like those of the common form but smaller, more crowded, almost imbricated (in British gardens), white above, distinctly keeled beneath.

J. communis hemisphaerica, Parlatore, D. C. Prodr. XVI. 479. Beissner, Nadelholzk. 137. J nana hemisphaerica. Carrière, Traité Conif. ed II 16. J. hemisphaerica, Presl, Delic. Prag. 142. Endlicher, Synops. Conif. 12. Gordon, Pinet. ed. II. 134. J. echinoformis, Hort.

var.—nana.

A dwarf decumbent or prostrate shrub with short thickish branches much ramified. Branchlets short. Leaves smaller than in the common form, close-set, incurved, almost imbricated. Fruits smaller but in other respects conforming to the type.

J. communis nana, Loudon, Arb. et Frut. Brit. IV. 2489, with fig. J. nana, Wildenow, Sp. Plant IV. 854. Endlicher, Synops Conif. 13. Carrière, Traité Conif. ed. II. 14. Gordon, Pinet. ed. II. 136. Beissner, Nadelholzk. 132. J communis alpina, Parlatore, D. C. Prodr. XVI. 480.

var.—oblonga.

A large bush or low tree with somewhat slender, spreading or sub-pendulous branches and with angular, slender, elongated branchlets. Leaves longer and more spreading than in the common form, white above and bright green beneath. Fruits elliptic-oblong, not spherical.

J. communis oblonga, Loudon, Arb et Frut. Brit. IV. 2489. Parlatore, D. C. Prodr. XVI 479. Beissner, Nadelholzk. 137. J. oblonga, Bieberstein, Fl. taurico-cauc. II 426. Carrière, Traité Conif. ed. II. 19. Gordon, Pinet. ed. II. 137 (oblongata). J. communis caucasica, Endlicher, Synops. Conif. 16.

The most striking fact respecting the common Juniper is the enormous area over which it is spread. On the eastern continent it is distributed over the whole of Europe and Asia north of and including the series of great mountain chains extending eastwards from Spain to China, and restricted northwards only by the limits imposed by climate on arborescent vegetation, and excluding the steppe and desert regions of south-east Europe and Central Asia. On the western continent its range northwards is only checked by the same cause as in the eastern, whilst southwards it spreads on the Atlantic side to the highlands of Pennsylvania; in the central region to northern Nebraska and along the Rocky Mountains to Arizona, New Mexico and western Texas; and on the Pacific side from Alaska to northern California.*

Juniperus communis varies exceedingly in habit according to the latitude and vertical elevation at which it is found; in valleys and lowlands it attains the dimensions of a tree 20—25 or more feet high; on mountain slopes and on exposed hill-sides it is mostly a dense shrub 3—5 feet high; and at the highest elevations and in the highest latitudes in which it can live it is a prostrate bush, rising but a few inches above the ground. The varieties described above are all geographical deviations from the ordinary type with the exception of *aureo-variegata*, which is of garden origin. From a horticultural standpoint they are superior to the common form as decorative plants, and among the most useful of their kind, especially *fastigiata*, the well-known

* Sargent, Silva of North America, X. 77.

Swedish Juniper so called from its Scandinavian origin. The variety *hemisphaerica*, found wild in beech-woods covering the higher slopes of the mountains of Greece and southern Italy, and also on Mount Etna, is a modification or climatic form of the widely dispersed variety *nana* of northern latitudes; this variety also occurs on the mountains of Europe, ascending to 6,000 - 7,500 feet on the Alps; it is also abundant on the north-western Himalaya up to 14,000 feet. The variety *oblonga* of the Caucasian region is probably not in cultivation in this country; the *oblonga pendula* of gardens is not a variety of *J. communis* but a synonym of *J. taxifolia*, a species inhabiting northern China.

Not much can be said of the economic value of the common Juniper, as it rarely attains a sufficient size to yield workable timber. In India the twigs are burned as incense, and in the higher Himalayan passes the wood is used for fuel. The fruit is extensively used on account of the diuretic properties which it imparts to gin, and when crushed and distilled, yields an essential oil.

Juniperus drupacea.

Fig. 56. *Juniperus drupacea.*
(From the *Gardeners' Chronicle*.)

A diœcious tree 25 - 30 feet high, trees of the two sexes differing somewhat in habit; the male dense, of columnar or sharply conical outline with short branches, the female more diffuse with longer spreading branches. In Great Britain the older trees densely columnar with a single or divided trunk, in the latter case the secondary trunks erect or but slightly divergent. Primary branches short, ascending and covered with reddish bark; secondary branches short and irregularly disposed. Leaves persistent four — five years, homomorphic, in whorls of three, linear-acicular, rigid, pungent, and spreading, 0·5 — 0·75 inch long, slightly concave with two greyish white stomatiferous lines above, sharply keeled and light green beneath. Staminate flowers in clusters of three — six each composed of nine — twelve stamens, and surrounded at the base by six, in two series of three, ovate, leaf-like, strongly keeled bracts about one-fourth as long as the leaves. Fruits ovoid, obtuse or sub-spherical, about an inch in diameter, consisting of six - nine closely united, fleshy scales in verticils of three, enclosing a hard bony kernel generally containing three coalescent seeds, but sometimes by non-development only one; the fleshy external covering deep purple with a glaucous bloom.

Juniperus drupacea. Labillardière.* Plant. syr. decad. II. 14, t. 8 (1791). Loudon, Arb. et Frut. Brit. IV. 2494. with figs. Endlicher. Synops. Conif. 8. Lindley in Gard. Chron. 1855. p. 455, with fig. Carrière, Traité Conif. ed. II. 8. Parlatore, D. C. Prodr. XVI. 476. Gordon, Pinet. ed. II. 133. Boissier, Fl. orient. V. 706. Tristram, Fl. Pal. 451. Beissner. Nadelholzk. 140. Masters in Journ R Hort. Soc. XIV. 212.

Eng. Syrian Juniper. The Arceuthos. Fr. Genevrier de la Syrie. Germ. Steinfrüchtiger or Pflaumenfruchtiger Wachholder Ital. Ginepro della Siria.

The earliest notice of *Juniperus drupacea* occurs in a work by Pierre Belon published in Paris in 1588 and entitled "Les observations de plusieurs singularités et choses mémorables trouvées en Grèce, Asie, etc.," his description of the fruit being sufficiently clear for the identification of the species. The author first met with it while making the ascent of Mount Lebanon† where it is still common; it is also common on Anti-Lebanon whence it spreads northwards along the Syrian coast range to the Cilician Taurus where it attains its greatest development. On Bulghar-Dagh and Khara-Dagh it is very abundant between 1,750 and 5,550 feet elevation, in some places forming an undergrowth in the light Oak and Pine forests, in others covering large stretches unmixed. It was introduced into European gardens by Theodor Kotschy in 1854.

Juniperus drupacea has secured a place in many British gardens on account of its hardiness, the unique shade of green of its foliage, and the small space it requires. But although so long a denizen of this country it is a curious fact that no fruit-bearing trees have been observed, or if observed not recorded. It is highly probable that diœcity in this species is absolute, and that the male form only is in cultivation; and as propagation is easily effected by means of cuttings that form alone has been perpetuated.‡ Siehe states that the fruits are eaten by the inhabitants of the villages situated high up on the Cilician Taurus.§

Juniperus excelsa.

A monœcious tree,|| of very variable dimensions in different localities of the extensive region over which it is spread. At its greatest development it attains a height of 50–70 or more feet with a slender trunk often not more than 12–15 inches in diameter; more frequently a smaller tree 30–45 feet high with a thicker trunk; at its highest

* Labillardière travelled in the Levant in 1787–1789; the descriptions and figures of the plants he discovered were published in Paris two years afterwards in five decades.

† This was about the year 1550 according to Loudon who quotes Belon's account of the Cedars. This intrepid traveller was one of the first Europeans who saw them after the Turkish conquest of Syria.

‡ From a communication received from Signor Gaeta of Florence, it would seem that the fruiting of *Juniperus drupacea* is an extremely rare occurrence in Italy.

§ Gartenflora. 1897. p. 207.

|| Walter Siehe in Gartenflora, 1897, p. 210, states the trees observed by him on the Cilician Taurus were for the most part diœcious, and that the two sexes are easily distinguishable. The scale-like leaves of the male trees are thicker and of a brighter green than those of the fruit-bearing trees.

vertical limit reduced to a small confused bush scarcely knee high. Bark of trunk fibrous, peeling off in longitudinal shreds, that of the branches pale brown and smooth. Primary branches spreading or ascending; secondary branches short, much ramified, and terminating in numerous slender leafy branchlets pinnately divided. Leaves dimorphic: on the axial shoots in whorls of three, ovate-triangular, acute, adnate at the base, free at the apex, with a small oblong gland on the dorsal, and a white stomatiferous band on the ventral side, becoming effete the third or fourth year; on the younger branchlets in decussate pairs, scale-like, imbricated, concrescent or closely appressed, dull, dark green, often with a grey margin. Staminate flowers very numerous, terminal on short branchlets of the preceding year, oval, pale yellow, consisting of nine anther lobes. Fruits spherical, somewhat larger than a large pea, mostly in clusters of five—nine or more, dark glaucous purple composed of six concrescent scales each with a small transverse umbo.

Juniperus excelsa, Bieberstein, Fl taurico-caucas. II. 425 (1808). London, Arb. et Frut. Brit IV 2503 (in part). Endlicher, Synops. Conif 25. Carrière, Traité Conif. ed. II. 36. Parlatore, D. C. Prodr. XVI. 484 Brandis, Forest Fl N.W. India. 538.* Gordon, Pinet. ed. II. 143. Boissier, Fl. orient. V. 708. Aitchison in Journ. Linn. Soc. XVIII. 97. Beissner, Nadelholzk. 112. Masters in Journ. R Hort. Soc. XIV. 212.

J. phoenicea, Pallas, Fl. ross. I. 16, t. 7 (not Linnaeus).

J. religiosa, Carrière, Traité Conif. ed. II. 39; and Gordon, Pinet. ed. II. 148 (not Royle).

Eng. Greek Juniper. Tall Juniper. Fr. Genévrier d'orient. Germ Hohe Sadebaum. Ital. Ginepro greco.

var. stricta.

Differs from the common form in having a more tapering outline and a more glaucous foliage, imparting to the plant a greyish white aspect when viewed from a distance. It is of garden origin.

J. excelsa stricta, Hort. Beissner, Nadelholzk. 112.

The geographical range of *Juniperus excelsa* is very extensive, comparable in this respect with *J. virginiana* of which it is the representative in the eastern hemisphere. But whilst *J. virginiana* attains its greatest development in the low-lying, swampy lands of the south-eastern States of North America, *J. excelsa* is for the most part an alpine tree that attains its greatest size on mountain slopes 3,000—5,000 feet above sea-level. Its western limit is in the islands of the Greek Archipelago, whence it spreads eastwards through Asia Minor, Syria, Persia and the Himalaya as far as Nepal, inhabiting well-nigh all the high mountain chains between lat. 30° and 45° N. and long. 25° and 80° E. On the Cilician Taurus it forms forests many miles in extent along the lower fringe of the Cedar belt in which trees 70—90 feet high are not infrequent.† Towards its eastern limit its vertical range is greater and much higher; on the mountains skirting the Kuram valley in Afghanistan it forms fully

* Referred to Boissier's *Juniperus macropoda* by Sir. J. D. Hooker in Flora of British India, V. 647.

† Walter Siehe in Gartenflora, 1897, p. 208, with fig.

half the forest at 9,000 feet elevation: on the summits of the limestone formation at 10,000—12,000 feet and in the neighbourhood of Quetta it is the only valuable timber tree.* On the inner drier ranges of the Himalaya it ascends to 15,000 feet where it becomes a stunted bush.

The economic value of *Juniperus excelsa* is very considerable in all the districts in which it is abundant. The heart-wood is of a deep red colour, delightfully fragrant, durable and easy to work; it is used for all kinds of constructive purposes and indoor carpentry. The people of the Hariab district in Afghanistan make pads of the strips of its fibrous bark on which they carry their water-jugs.

The date of the introduction of *Juniperus excelsa* into British gardens is not accurately known. As Loudon has mixed up this species with another Juniper from Siberia described by Pallas and a third found on the Rocky Mountains by Lewis and Clark, his statement that it was introduced in 1806 by Sir Joseph Banks is open to doubt, the more so as it is not mentioned by Aiton in the second edition of the "Hortus Kewensis" published in 1813. The oldest trees in British gardens are of columnar or elongated conical habit, from 20 to 25 feet high and of rather dark aspect; but in its young state *Juniperus excelsa* is very ornamental and easily distinguished amidst its surroundings by its dark green colour apparently covered with fine dust which is an optical effect produced by the grey stomatiferous lines of the acicular leaves.

With *Juniperus excelsa* may be grouped three Junipers which have received specific rank at the hands of the several botanists who have dealt with them, but who seem to have relied upon characters of insufficient value for specific distinction even if they are constant, and of this further evidence is desirable.

Juniperus fœtidissima.

Wildenow, Sp. Plant IV. 843. Endlicher, Synops. Conif. 25. Parlatore, D. C. Prodr. XVI. 485. Boissier, Fl. orient. V. 710. And others.

This occurs, according to Parlatore, on the mountains of Greece and spreads eastwards through Asia Minor to Armenia and the Caucasian provinces and also to the Cilician Taurus and Syria often associated with *Juniperus excelsa*. It is said to differ from *J. excelsa* in its thicker branchlets; in its larger, more sharply pointed leaves that are for the most part glandless and free at the apex; and in its larger fruits of a different colour with fewer seeds,† characters I have failed to discern in specimens to which I have had access.

Juniperus macropoda.

Boissier, Fl. orient. V. 709. Hooker fil. Fl. Brit. Ind. V. 647.

This form inhabits the inner drier ranges of the Himalaya from Nepal westwards to Afghanistan and western Thibet, from 5,000 to 15,000 feet, as described above under *Juniperus excelsa*, to which it is referred by Sir Dietrich Brandis but separated from it by the

* Aitchison in Journal of the Linnean Society, *loc. cit. supra*.

† Arbor vel frutex a *J. excelsa* ramulis crassis, foliis majoribus, apice patulis, mucronato-pungentibus, plerumque eglandulosis et galbulis fusco-purpureis, sæpissima 1—2 nuculas majusculas gerentibus.—Parlatore, De Candolle's Prodromus, *loc. cit. supra*.

Swiss botanist, Edmund Boissier, who distinguished it from *J. excelsa* by "the scaly peduncles of the staminate flowers and the crest-like tips of the scales of the fruit and the fewer seeds." This distinction is doubtfully accepted by Sir J. D. Hooker in the "Flora of British India."

Juniperus procera.

Hochstetter. Plant. Abyss. II. No. 537. Endlicher, Synops. Conif. 26. Parlatore, D. C. Prodr. XVI. 485. J. excelsa procera, Carrière, Traité Conif. ed. II. 37.

This first became known to science from herbarium specimens brought from Abyssinia in 1841 by the German traveller, Schimper. It has quite recently been detected in Somaliland and other parts of East Africa attaining a height of 80—100 feet. It is thence a tropical tree separated geographically from *Juniperus excelsa*, but from which it can scarcely be distinguished in herbarium specimens.

Juniperus flaccida.

A tree 20—30 feet high, the trunk and primary branches covered with thin reddish bark. Branches lax, deflexed or spreading, the branchlets and their ramifications slender, flaccid and pendulous, the axial growths sometimes greatly elongated and with sub-distichous ramification, the youngest lateral growths slender and nearly parallel. Leaves dimorphic: on the axial growths in verticils of three, narrowly oblong, acute, glandular, concrescent but free and slightly spreading at the acute tip; on the younger growths in decussate pairs, much smaller, scale-like, ovate or ovate-lanceolate, the lateral pairs sharply keeled, bright grass-green. Staminate flowers four-angled, composed of 16—20 anthers. Fruits numerous, terminal on short lateral branchlets, globose, 0·5 inch in diameter, composed of eight concrescent scales each with a small transverse apiculate umbo, dark purple, highly glaucous when mature and enclosing six seeds.*

Juniperus flaccida. Schlechtendal in Linnaea. XII. 495 (1838). Endlicher, Synops. Conif 29. Carrière, Traité Conif. ed. II 48. Parlatore, D. C. Prodr. XVI. 492. Gordon, Pinet. ed. II. 145 Sargent, Silva N. Amer. X. 83, t. 519.

Juniperus flaccida, one of the most beautiful of Junipers, as seen in the Botanic gardens in the south of Europe, was discovered by Schiede on the mountains of central Mexico in 1838 and was subsequently found by other botanical explorers of that region at altitudes ranging from 5,000 to 7,000 feet: it is also common in various parts of north-east Mexico, ascending to 6,000—8,000 feet on the mountains east of the great central plateau whence it spreads into south-west Texas. It was introduced into Europe soon after its first discovery,† but thrives in the open air only in places where the temperature in the winter season does not fall below the freezing point as in the south of France. In Great Britain

* Fruiting branchlets were communicated by the late M. Charles Naudin from the Villa Thuret Botanic garden, Antibes.

† Ex Carrière, Traité Général des Conifères, p. 48.

its gracefully pendulous and symmetrically branched sprays of the brightest green should render it an attractive plant for the Conservatory and Winter Garden.

Juniperus occidentalis.

A tree with a straight trunk 15—25 feet in height and 2—3 feet in diameter with long, stout, spreading branches; occasionally much smaller with a more slender trunk and shorter branches, and "on rocky slopes towards the northern limits of its range, shrubby with many short, erect or semi-prostrate stems."* Branchlets stout and covered with thin red-brown bark, sub-distichous and alternate, the herbaceous shoots pinnately ramified and emitting a faint fetid odour when bruised. Leaves scale-like, in decussate pairs, ovate, sub-acute, with denticulate margins, concrescent or closely appressed and imbricated, glandular, dull pale green. "Staminate flowers about an eighth of an inch long with twelve—eighteen broadly ovate, rounded acute anther scales." Fruits sub-globose, 0·25—0·35 inch in diameter, with a thick blue-black epidermis coated with a glaucous bloom and enclosing two—three seeds.

Juniperus occidentalis, Hooker, W. Fl. Bor. Amer. II. 166 (1840). Endlicher, Synops Conif. 26 (1847). Carrière, Traité Conif. ed. II. 40. Parlatore, D. C. Prodr. XVI. 489. Hoopes, Evergreens, 299 (exclu. syns.). Gordon, Pinet. ed II. 162 (in part). Brewer and Watson, Bot. Califor II. 113. Macoun, Cat. Canad. Plants, 461. Beissner, Nadelholzk. 128. Masters in Journ. R. Hort. Soc. XIV. 213 (exclu. syn. *J. pyriformis*). Sargent, Silva N. Amer. X. 87, t. 521.

J. dealbata, Loudon. Encycl. of Trees, 1090 (1842). Carrière, Traité Conif. ed II 41.

J. andina, Nuttall, Sylva, III 95, t. 110; and ed. II. Vol. II 157.

Juniperus occidentalis is a tree or shrub of high altitudes, growing abundantly on the mountain slopes of Idaho, eastern Washington and southwards along the Cascade and Sierra Nevada mountains far into California, and also the dry mountain ranges between the Sierra and the Pacific coast range of northern Mexico, rarely descending below 6,000 feet. In these alpine regions it is often seen "standing like a sentinel with its massive stem and few spreading branches impervious to the fiercest gales; it has such a hold on the ground, and offers such resistance to the elements that it dies standing and wastes insensibly out of existence."† In exposed situations it grows very slowly but attains a great age; in the rich sub-alpine moraines it is a tall symmetrical tree, and towards its southern limits it forms in places pure forests of considerable extent.

The date of the first introduction of *Juniperus occidentalis* to the British Pinetum cannot be determined, as it was for a long time confused with *J. californica*. It is even now doubtful to which of the two species the few plants under the name of *J. occidentalis* that still linger alive in this country should be referred.

Mention may here be made of two closely allied species or geographical forms of *Juniperus occidentalis*.

* Sargent, Silva of North America, Vol. X. p. 87.
† Muir, Mountains of California, ex Silva. *loc. cit.*

Juniperus monosperma.

Sargent. Silva N. Amer. X. 89. t. 522. J. occidentalis. var. monosperma, Engelmann in Trans. St. Louis Acad. III. 590. Beissner. Nadelholzk. 129. Masters in Journ. R. Hort. Soc. XIV. 213. J. occidentalis gymnocarpa, Lemmon. W. Amer. Cone-bearers. 80. J. occidentalis, Parlatore, D. C. Prodr. XVI. 489 (in part).

This is chiefly distinguished from *Juniperus occidentalis* by its smaller globose fruits often monospermous, its more slender branchlets, and the absence of glands in the leaves. It is widely distributed over the region east of the Rocky Mountains to the river Arkansas and western Texas, spreading over the plateau of Colorado and southwards into Arizona and New Mexico. It is probably not in cultivation in Great Britain.

Juniperus tetragona.

Schlechtendal in Linnaea. XII. 495 (1838). Endlicher. Synops. Conif. 29. Parlatore, D. C. Prodr. XVI. 419. J. occidentalis. var. conjungens, Engelmann in Trans. St. Louis Acad. III. 590. J. Sabinioides, Sargent. Silva N. Amer. X. 91. t. 523 (not Grisebach and Endlicher). Cupressus Sabinioides, Humboldt, Bompland and Kunth. Nov. Gen. et Sp. II. 3 (1815).

This is distinguishable from *J. occidentalis* chiefly by its different habit and its distinctly four-angled branchlets which suggested the name. It is a more southern tree than *J. occidentalis* or *J. monosperma*; it covers large areas in central Texas and spreads over the Mexican plateau to near the city of Mexico where it was first discovered by Humboldt at the beginning of the nineteenth century.

Juniperus Oxycedrus.

A diœcious spreading shrub, occasionally a low tree 9—12 feet high with the trunk and primary branches covered with smooth reddish brown bark. Branches numerous, erect or spreading; branchlets short and much ramified, the youngest shoots angulate. Leaves homomorphic, persistent two—three years, in whorls of three, linear or linear-lanceolate, mucronate, rigid and pungent, 0·25—0·5 inch long, obscurely bi-canaliculate, silvery white with green median and marginal lines above, keeled and green beneath. Staminate flowers axillary, globose, sub-sessile and bearing six anthers. Fruits solitary, or two—three together, sub-sessile or very shortly stalked, spherical, variable in size, the largest somewhat more than 0·5 inch in diameter, reddish brown when ripe, composed of three concrescent, apiculate scales that are distinguishable only at the apex of the fruit where the outer margins are separated by a tripartite cleft.*

Juniperus Oxycedrus, Linnaeus, Sp. Plant. II. 1038 (1753). Bieberstein, Fl. Taurico-caucas, II. 426 (1808). L. C. Richard, Mém. sur les Conif. 39, t. 6, fig. 1 (1826). Loudon, Arb. et Frut. Brit. IV. 2494, with fig. Endlicher. Synops. Conif. 10. Carrière, Traité Conif. ed. II. 12. Parlatore, D. C. Prodr. XVI. 475. Gordon Pinet. ed. II. 137. Willkomm. Forstl. Fl. ed II. 259. Beissner. Nadelholzk 138. Masters in Journ. R. Hort. Soc. XIV. 212 And many others.

J. rufescens. Link in Flora, 1846. p. 519. Endlicher, Synops. Conif. 11. Gordon, Pinet ed. II. 138.

Eng Oxycedrus. Prickly Cedar. Fr. Genévrier cade. Germ. Cederwachholder. Ital. Cedro spinoso.

* Branches from both ♂ and ♀ trees were communicated by the late M. Charles Naudin from the Villa Thuret Botanic garden. Antibes.

Juniperus Oxycedrus is common throughout the Mediterranean region from Portugal to Syria and formerly in Madeira, inhabiting the most exposed and sterile mountain slopes in the neighbourhood of the coast, in places ascending to 5,000 feet, but most abundant on the arid rocks near the shore. It is too common for cultivation in the region it inhabits and scarcely of any value; in places its fragrant wood is used for fuel and its prickly sprays are used in hedges to prevent the ingress of small animals much in the same way as gorse branches are sometimes used in Great Britain. Aiton states that it was cultivated by Miller in the old Physic Garden at Chelsea in 1739,* and it is known to have been frequently re-introduced since; it is now but rarely if ever seen in other than botanic gardens in this country; as an ornamental shrub it is far surpassed by *J. drupacea* which is also much hardier.

Three species, or geographical forms of *Juniperus Oxycedrus* that are unsuitable for the climate of Great Britain may be here noticed.

Juniperus brevifolia.

Parlatore, D. C. Prodr. XVI. 478. Trelase, Bot. Observ. Azores, 169. J. Oxycedrus, var. brevifolia, Hockstetter, Fl. Azor. 26. J. Cedrus brevifolia, Gordon, Pinet. ed. II. 130.

This Juniper occurs only in the Azores where it once formed a conspicuous ingredient of the indigenous vegetation till the clearing of the land for cultivation greatly reduced it in numbers; it usually takes the form of a dense shrub or low tree, but where protected from the sea-wind it sometimes attains a considerable size. Compared with *J. Oxycedrus*, the leaves are more crowded, shorter with shorter spines at the tip and the fruits are smaller. It must have inhabited the islands from a remote period, as trunks and branches of it are found so frequently beneath the soil in certain localities that the inhabitants when in want of wood simply pierce the surface with an iron stake to discover and disinter these remains of an ancient forest.

Juniperus Cedrus.

Webb, Phytogr. Canar. III. 277, t. 2. Carrière, Traité Conif. ed. II. 11. Parlatore, D. C. Prodr. XVI. 478. Gordon, Pinet. ed. II. 129.

A tall tree formerly abundant in the sub-alpine districts and higher valleys of the Canary islands, but now become quite rare in consequence of the destruction of the trees for the sake of their timber. A young plant, cultivated in the Temperate House at Kew, is of arborescent habit with horizontal primary branches ramified in the same way and with the youngest shoots angulate as in *J. Oxycedrus*; the leaves are identical in size and shape with those of *J. Oxycedrus* but less rigid, of a deeper green, less glaucous and not so spreading, the result perhaps of being produced under the artificial conditions in which the plant is placed.

* Hortus Kewensis, ed. II. Vol. V. p. 415.

Juniperus macrocarpa.

Sibthorp. Fl. Graec Prodr. II 263 1813. Endlicher. Synops. Conif. 10. Carrière. Traité Conif. ed. II. 10. Parlatore. D C. Prodr. XVI. 476. Willkomm, Forstl. Fl. ed. II. 260 Beissner, Nadelholzk. 139 And others.

The habitat of *Juniperus macrocarpa* as delineated by the authors quoted above is nearly conterminous with that of *J. Oxycedrus*, and many localities in which it has been seen or gathered are also quoted for *J. Oxycedrus*. Endlicher distinguishes *J. macrocarpa* from *J. Oxycedrus* by its slightly broader leaves; by its fruits being attenuated at the base and not spherical and which are pendulous and for the most part furnished with three tubercles at the apex and as many more at the sides, and also that they are always blue, not brown. We have, however, been unable to detect these differences in the specimens labelled *J. macrocarpa* preserved in the national herbaria. Sibthorpe, the author of the species, if species it is, states that the fruits of *J. macrocarpa* are nearly as large again as those of *J. Oxycedrus*; but the great variability in the shape and size of the fruits of the latter would seem sufficient to include even this difference.

Juniperus pachyphlœa.

A tree often 50—60 feet high with a stout trunk 3—5 feet in diameter and long, stout, spreading branches. Bark of trunk 1—4 inches thick, dark brown tinged with red, and deeply fissured and divided into nearly square plates. Branchlets slender, covered with light red-brown bark after the disappearance of the leaves. Leaves scale-like, in decussate pairs, appressed, ovate, apiculate, obscurely keeled, and conspicuously glandular on the back, bluish green: those on vigorous shoots and young branchlets, linear-lanceolate, rigid and pungent with slender cartilaginous points. Staminate flowers about an eighth of an inch long, composed of ten stamens with broadly ovate, obscurely keeled connectives. Fruit globose, irregularly tuberculated 0·5 inch in diameter, dark red-brown more or less covered with a glaucous bloom, and containing four seeds.—Sargent, *Silva of North America*, X. 85, pl. 520.

Juniperus pachyphlœa, Torrey. Pacific Ry. Report, IV. pt. V. 142 (1858). Carrière, Traité Conif. ed. II. 56. Parlatore. D. C. Prodr. XVI. 490. Gordon, Pinet. ed. II. 164. Beissner. Nadelholzk. 130. Masters in Journ. R. Hort. Soc. XIV. 214.

This remarkable Juniper was discovered in 1851 in eastern New Mexico by Dr. Woodhouse, surgeon and naturalist to Sitgreave's Expedition down the Zuñi and Colorado Rivers; it inhabits dry, arid mountain slopes from 4,000 to 6,000 feet elevation in south-west Texas and westwards along the desert ranges of New Mexico and Arizona south of the Colorado plateau; also on the lower slopes of the mountains of north Arizona, and in Mexico it spreads along the Sierra to the state of Juliasco. It is singular among Junipers for its thick hard bark which suggested the specific name, παχὺς (thick), and φλοίος (bark).

Juniperus pachyphlœa is described by those who have seen it in the elevated cañons of its native mountains as the most beautiful of the western American species, a tree with an open shapely head, massive trunk with checkered bark and foliage of a cheerful colour. It was introduced into Great Britain many years ago, but it has proved disappointing, and is now but rarely seen.

Juniperus phœnicea.

A monœcious, sometimes diœcious shrub or small tree of variable dimensions in the different localities it inhabits, but rarely exceeding 15—18 feet in height. Primary branches numerous, erect or ascending, covered with smooth reddish brown bark that peels off in paper-like flakes; branchlets numerous, slender and much ramified. Leaves dimorphic, on the axial growths of young plants in whorls of three, lanceolate or ovate-lanceolate, acute, concrescent at the base, free at the tip; on lateral shoots and on old plants in decussate pairs, much smaller, scale-like, ovate, acute, imbricated, dull dark green. Staminate flowers on lateral branchlets of the preceding year, four-angled, pale yellow and consisting of eight—ten anthers. Fruits numerous, globose, shortly stalked, about the size of a garden pea, greenish brown changing to reddish brown when mature; scales six, concrescent, each with a small, acute, transverse umbo.

Juniperus phœnicea, Linnæus, Sp. Plant II. 1040 (1753). Loudon, Arb Frut. Brit. IV. 2501. with figs. Endlicher, Synops. Conif. 30. Carrière, Traité Conif. ed. II. 50. Parlatore, D C Prodr XVI. 486. Gordon, Pinet. ed. II. 164. Boissier, Fl. orient. V. 710. Willkomm, Forstl. Fl. ed. II 253. Beissner, Nadelholzk, 116. Masters in Journ. R Hort. Soc XIV. 214

J. Lycia, Linnæus, Sp. Plant. II. 1039. Loudon, Arb. et Frut. Brit. IV. 2502.

Eng. Phœnician Juniper. Germ. Rothfrüchtiger Sadebaum. Ital Ginepro fenicio.

var.—filicaulis.

A shrub with greatly elongated tortuous branches and slender branchlets with dimorphic foliage, one form of leaves being scale-like as in the type, the other, more sparingly produced, acicular, spreading, in whorls of three, and with a glaucous line on the upper side.

J. phœnicea filicaulis, Carrière, Traité Conif. ed. II. 52.

var.—Langoldiana.

Of more open habit than the common form; branches and branchlets more distant, the herbaceous shoots and foliage of a brighter green with a slight glaucous tint.

J. phœnicea Langoldiana, Hort.

var.—turbinata.

Distinguished by its ovoid or somewhat top-shaped fruits, not spherical as in the common form.

J. phœnicea turbinata, Parlatore, D. C. Prodr. XVI. 487.

The Phœnician Juniper is widely distributed throughout the Mediterranean region from Portugal to Palestine: it is also endemic in Madeira and the Canary Islands. It grows mostly on the arid, rocky hills near the coast, and on the higher ranges, as the

Maritime Alps and the Sierra Nevada on which it ascends to a considerable elevation. According to Aiton* *Juniperus phœnicea* was first cultivated in this country by James Sutherland, Curator of the Royal Botanic Garden, Edinburgh, in 1683; its long acclimatisation in Great Britain has caused it to be represented in many gardens and shrubberies where it forms a low tree or shrub-like bush of conical or columnar outline and dense habit till it becomes old, when it has a more open aspect with the trunk exposed, which is usually forked near the base. It is not unusual in the monœcious plants for some of the branches to be loaded with fruits.

The variety *filicaulis* originated many years ago in the seed-bed of a nursery at Bourg-Argental in France; it has its analogue in *Thuia orientalis pendula*, *Cupressus pisifera filifera*, etc., and is probably not in cultivation in this country. *Langoldiana* is a more vigorous grower and of a brighter green than the common form; *turbinata*, according to Parlatore, occurs with the common form on dry maritime hills in Spain, Sicily, Dalmatia, and probably wherever the species is common.

Juniperus prostrata.

A prostrate shrub with elongated branches lying flat on the ground and much ramified. Branchlets numerous, mostly ascending at a greater or less angle to their primaries and much branched, the youngest shoots short and close-set. Leaves dimorphic: on the axial growths and vigorous shoots of young plants in whorls of three, acicular, slightly dilated at the base, pungent, bent towards the stem, concave and greyish white above, rounded and green beneath; on the younger branchlets and on old plants, smaller, in decussate pairs, ovate-lanceolate, appressed or concrescent at the base, free at the apex, or scale-like, concrescent, light green becoming glaucous when fully developed Fruits small, sub-globose, blackish blue, tuberculated when ripe.

Juniperus prostrata, Persoon, Synops. Plant II. 632 (1807). Endlicher, Synops Conif. 18 (1847) Carrière, Traité Conif. ed. II. 22. Gordon, Pinet. ed II. 146 Hoopes, Evergreens, 282.

J. Sabina, Hooker W. Fl. Bor. Amer. II. 166 (1840).

J. Sabina prostrata, Loudon, Encycl. Trees, 1086 (1842). Beissner, Nadelholzk. 111

J. Sabina procumbens, Macoun, Cat. Canad. Plants, 463.

J. procumbens, Kent in Veitch's Manual, ed I. 280 (not Siebold).

J. repens, Nuttall, Gen. Amer. II 245.

Juniperus prostrata is the American representative of the Savin Juniper of central and southern Europe; it is widely distributed over the northern half of the continent from Anticosti and Nova Scotia westwards through Canada and across the prairie region to the summit of the Rocky Mountains; also through the northern United States in the neighbourhood of the great lakes, chiefly on exposed slopes and river banks.

Juniperus prostrata has been referred by several authors to the common Savin as a variety from which it is not separable specifically

* Hortus Kewensis, ed. II. Vol. V. p. 415.

by any very well-defined characters, although the two are readily distinguishable at sight, the difference being most marked in the foliage and fruit. In *J. prostrata* the leaves are mostly acicular and of a greyish blue tint, whilst in the typical *J. Sabina* the acicular leaves are absent from an early age, and the foliage is dark green; the fruits of *J. prostrata* are also of a different colour from those of *J. Sabina*, especially before maturity. *J. Sabina* is a shrub of high altitudes, *J. prostrata* of low-lying plains and river banks; the habitat of the one is separated from that of the other by the broad Atlantic Ocean.

Juniperus prostrata is a useful plant for the rock garden and for covering exposed banks, forming dense masses of foliage which cover a considerable area when the plants are allowed to grow unchecked.

Juniperus Pseudo-Sabina.

A robust shrub or tree, in Sikkim a tree 60 feet high with a stout trunk and thick ramification and foliage.* In Great Britain, under cultivation, a prostrate or semi-prostrate shrub with numerous primary branches much ramified and covered with smooth cinnamon-brown bark; secondary branches with pale orange-brown bark and tetrastichous ramification; the herbaceous shoots similarly divided. Leaves dimorphic, on vigorous-growing plants in whorls of three, crowded, linear-subulate, more or less spreading, 0·25—0·5 inch long, with a pale stomatiferous band on the upper side, bright green and keeled beneath; in adult plants scale-like in decussate pairs, rhombic-ovate, closely imbricated, free at the tip and obscurely keeled at the back.† Staminate flowers axillary on short lateral shoots of the preceding year, globose, pale yellow, consisting of six anthers in decussate pairs. Fruits elliptic-ovoid, about 0·5 inch long, blackish blue without glaucescence, composed of six concrescent scales marked by an apiculus and enclosing a thick bony endocarp containing a single seed.

Juniperus Pseudo-Sabina, Fischer and Meyer. Index Sem. Hort. Petrop. VIII. 65 (1841); and Pl. Schrenk, II. 13. Endlicher, Synops. Conif 21 (1847). Carrière, Traité Conif ed. I. 33; and ed. II. 25. Parlatore, D. C. Prodr. XVI 482. Hooker fil, Fl. Brit. Ind. V. 646. Beissner, Nadelholzk. 106. Masters in Journ. R. Hort. Soc XIV. 214.

J. Wallichiana, Brandis, Forest Fl. N.W. Ind. 537 (1874). Gamble, Manual Ind. Timb. 412.

J. recurva densa, Hort.

The Juniper above described inhabits the temperate Himalaya, its vertical range being from 9,000 to 15,000 feet; it is very abundant in the north-west as a large gregarious shrub near its highest limit, but it becomes more scarce eastwards. It has long been in cultivation in British gardens, but I find no record of the date of introduction; it is quite hardy, at least in the south and west of England and in Ireland; where space and full exposure to sun and air have been provided for it, it has proved to be an attractive and useful shrub for the rock-garden, for covering tree stumps and similar purposes.

* Sir J. D. Hooker, Flora of British India, V. 646.

† The squamiform foliage is comparatively rare on plants growing in Great Britain.

The specific name *Pseudo-Sabina* was first given by Fischer and Meyer to a Juniper gathered by Schrenk in 1840 or 1841 on the Altai Mountains in the Baikal region of southern Siberia. To this Juniper Parlatore referred, and probably rightly, the Himalayan species above described, in which he is followed by Sir J. D. Hooker in the "Flora of British India." The Siberian type was evidently known to the Russian botanists, for Dr. Albert Regel during his exploration of southern Turkestan in 1879—1883 detected it in several localities at high elevations,* thus indicating that the species has an extensive range on the Asiatic continent. Closely allied to and perhaps even identical with *J. Pseudo-Sabina* is a Juniper figured in the "Flora Rossica" of Pallas published in 1784 under the name of *J. davurica*, which had been discovered in the same region as Fischer and Meyer's *J. Pseudo-Sabina*, and which, according to the late Professor Bunge and other explorers of eastern Siberia, spreads eastwards from Lake Baikal through the Amur region. Loudon states that *J. davurica* was introduced into this country in 1791,† but it is extremely doubtful whether it is now to be found either in British or continental gardens. Should the supposed identity of *J. davurica* and *J. Pseudo-Sabina* be hereafter confirmed it is evident that the older name of Pallas should be accepted for the species.

Juniperus recurva.

A small tree with a straight erect trunk, conical head and spreading branches, or an erect bush or prostrate shrub, according to situation and altitude. In Great Britain usually a broadly conical or round-topped large shrub with several erect or ascending stems much branched upwards, and clothed with reddish brown bark that is thrown off in recurved flakes. Branchlets and herbaceous shoots decurved or pendulous. Leaves in whorls of three, becoming effete on the axial growths the third or fourth year, but persisting much longer, subulate acute, imbricated and appressed, 0·2—0·5 inch long, convex on the back and pale green; concave and whitish on the inner side. Flowers monœcious, rarely diœcious; staminate flowers small, oval-oblong, obtuse, composed of six—eight pale yellow stamens. Fruits solitary on the ends of short lateral branchlets of the preceding year, ovoid-oblong, about 0·5 inch long, blackish blue when mature.

Juniperus recurva, Hamilton ex Don Prodr. Fl. Nep. 55 (1825). Loudon, Arb. et Frut Brit. IV. 2504. with fig Endlicher, Synops Conif. 18. Carrière, Traité Conif. ed. II. 27. Parlatore, D. C. Prodr XVI. 481. Gordon, Pinet. ed. II. 147. Brandis, Forest Fl. N.W. Ind. 537. Boissier, Fl. orient V. 708. Hooker fil, Fl. Brit. Ind. V. 647. Beissner, Nadelholzk. 104. Masters in Gard. Chron. XIX. (188), p. 468. with fig ; and Journ. R. Hort. Soc. XIV. 211.

var.—squamata.

A prostrate, spreading, much-branched shrub; secondary branches mostly short and erect with smooth, reddish brown bark ; branchlets numerous, short and somewhat rigid. Leaves subulate, much crowded on the young shoots, more distant on the axial growths, greyish white above, pale green beneath.

* Gartenflora, XXVI. 339 ; XXVII. 36 ; XXIX. 48.
† Arboretum et Fruticetum Britannicum, IV. 2500.

J. recurva var. squamata, Parlatore, D. C. Prodr. XVI. 482. Hooker fil, Fl. Brit. Ind. V. 647. J. squamata, Hamilton in Lambert's Pinus, ed. I. Vol. II. 17. Carrière, Traité Conif. ed. II. 28. Gordon, Pinet. ed. II. 152. J. religiosa, Royle, Illus. Him. Plants, I. 351 (name only). J. densa, Gordon, Pinet. ed. II. 141.

Juniperus recurva first became known to science through Dr. Hamilton who discovered it during his journey through Nepal in 1802—1803. Specimens were communicated by him to Mr. Aylmer

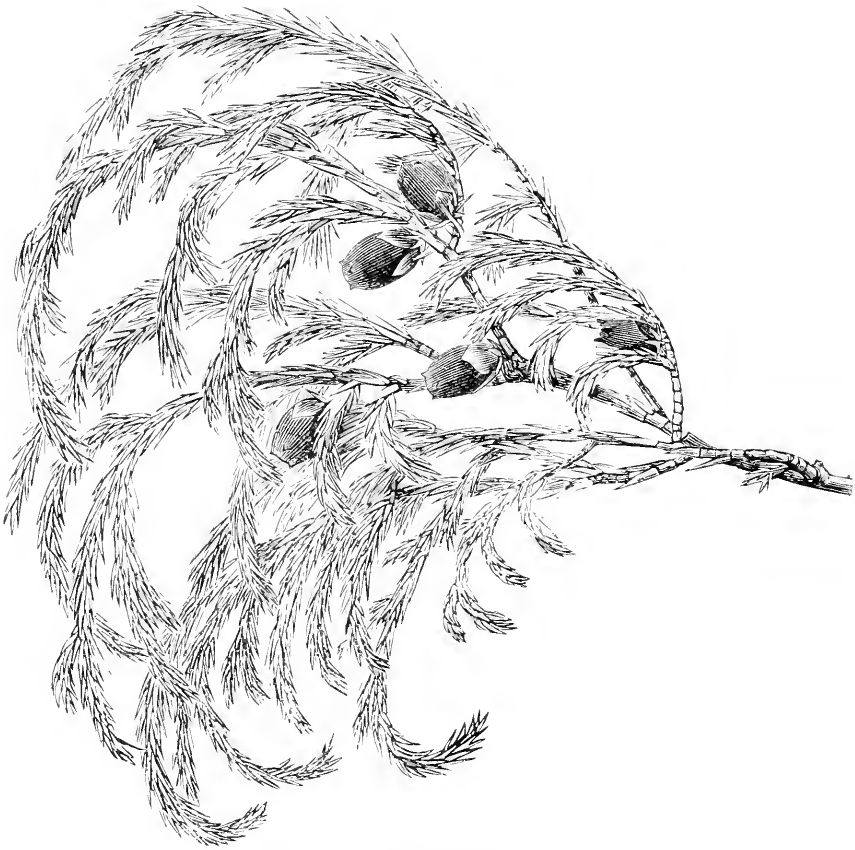


Fig. 57. *Juniperus recurva.*
(From the *Gardeners' Chronicle.*)

Lambert in whose herbarium they remained many years undescribed. The species is distributed over the temperate and alpine Himalaya from 7,500 to 15,000 feet elevation from Bhotan to Afghanistan. Throughout this region it varies much in habit and dimensions; as seen by Sir J. D. Hooker in the Lachin valley in Sikkim, it is a tree 30 feet high with spreading branches and pendulous branchlets;* at and near its highest limit, it takes the form described above as

* Himalayan Journals, II. 45.

var. *squamata* which with its decumbent stems and erect branches in places covers large areas that cannot be traversed without great difficulty. The wood of the arborescent form is fragrant and reddish brown like that of the American Red Cedar; the resinous twigs of the shrubby form are used for incense.*

The date of the introduction of *Juniperus recurva* into Great Britain does not appear to have been recorded. London states that there was a plant four years old in 1837 in the Horticultural Society's garden at

Fig. 58. *Juniperus recurva* in Sikkim.
(From the Himalayan Journals of Sir J. D. Hooker.)

Chiswick and one still older in Loddiges' nursery at Hackney which had borne the fruit from which his figure was taken. In British gardens it is a distinct shrub or low tree with pendulous feathery branchlets clothed with greyish green foliage; in situations favourable for its development it is a graceful and picturesque plant quite unlike any other, affording a pleasing contrast to its surroundings; in dry soils the persistent older leaves often become rusty brown and chaff-like, imparting to the plant an unhealthy aspect. The monœcious form is most common but an exception occurs in the grounds of the Right Hon. A. H. Smith-Barry at

* Brandis, Forest Flora, *loc. cit. supra.*

Fota Island, near Cork, where there is a male plant of very attractive aspect which differs from it chiefly in the branchlets being more distant and more elongated, and in the leaves being longer, narrower, more closely appressed to the stems and more distinctly glaucous.

Juniperus rigida.

A small tree 20—25 feet high with spreading branches and pendulous or sub-pendulous branchlets; more frequently a low spreading bushy shrub. Leaves homomorphic, persistent about three years, in whorls of three, subulate, acuminate, trigonous, pungent, 0·75—1 inch long, channelled and marked with a white stomatiferous line on the ventral (upper) side, keeled and pale green on the dorsal (lower) side. Staminate flowers mostly in the axils of two-years-old leaves, cylindric, about 0·25 inch long, consisting of twelve—eighteen stamens with a sub-deltoid connective. Fruits globose, somewhat larger than those of the common Juniper, blackish blue and glaucous when mature and containing three—four seeds.

Juniperus rigida, Siebold and Zuccarini, Fl. Jap. II. 56. t. 125 (1842). Endlicher, Synops Conif. 17. Carrière, Traité Conif. ed. II. 20 Parlatore, D. C. Prodr. XVI 480 Gordon, Pinet. ed. II. 138. Franchet and Savetier, Enum. Plant. Jap I. 471. Beissner, Nadelholzk. 131. Masters in Journ. Linn. Soc. XVIII. 496; and Journ. R. Hort. Soc. XIV. 214.
J. communis, Thunberg, Fl. Jap. 264 (1784), not Linnæus.

Juniperus rigida, the Japanese representative of the common Juniper, is generally distributed over the central island, growing mostly in dry gravelly soils; it is also more generally cultivated in Japan than any other Juniper. It first became known to science through the Swedish botanist Thunberg who mistook it for *J. communis* from which it differs in its longer, almost trigonous leaves that are channelled on the upper side and in its larger fruits.

Juniperus rigida was introduced into British gardens by the late Mr. John Gould Veitch in 1861; it grows freely in most soils and situations when not crowded by other shrubs, and as a plant for garden decoration it is superior to the common Juniper.

Closely allied to *Juniperus rigida* and perhaps but a local or climatic form of it is a Juniper occurring in northern Japan, of which specimens are preserved in the national herbaria but which is not known to be in cultivation, viz:—

Juniperus conferta.

Parlatore, D. C. Prodr. XVI. 481. Gordon, Pinet. ed. II. 133. J. littoralis,* Maximowicz in Bull, Acad. Petersb. 230, ex Parlatore. *loc. cit.* Beissner, Nadelholzk. 130.

A sea-side plant originally discovered by the American botanical explorer, Charles Wright, on the sandy dunes of the Bay of Hakodati and afterwards by Maximowicz in the same locality. As represented in British herbaria it differs from *Juniperus rigida* in its shorter leaves much crowded in tufts and in its larger spherical fruits; its habit is described as prostrate with long straggling branches and close-set branchlets clothed with grey-green foliage.

* The *Juniperus littoralis* of some gardens is a different plant from this, and should be referred to the *J. Pseudo-Sabina* of Fischer and Meyer.

Juniperus Sabina.

A shrub of very variable habit and dimensions; occasionally arborescent in southern Europe with a straight erect trunk 10—15 feet high. Branches spreading or ascending, clothed with red-brown bark that peels off in thin papery flakes; ramification pseudo-distichous. Branchlets relatively short, close-set, pale reddish brown, the latest formed tetrastichous, pinnately divided and falling off the third or fourth year. Leaves in decussate pairs, glandular; on the axial growths subulate-oblong, mucronate, concrescent; on the lateral herbaceous shoots smaller, scale-like, rhomboidal, sub-acute, closely imbricated or concrescent, dull dark green. Staminate flowers very numerous, terminal on short lateral branchlets of the preceding year, oval, pale yellow, consisting of about ten anthers. Fruits small, solitary, subglobose, blackish brown with a bluish glaucescence when mature and containing one—four seeds.

Juniperus Sabina, Linnaeus, Sp. Plant. II. 1039 (1753). Loudon, Arb et Frut. Brit. IV. 2499. with figs. Endlicher, Synops. Conif. 22. Carrière, Traité Conif. ed. II. 23. Parlatore, D. C. Prodr. XVI. 483 (exclu. American habitat). Gordon. Pinet. ed. II. 150 Boissier. Fl. orient. V. 708. Willkomm. Förstl. Fl. ed. II. 254. Beissner, Nadelholzk. 107, with figs. (exclu. Siberia). Masters in Journ. R. Hort. Soc. XIV. 214. And many others.

Eng. Savin Juniper. Fr. Genévrier Sabine. Germ. Gemeiner Sadebaum. Gemeiner Sevenbaum. Ital. Sabina.

var.—humilis.

A dwarf, occasionally prostrate, shrub with numerous spreading branches and close-set ascending or erect branchlets much ramified, the latest formed shoots short, slender, pinnately branched and clothed with scale-like leaves of a brighter green than the common form, and among which some acicular, pungent, spreading leaves are sparingly intermixed.

J. Sabina humilis, Endlicher, Synops. Conif. 23 (in part). Beissner, Nadelholzk. 110. J. Sabina nana, Carrière. Traité Conif. ed. II. 23. Gordon. Pinet. ed II. 150. And others.

var.—tamariscifolia.

A procumbent or spreading shrub, more vigorous in its growth and of larger dimensions than the variety *humilis*. Leaves dimorphic; on the older part of the branchlets in whorls of three, awl-shaped, pungent, adnate at the base, free at the tip, bluish or grey-green; on the younger growths in decussate pairs, concrescent, scale-like and bright green. Fruits smaller than in the common form.

J. Sabina tamariscifolia, Aiton in Hort. Kew. ed. II. V. 414 (1813).* Loudon, Arb. et Frut. Brit. IV. 2499, with figs. Carrière, Traité Conif. ed. II. 23. Beissner, Nadelholzk. 110. And others.

var.—variegata.

Differs from the common form in its dwarfer and denser habit and in having the tips of the youngest growths cream-white; the plant has thence a speckled and checkered appearance which renders it a useful subject for the rock-garden.

J. Sabina variegata. Hort.

* Referred by Endlicher to *Juniperus thurifera* (Linn.).

The Savin Juniper is abundant on all the mountains of central Europe from the Alps to the Carpathians and of southern Europe from the Sierra Nevada to the Caucasus; its vertical range varies with the latitude and exposition of the localities from 4,000 to 10,000 feet above sea-level, frequently ascending to near the snow-line on southern aspects. It prefers dry, rocky, sunny slopes especially on the limestone formations of the Alps and Carpathians, where in places it covers large areas unmixed with any other plant; it is also an ingredient of the undergrowth of the light coniferous forests that form the higher zone of arborescent vegetation on these mountains. The Siberian habitat assigned to *Juniperus Sabina* by Parlatore and other authors must be accepted with reserve, as it is highly probable that the *J. davurica* of Pallas and the *J. Pseudo-Sabina* of Fischer and Meyer, if they are distinct, are the true Siberian Savins. The North American Juniper referred to the common Savin by Sir William Hooker and others is recognised in this work as a species under the name of *J. prostrata*.

The Savin Juniper was introduced into British gardens at a very early date, as it is mentioned in Turner's "Names of Herbes," published in 1548. It was formerly much more cultivated than at present, especially during the revival of horticulture in the late Stuart period when the species of evergreen trees and shrubs available for garden decoration were comparatively few. As an ornamental plant it is surpassed by the varieties described above, and which have nearly superseded it as a garden plant. The variety *humilis* occurs in the Tyrol, Carniola and other districts on the Alps at and near the higher vertical range of the species; it is the Green Carpet Juniper of gardens. The variety *tamariscifolia* is somewhat vaguely stated to occur wild on the Sierra Nevada, in Sicily, Greece and other places; it appears to have been recognised at a very early period; as seen in British gardens it is usually prostrate and easily distinguished by its dimorphic foliage. To this variety Carrière and Beissner have referred the *Juniperus Sabinoides* of Grisebach,* but this plant is still an enigma to botanists.

Juniperus sphærica.

A tree of the habit and aspect of *Juniperus chinensis*, attaining a height of 30—40 feet with a rather slender trunk covered with dark brown bark that peels off in longitudinal shreds exposing a reddish brown inner cortex. Branches short, spreading or ascending, much ramified towards the extremities. Branchlets with tetrastichous ramification, the youngest shoots slender, four-angled and pinnately divided. Leaves homomorphic (?), scale-like, in decussate pairs, ovate, obtuse, concrescent, dark green with a small circular pit on the back. Staminate flowers not seen. Fruits spherical, nearly 0·4 inch in diameter, blackish violet-blue, composed of six concrescent scales each with short apiculus and enclosing three (?) seeds.

* Specilegium Floræ Rumelicæ et Bythinicæ. Vol. II. p. 352.

Juniperus sphaerica, Lindley in Paxton's Flower Garden, I. 58, with fig. (1850). Carrière, Traité Conif. ed. II. 32. Parlatore, D. C. Prodr. XVI. 488. Beissner, Nadelholzk. 121. Masters in Journ. R. Hort. Soc. XIV. 215.

This Juniper, rarely seen except in Botanic gardens, was introduced by Fortune in 1846 from China, but nothing more appears to be known of its habitat. The species, if species it is, is said to be monœcious and thence differs in that respect from *Juniperus chinensis* and also in its fruits which are almost twice as large. A Juniper mentioned by Loudon under the name of *J. chinensis Smithii*, and another described in the former edition of this Manual as *J. Sheppardi* have been referred to *J. sphaerica* by some authors.

Juniperus taxifolia.

In Great Britain, a sub-fastigiate tree 15—20 feet high with a trunk 9—12 inches in diameter covered with thin reddish brown bark peeling off in oblong flakes. Primary and secondary branches ascending and nearly parallel with the trunk, the latter much ramified. Branchlets slender, 12—18 inches long, quite pendulous, with orange-brown bark, the youngest shoots angulate, pale green. Leaves persistent two—three years, in whorls of three, acicular, acuminate with a cartilaginous tip, 0·25—0·75 inch long, with two white stomatiferous bands on the ventral side, grass-green and keeled on the dorsal side. Staminate flowers and fruits not seen.

Juniperus taxifolia, Hooker and Arnott. Beechey's Voy. 271 (1841). Endlicher, Synops. Conif. 17. Carrière, Traité Conif. ed II. 21. Parlatore, D. C. Prodr. XVI. 418. Beissner, Nadelholzk. 131. Masters in Journ. R. Hort. Soc. XIV. 215.

J. oblonga pendula, Hort.

The Juniper described above is cultivated in many gardens under the name of *Juniperus oblonga pendula*, an unauthentic name implying a connection with the Caucasian *J. oblonga* of Bieberstein, long since recognised as a geographical variety of *J. communis*, but from this it is specifically distinct. It is believed to have been introduced from China by Fortune about the year 1856, and was afterwards distributed from Osborne's nursery at Fulham under its garden name.

Juniperus thurifera.

A low or medium-sized tree of columnar or sub-pyramidal outline, in places attaining a height of 35—40 feet with a trunk covered with greyish white bark; sometimes a shrub with spreading or ascending branches. Secondary and ternary branches much ramified; branchlets slender, short and pinnately divided. Leaves dimorphic; on young plants and vigorous shoots of older ones, in whorls of three, acicular, pungent and spreading;* on adult plants always squamiform, in decussate pairs, concrescent with or adnate to the stem; on the axial

* This form is rarely seen on plants growing in Great Britain.

growths larger and often free at the apex, glaucous bluish green. Staminate flowers not seen. Fruits small, globose-ovoid, dark brownish violet with a glaucous bloom.

Juniperus thurifera, Linnaeus, Sp. Plant. II. 1039 (1753). Loudon, Arb. et Frut. Brit. IV. 2503, with fig. Carrière, Traité Conif. ed. II. 34 (exclu. localities, except Spain). Parlatore, D. C. Prodr. XVI. 487. Gordon, Pinet. ed. II. 153. Beissner, Nadelholzk. 117. Masters in Journ. R. Hort. Soc. XIV. 215.

J. hispanica, Miller, Dict. ed. VIII. No. 13 (1768).

J. sabinoides, Grisebach, ex Endlicher, Synops. Conif. 23 (exclu. loc.).

J. cinerea, Carrière, Traité Conif. ed. II. 35. And others.

Eng. Spanish Juniper. Incense Juniper. Fr. Genévrier porte-éncens. Germ. Weihrauch-Sadebaum. Ital. Ginepro incenso.

Juniperus thurifera has a limited geographical range in the western Mediterranean region, from Cape St. Vincent in Portugal eastwards to the Sierra Nevada in Spain where it ascends to 3,500 feet; also along the coast range of Morocco and Algiers. It was cultivated by Miller in the Chelsea garden in 1752, and was probably introduced by him. Although so long cultivated in this country, Gordon's assertion that the Spanish Juniper is "quite hardy" must be accepted with reserve, as it is only in warm and sheltered situations that it occasionally attains a height of 20 to 25 feet; in its young state it has a slender columnar outline but often tapering to a sharp point; as such with its very distinct, grey-green foliage, it is a very ornamental plant for a spot protected from severe frosts.

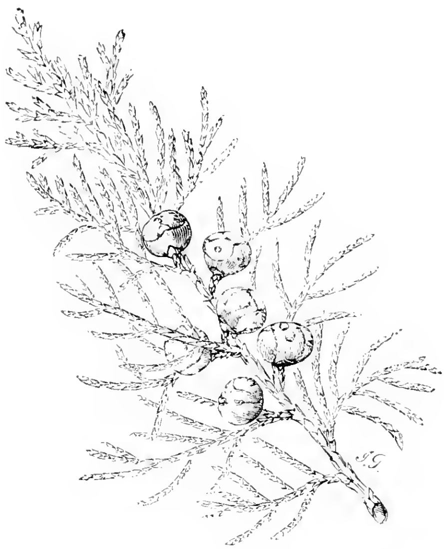


Fig. 59. *Juniperus thurifera.*

Juniperus virginiana.

A tree of variable size and habit; at its greatest development 100 feet high with a straight trunk 3–4 feet in diameter near the ground; usually much smaller and averaging 40–50 feet high; in places reduced to a low bushy shrub. Bark of trunk thin, light brown tinged with red and separated into long narrow scales fringed on the margins.* Branches slender, usually horizontal, but often ascending, especially in the young state of the tree; secondary branches slender with smooth chestnut-brown bark; ramification of the branchlets

* Ex Silva of North America, Vol. X. p. 93.

mostly pseudo-distichous and alternate, of the herbaceous shoots often tetrastichous (four-ranked), very short and four-angled. Leaves dimorphic; on the axial shoots and on young trees in whorls of three, acicular or linear-lanceolate, acuminate, adnate at the base, free at the apex, changing to reddish brown or grey and becoming effete in the third year; on adult trees small, scale-like, in decussate pairs, ovate, acute, imbricated or concrescent, light green changing to russet-brown on pollen-bearing trees, green or glaucescent on fruit-bearing trees; on young plants larger and changing to dull violet-brown in winter. Flowers diœcious, less commonly monœcious, the staminate flowers about an eighth of an inch long composed of eight—ten stamens. Fruits produced on the ends of short lateral shoots of the preceding year, sub-globose, 0·25 inch in diameter, dark blue-purple covered with a whitish glaucous bloom, and ripening the first season.

Juniperus virginiana, Linnaeus, Sp. Plant. II. 1039 (1753). Michaux, Hist. Arbr. Amer. III. 42, t. 5 (1813). L. C. Richard, Mém. sur les Conif. 37 (1826). Loudon, Arb. et Frut. Brit. IV. 2495, with figs (1838). Endlicher, Synops. Conif. 27 (1847). Carrière, Traité Conif. ed. II. 43. Parlatore, D. C. Prodr. XVI. 488. Hoopes, Evergreens, 291. Gordon, Pinet. ed. II. 154. Beissner, Nadelholzk. 122, with figs Masters in Journ. R. Hort. Soc. XIV. 215. Sargent in Garden and Forest, VIII 61; and Silva N. Amer. X. 93, t. 52. And many others.

Eng. and Amer. Red Cedar. Fr Cédre de Virginie. Germ. Virginischer Sadebaum. Ital. Cedro della Virginia.

Varieties distinguished chiefly by habit.

var.—Bedfordiana.

In Great Britain a dense much-branched low tree of columnar habit, with slender elongated pendulous or reflexed branchlets clothed with bright green acicular leaves with a grey stomatiferous line on the ventral side.*

J. virginiana Bedfordiana, Parlatore, D. C. Prodr. XVI. 489. J. virginiana barbadensis, Gordon, Pinet. ed. II. 155. J. gracilis, Endlicher, Synops. Conif. 31. J. Bedfordiana, Hort And others.

var.—dumosa.

A shrub with short, close-set, ascending branches, and with a rounded top. Leaves dimorphic, for the most part acicular, spreading, bluish green above; on the herbaceous shoots scale-like and bright green.

J. virginiana dumosa, Carrière, Traité Conif. ed. II. 46. Gordon, Pinet. ed. II. 156. Beissner, Nadelholzk. 126.

var.—pendula.

Several pendulous forms are described by different authors. According to Gordon three such are to be found in British gardens differing more or less in the manner and degree of pendulosity and in the colour of the foliage. They are thus distinguished:—One has spreading branches and pendulous branchlets clothed with scale-like leaves only,

* This is one of the most beautiful of Junipers, but unfortunately too tender for the climate of Great Britain generally. Although long cultivated in this country its origin is obscure; there is strong evidence in support of an hypothesis that it is the Juniper of the Gulf States and some of the West India Islands, and thence the *J. barbadensis* of Linnæus and specifically distinct from *J. virginiana*.

and producing only staminate flowers. A second form has long and slender primary branches that with their appendages are more or less pendulous; this was known in some gardens as Chamberlayne's Weeping Red Cedar. A third has elongated pendulous branchlets clothed with bright green scale-like leaves: it is the handsomest of the three, and the only one generally cultivated at the present time.

J. virginiana pendula, Carrière, Traité Conif. ed. II. 46. Gordon, Pinet. ed. II. 156. Beissner, Nadelholzk. 125. J. virginiana pendula viridis, Hort. J. virginiana Chamberlaynei, Hort. J. virginiana Smithii, Hort. And others.

var.—Schottii.

A narrowly pyramidal or columnar tree of smaller dimensions and denser habit than the common form; the younger branchlets are shorter, more crowded and clothed with scale-like foliage of a remarkably bright green colour.

J. virginiana Schottii, Gordon, Pinet. ed. II. 157. Beissner, Nadelholzk. 126. J. virginiana viridis, Hort.

var.—tripartita.

A low, spreading shrub with the habit of the common Savin; branches and branchlets much ramified and clothed with acicular leaves only that have a bluish green tint caused by the apparent blending of the glaucous stomatiferous lines with the green surface.

J. virginiana tripartita, Gordon.

Varieties distinguished by the colour of the foliage.

var.—albo-variegata (syn. *alba spica*).

This has many of the youngest growths and leaves cream- or yellowish white interspersed among the green branchlets and which change to pale green in the following season.

var.—aureo-variegata.

In this variety many of the young growths are yellow; the variegation is sometimes unequally distributed over the plant.

var.—elegans.

Branchlets slender and elongated, clothed with acicular foliage and having many of the youngest lateral growths light yellow.

var.—glauca (syn. *argentea*).

In this variety the whole of the youngest growths and their foliage are of almost silvery whiteness, which changes to pale glaucous green in winter.

var.—Triomphe d'Angers.

The greater portion of all the terminal growths cream-white, affording a strong contrast to the dark bluish green of the older foliage.

Besides the varieties described above, a large number of others which have originated in the seed-beds of British and continental nurseries have received distinguishing names; it is, however, doubtful whether many of them can now be identified, as seminal varieties frequently lose their distinctive character with age.

The geographical range of *Juniperus virginiana* is one of the most extensive of the genus; it may be stated in general terms to extend in a meridional direction from the great lakes of North America and westwards of them from about the 50th parallel to the Gulf States and Florida, and longitudinally from the Atlantic coast to the Rocky Mountains; and even crossing these at its northern limit, it spreads through southern Columbia to Vancouver's Island. Within this area occur the most diverse phases of climate, from the sub-arctic winters of Nova Scotia and the Lake region to the tropical summers of the Gulf States; from the arid plains of Utah and Nevada where the annual rainfall rarely reaches ten inches to the low-lying tracts of the south-eastern States where it often exceeds sixty inches. It is not surprising, therefore, that growing spontaneously over half the North American continent, in widely different soils, situations and aspects and also under extreme conditions of climate, that *Juniperus virginiana* should be one of the most variable of Conifers as regards habit and dimensions. In the Atlantic States it is usually scattered over dry slopes and rocky ridges; on the coast often stunted and with short tough branches that resist the fiercest gales; further inland, as in Kentucky, Tennessee and adjacent States, it is a medium-sized tree covering large areas with nearly pure forests; in the humid and hot climate of the eastern Gulf States it attains its greatest dimensions, becoming a tall wide-topped tree of very elegant aspect; towards its western limits and on the Rocky Mountains it is often reduced to a low bushy shrub.*

According to Aiton† *Juniperus virginiana* was cultivated by Evelyn prior to 1664, the date of publication of the first edition of the "Sylva"; it was thence one of the first American trees introduced into British gardens. Since that period it has been in constant use for ornamental planting, and prior to the discovery and introduction of the north-west American and east Asiatic Cupressineæ, much more extensively than at present. Its average growth in Great Britain is not more than from 10 to 15 feet in the first ten years from the seed, and the average height attained by it is rarely more than 30 to 40 feet, so that the tree does not often attain a timber-like size except in deep rich soils that could be more profitably cropped with other vegetation. Under cultivation the Red Cedar is very polymorphous, of which every seed bed furnishes abundant instances, but the peculiar form which characterises individuals frequently disappears with age. M. Carrière was of opinion that this variation is an effect of the sexuality of the plants, and certainly there

* Silva of North America, X. 94. Professor Sargent has since separated the Junipers of the Rocky Mountains and of the Gulf States from *Juniperus virginiana*, constituting the former a new species under the name of *J. Scopulorum* and referring the latter to the Linnean *J. barbadensis*.

† Hortus Kewensis, ed. II. Vol. V. p. 414.

are facts that can be adduced in support of that hypothesis,* for example—the male trees (at least up to 25 or 30 years) may be always recognised by their primary branches spreading horizontally and by the elongated branchlets clothed with scale-like leaves which in winter have a russet-brown tint quite peculiar to this form. The female trees have also spreading branches but with more lax ramification than the males; the foliage is at first dimorphic but the acicular leaves disappear in time and the scale-like foliage is of a decided green tint, rarely glaucous, throughout the year. Monœcious trees are fairly intermediate, generally of columnar or sub-fastigiate habit up to 25—30 years, with dimorphic foliage while the trees are relatively young; in some instances the fruit is borne on a single branch or on a very few branches, and in others the staminate flowers are restricted to one or to a very few branches, whilst between these extremes every possible gradation occurs, and every such variation is usually accompanied by a greater or less variation in habit.

The wood of the Red Cedar is one of the most valuable of the forest products of North America. Its use in the manufacture of "cedar pencils" is well known: its resistance to decay by water is so great that no better wood can be found for fencing-posts and railway ties, door-sills and other purposes in which wood-work is in contact with the soil. Moths flee from its pungent odour, and a chest or closet lined with this wood affords an efficient protection against their inroads. From the waste of pencil factories, a kind of paper is manufactured that has been found useful for underlaying carpets and for wrapping wools, furs and other articles liable to be injured by moths.

FITZROYA.

Hooker fil in Bot. Mag. sub. t. 4616 (1851). Parlatore, D. C. Prodr. XVI. 463 (1868). Bentham and Hooker, Gen. Plant. III. 425 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 95 (1887). Masters in Journ. Linn. Soc. XXX. 17 (1893); and including Diselma, Hooker fil. Fl. Tasman. I. 353. t. 98.

A genus of evergreen trees or shrubs, including two species which have their homes in two regions remote from each other—one, the type, in the extreme south of South America and the other in the island of Tasmania. From a scientific standpoint, the genus is a highly interesting one, both in respect of the geographical position of the species and the structure of the fruit by which it is chiefly distinguished from the other Cupressineæ.

The essential characters are:—

Flowers diœcious. Staminate flowers small, solitary and terminal Anthers four—eight, shortly stipitate with a peltate, broadly ovate or sub-orbicular connective bearing two—four anther cells.

* Il y a des individus exclusivement mâles, d'autres exclusivement femelles, et d'autres enfin qui, a des degrés différents, portent les deux sexes. Ce qui est encore à remarquer, c'est que ces caractères agissent sur le facies et qu'elles donnent souvent aux plantes un aspect particulier. Cette particularité, qui probablement s'applique à d'autres espèces de Juniperus, pourrait, peut-être, expliquer la multiplicité qu'on a faite d'espèces qui, pour beaucoup, ne sont probablement que des formes d'un seul type.—*Traité Général des Conifères*, ed. II. p. 47.

Ovuliferous flowers also small, solitary and terminal, composed of two—four pairs of scales of which the two uppermost and largest bear two—three orthotropous (erect) ovules.

Strobiles small, globose: scales sub-ligneous, persistent, the two uppermost pairs alone fertile and bearing two—three winged seeds.

The vegetative organs are sufficiently described under each species.

The genus is named in compliment to Captain Fitzroy, commander of H.M. surveying ship "Beagle," during the voyage of which (1831—1836) the type species was discovered.*

Fitzroya Archeri.

A low tree with a trunk sometimes 15—18 inches in diameter; more frequently a much-branched erect shrub 5—12 feet high. Branches numerous with dark chestnut-brown bark and tetrastichous (four-ranked) ramification; branchlets slender, four-angled and similarly ramified. Leaves small, scale-like, in decussate pairs, ovate-triangular, obtuse, strongly keeled at the back, concrescent or closely imbricated, dark green with a white stomatiferous line on each side of the keel; somewhat larger on the axial growths, more acute, free at the apex and becoming effete in the third or fourth year. Staminate flowers composed of six—eight anthers in decussate pairs. Ovuliferous flowers consisting of four scales in opposite pairs, of which the smaller outer pair are sterile and the larger inner pair each bears two orthotropous ovules.

Fitzroya Archeri, Bentham in Gen. Plant III. 425 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 95.

Diselma Archeri, Hooker fil, Fl. Tasman. I. 353. t. 98 (1860). Carrière, Traité Conif. ed. II. 84. Parlatore, D. C. Prodr. XVI. 462. And others.

This, the Tasmanian species, has a very restricted habitat around Lake St. Clair and on the western mountains which it ascends to the summit, about 4,500 feet above the level of the neighbouring ocean. It was first described as a monotypic genus under the name of Diselma, but afterwards joined with the South American species by Mr. Bentham on the ground that the essential characters of the two are the same.

Fitzroya Archeri has long been cultivated in the Temperate House in the Royal Gardens at Kew, but no experience of it in the open ground in this country is recorded. As it is associated in its native island with *Athrotaxis cupressoides* it might be expected to prove as hardy as that species. It is named in compliment to the late Mr. William Archer of Cheshunt, who resided upwards of ten years in Tasmania, during which he sedulously investigated the botany of the district surrounding his property. He returned to

* The voyage of the "Beagle" will be ever memorable in the annals of science. The vessel was dispatched by the British Government "to complete the survey of Patagonia and Tierra del Fuego, to survey the shores of Chile, Peru and of some islands in the Pacific and to carry a chain chronometrical measurement round the world." Mr. Charles Darwin was invited to accompany the expedition, an invitation which he accepted; and during the long voyage was commenced the series of profound researches which ultimately made a permanent impress on biological science.

England in 1857 with an excellent herbarium, copious notes, analyses and drawings; with these, and by means of the accurate information he possessed of the vegetation of the island, he rendered valuable assistance to Sir Joseph Hooker in the compilation of the "Flora of Tasmania," besides defraying a large portion of the expense of the illustrations.*

Fitzroya patagonica.

A diœcious tree of variable dimensions; at its greatest development on the western slopes of the Andes of southern Chile, with a trunk 80—100 or more feet high, covered with deeply furrowed, fibrous bark 3 inches thick: at its highest vertical limit, a small much branched shrub. In Great Britain, a low tree or shrub of irregular outline; the arborescent form with a trunk 9—12 inches in diameter covered with pale reddish brown bark fissured longitudinally into narrow plates, and exposing a dark inner cortex. Primary branches unequal in length and thickness, and very irregularly ramified. Branchlets flexible, obscurely tetrastichous, the youngest shoots decurved, and often pinnately divided. Leaves in decussate pairs, persistent several years, but becoming effete in the third or fourth season, narrowly ovate-oblong or spathulate oblong, mucronate, more or less imbricated, dark green and concave above, keeled on the back and with two white stomatiferous lines. Staminate flowers not seen. Strobiles on short lateral shoots of the preceding year, globose, composed of three decussate pairs of scales, each with a prominent compressed umbo on the outer side, the largest uppermost pair fertile, each bearing three seeds or fewer by abortion.

Fitzroya patagonica, Hooker fil. ex. Hooker W. in Bot. Mag. sub t. 4616 (1851). Lindley in Paxton's Fl. Gard. II. 147. Gay, Fl. Chil V. 411. Van Houtte, Flore des Serres, VII. 130, with fig Carrière, Traité Conif. ed. II. 463. Gordon, Pinet. ed. II. 115. Masters in Journ. R. Hort. Soc. XIV. 219.

The geographical range of *Fitzroya patagonica* on the South American continent has not yet been clearly ascertained; so far as at present known, its northern limit may be placed at about the 40th parallel of south latitude whence it spreads southwards along the Andes to the Straits of Magellan. It is very abundant on the brows of the hills around Valdivia where it ascends to 1,500 feet elevation, and where its tall columnar stems are visible from a great distance.† It was introduced from this locality by the Veitchian firm in 1849 through William Lobb.

Although *Fitzroya patagonica* has been in cultivation half-a-century and has proved quite hardy, it cannot be regarded as a satisfactory subject for British gardens. In the most favourable localities as in Devon and Cornwall, its growth is slow, and when left to itself it often forms a multiplicity of leader shoots, none of which grow more

* Flora of Tasmania, Introduction, p. 127.

† Richard Pearce *in lit.*, who affirmed that it is the Fitzroya which supplies the valuable Alerze timber of the Chilians, not *Libocedrus tetragona* as stated by most authors.

than a few inches in a single season; the branches are for the most part irregularly developed and impart an unsymmetrical habit to the tree unless occasionally pruned.* It is worthy of remark that none of the Fitzroyas (Chilian species) growing in Great Britain so far as they have been observed, produce staminate flowers, but ovuliferous strobiles are produced in great profusion from an early age of the tree.

CUPRESSUS.

Linnæus, Sp. Plant. II. 1002 (1753). Endlicher, Synops. Conif. 55 (1847). Parlatore, D. C. Prodr. XVI. 467 (1868). Bentham and Hooker, Gen. Plant. III. 427 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 99 (1887). Masters in Journ. Linn. Soc. XXXI. 325 (1896). Including Chamæcyparis, Spach, Hist. Nat Veg. Phan. XI. 329 (1842); and Retinispora, Siebold and Zuccarini, Fl. Jap. II. 42 (*genus falsum*).

The genus Cupressus includes some of the most beautiful and interesting trees in Nature, and as the majority of the species are more or less hardy in Great Britain their value as subjects for garden decoration is very great, a value greatly enhanced by the numerous abnormities into which many of them have diverged under cultivation, and which has resulted in the "fixing" of forms of very distinct habit and aspect originating from the same species. The most remarkable instances of polymorphism occur in *Cupressus Lawsoniana*, *C. obtusa* and *C. pisifera*, of which it may be remarked that the abnormities of the one for the most part simulate those of the others, thus affording evidence of order and method in the production of an apparently inexplicable diversity of forms.†

The genus in its extent and circumscription as here understood, is the same as in the monograph elaborated by Dr. Maxwell Masters in the "Journal of the Linnean Society," *loc. cit. supra*. The essential characters are:—

Flowers monœcious. Staminate flowers terminal on short branchlets of the preceding year. Stamens numerous, in decussate pairs with short filaments and orbicular or sub-peltate connectives bearing two—six anther cells.

Seminiferous cones (strobiles) composed of eight—ten scales thickened at the apex or exposed side into a peltate expansion and bearing beneath it two—seven or more seeds in one—two series.

* Among the largest specimens known to the author is one at Killerton in South Devon over 25 feet high; one at Upcott, near Barnstaple, of nearly the same dimensions; one at Fota Island, near Cork, in which the terminal growths are much elongated and elegantly pendulous; and one at Kilmacurragh, Co. Wicklow, which has taken the form of a dense rounded shrub 12 feet in diameter. There is also one at Belsay in Northumberland over 20 feet high growing on sandstone quarry refuse, which has been watched and supernumerary leaders pruned off whenever they have appeared. The failure of the Fitzroya to grow satisfactorily in this country is doubtless due to climatic causes similar to those which affect *Saxegothæa conspicua* and *Libocedrus tetragona*.

† It should, however, be noted that whilst many of these abnormities may become "fixed" by propagation from cuttings and by grafting, many others lose their peculiar form and colour as they increase in age, the reversion to a normal type taking place more rapidly in some varieties than in others.

But while the above characters are common throughout the genus, there occurs a difference in the period of maturation of the fruits, in their size, in the texture of their scales and in the number of seeds borne by each, and these differences are generally but not always accompanied by a difference in the branching and consequently in the form of the branchlet system of the youngest or herbaceous growths, whence the species fall into two groups or sections thus distinguished :—

EUCUPRESSUS.—Strobiles large, attaining maturity in the second year; scales ligneous, each bearing numerous seeds in one—two series. Herbaceous branch systems tetrastichous (four-ranked) but often obscured from external causes, sometimes distichous (two-ranked). Leaves mostly homomorphic :

Arizonica, Benthamii, funebris, Goveniana, lusitanica, Macnabiana, macrocarpa, sempervirens, thurifera, torulosa.

CHAMÆCYPARIS.—Strobiles small, attaining maturity the first year; scales coriaceous, bearing two, rarely three—five seeds in one series. Herbaceous branch systems distichous, tetrastichous in some of the abnormal forms only. Leaves dimorphic, the lateral pairs more or less conduplicate, the dorsiventral pairs flat :

Lawsoniana, nootkatensis, obtusa, pisifera, thyoides.

Variable as is the habit of the Cypresses and the dimensions which individual trees attain, the spreading form in which the branches gradually diminish in length from below upwards during the vigorous life of the tree, appears to be that most natural to them. Instances of pendulosity occur in *Cupressus funebris* and *C. torulosa*, and fastigiate forms of *C. sempervirens* and *C. macrocarpa* are common. It is worthy of note that nearly all the species natives of the warmer parts of the temperate zone assume more or less the fastigiate habit in Great Britain.

The type species *Cupressus sempervirens* has been known from remote antiquity and has been noted by many authors down to the dawn of modern Botany. By the end of the eighteenth century four other species were known to science, *C. lusitanica*, *C. thyoides*, *C. nootkatensis* and *C. funebris*: all the remaining species are discoveries of the nineteenth century.* The genus now includes fifteen recognised species and two or three more forms whose specific rank is undecided; all these are distributed over the northern hemisphere from Japan westwards to the Pacific littoral of North America. Most of the species included in Eucupressus are natives of the warmer parts of the temperate zone, while all those in Chamæcyparis have a more northern habitat. For the British climate their value is wholly horticultural, but in their native countries where abundant and of sufficient dimensions, their timber ranks among the best for certain purposes that can be procured.

* A most useful chronological list of authorities for specific names and also complete lists of synonyms are appended to Dr. Masters' monograph in the Journal of the Linnean Society.

Cupressus arizonica.

A tree usually 30—40 feet but occasionally 70 feet high with a trunk 2—4 feet in diameter and horizontal branches forming a narrow pyramidal or occasionally a broad flat head. Bark on old trunks thin, dark red-brown and separating freely into long shreds which often remain hanging on it for years; on young trunks and on the branches, breaking into large irregular scales which, in falling, expose the bright red inner bark. Leaves ovate, acute, carinate and eglandular, or occasionally glandular pitted on the back, pale glaucous green, dying usually the second year. Staminate flowers 0·25 inch long, composed of six—eight stamens with broadly ovate, acute, yellow connectives. Strobiles sub-globose, about an inch in diameter on short peduncles and with six—eight scales furnished with stout, cylindrical, pointed umbos. Seeds variable in shape, from oblong to nearly triangular and furnished with thin narrow wings.—Sargent, *Silva of North America*, X. 105.

Cupressus arizonica, Greene in Bull. Torrey. Bot. Club. IX. 64 (1882). Watson in Proceed. Amer. Acad. Sci. XVIII. 157 (1883). Masters in Gard. Chron. X. ser. 3 (1891), p. 364; and Journ. R. Hort. Soc. XIV. 204. Lemmon, N.W. Amer. Cone Bearers, 75.

C. Benthami. var. arizonica. Masters in Journ. Linn. Soc. XXXI. 340.

Cupressus arizonica is the latest addition to the genus; it was discovered by Professor Greene in 1880 in the neighbourhood of Clifton in Arizona, and also on the mountain ranges north of Mount Graham; it is now known to be common on the mountains of central Arizona at 5,000 to 8,000 feet elevation, in places forming pure forests of considerable extent.

Cupressus arizonica was introduced into British gardens in 1882 from the Arnold Arboretum, near Boston, U.S.A. The young trees growing in this country are of fastigiate or columnar habit with a lightish green foliage; they have up to the present time proved quite hardy and are among the best of decorative Conifers for the lawn and small gardens.

Cupressus Benthamii.

A tree of variable habit and dimensions according to situation and environment. Branches spreading or deflexed, much ramified at the extremity; secondary branches covered with smooth, dark chestnut-brown bark. Branchlets distichous, opposite or alternate and pinnately ramified, the youngest growths equidistant and parallel. Leaves dimorphic, on the axial growths ovate, acuminate, glandular, adnate at the base, free at the apex, becoming effete in the third year; on the lateral branchlets smaller, scale-like, deltoid-ovate, appressed and imbricated, bright green. Staminate flowers with six anthers in decussate pairs. Strobiles solitary or in clusters of two three or more, shortly pedunculate, globose, about 0·75 inch in diameter, composed of eight rhomboidal scales each with a small umbo projecting from the centre.

Cupressus Benthamii, Endlicher, Synops. Conif. 59 (1847). Parlatore, D. C. Prodr. XVI. 472. Hemsley, Biol. Centr. Amer. III. 183. Gordon, Pinet. ed. II. 80. Masters in Journ. Linn. Soc. XXXI. 338.

C. Lindleyi, Klotsch, ex Endlicher, *loc. cit.*

C. lusitanica Benthamii, Carrière, Traité Conif. ed. II. 155

var.—Knightiana.

This differs from the typical *C. Benthamii* in its more symmetrical habit especially in the regularity of its branching, in its glaucescent foliage and also in the more prominent umbo of the cone scales.

C. Benthamii Knightiana, Masters in Gard. Chron. XVI. ser. 3 (1894), p. 668; and in Journ. Linn. Soc. XXXI. 340. C. Knightiana, Hort. C. elegans, Hort.

The information we possess respecting *Cupressus Benthamii* as seen in its native country and its geographical distribution is vague and disjointed. Not much more can be said of it than that it is spread over the *tierra fria* or alpine region of Mexico at 6,000 feet elevation and upwards, from Orizaba northwards to the Sierra Madre, and that herbarium specimens have been gathered in different places and at different times by botanical explorers of the region, among the earlier of whom was Karl Theodor Hartweg while collecting seeds and plants for the Horticultural Society of London, 1839—1843, through whom it was introduced.* The variety *Knightiana* was distributed by Messrs. Knight and Perry, the predecessors of Messrs. James Veitch and Sons at the Royal Exotic Nursery, who state in their Synopsis that its origin was unknown to them; it is the most elegant of the half-hardy Cypresses, and is still to be found in warm sheltered spots in Hampshire, Devon and Cornwall, and also at Powerscourt in Ireland where there is a remarkably beautiful specimen in perfect health. The species was named after the late Mr. George Bentham, one of the most eminent of British systematic botanists.

George Bentham (1800—1884), the son of Sir Samuel Bentham, was born at Plymouth, his father being at that time Inspector of the Royal Dockyards. While still a boy he spent some time at St. Petersburg where he acquired a knowledge of the Russian language. From 1814 to 1826 he lived with his family in the neighbourhood of Montpellier, and there he began his botanical career by a practical examination of the wild plants of Angoulême and Montauban, quickly followed by further researches into the flora of the Pyrenees. His first work, "A Catalogue of Plants indigenous to the Pyrenees and Bas Languedoc" was published in 1826. Returning to England in that year he first turned his attention to the law, but speedily devoted himself exclusively to botany. He attached himself to the Horticultural Society of London in the days when that Society did excellent service by dispatching collectors to various countries, and together with Lindley he undertook the determination of the many species introduced by Douglas Hartweg and others; he was Secretary to the Society from 1829 to 1840. From the time his connection with the Society ceased, up to within a year or two of his death, Bentham was constantly at work, elaborating monographs of genera and orders or preparing floras of various countries. Among the most important of these elaborations mention must be made of his monographs of the Labiatæ and Scrophularineæ in De Candolle's "Prodromus" and the floras of Hong-Kong and Australia in the series of Colonial floras projected by Sir William Hooker and worked out at Kew. But by far the most enduring monument of

* The only tree raised from the originally-introduced seeds known to the author is at Fota Island, near Cork, where it is recognised under the name of *Cupressus Lindleyi*; it is a superb specimen upwards of 80 feet high, with a trunk three feet in diameter near the ground.

Bentham's labours is the "Genera Plantarum," a work of immense value to botanical science, and which, till its appearance, was one of the most urgent desiderata of the age. The publication began in 1862 and terminated in 1883, a year prior to his death. To enable him to prosecute his researches, Bentham gradually accumulated a vast herbarium and library, which in 1854 he made over to the nation with the sole condition that they should be accessible to the public. These, incorporated with the collections of his friend, Sir William Hooker, formed the basis of the unrivalled collections at Kew. Bentham was a Fellow of the Royal Society, from whom he received the greatest honour in their power to bestow—the award of a Royal Medal; he was also a Member of the Institute of France and a Fellow of the Linnean Society of London, of which he became President in 1861 and continued for thirteen years to preside over the destinies of the Society.—*Gardeners' Chronicle*, XXII. (1884), p. 368.

Cupressus funebris.

A tree of singular aspect with a broadly pyramidal crown, wide spreading branches and pendulous branchlets, attaining a height of 50—60 feet and usually with an erect, straight trunk denuded of branches along the lower part. In Great Britain a fastigiate or columnar tree, the trunk sometimes divided at a greater or less distance from the ground into two or more secondary much-branched trunks, the branches and their ramifications short, stout, ascending and covered with smooth chestnut-brown bark. Branchlets distichous and alternate, slender and more or less drooping, the youngest branchlet system persistent about three years. Leaves scale-like, deltoid, acute, concrescent or closely imbricated, bright green. Staminate flowers sub-globose, consisting of eight anthers in four decussate pairs. Strobiles on short footstalks, solitary or in pairs, globose, composed of four pairs of umbinate scales of which the two middle pairs are fertile, each bearing three — four seeds.*

Cupressus funebris, Staunton Embassy, ed. II. 446, t. 41 (1798). Endlicher, Synops. Conif. 58 (1847). Planchon in Flore des Serres, VI. 90, with fig. (1850). Lindley in Paxton's Fl. Gard. I. 46, with fig. Carrière, Traité Conif. ed. II. 161. Parlatore, D. C. Prodr. XVI. 471. Gordon, Pinet. ed. II. 82. Brandis, Forest Fl. N.W. India, 533. Hooker fil, Fl. Brit. Ind. V. 646. Masters in Journ. Linn. Soc. XXXI. 337, with figs.

C. pendula, Lambert, Genus Pinus, ed. II. 124, t. 66 (1828). Loudon, Arb. et Frut. Brit. IV. 2479, with figs.

This remarkable Cypress first became known to Europeans during Lord Macartney's Embassy to Pekin in 1792 when it was seen growing in a place called "The Vale of Tombs" situated in a mountainous district in the north of China, and which is said to have a more rigorous climate than England. Nothing more was heard of it till it was re-discovered by Mr. Fortune in 1849 about 150 miles up the Hang-chow river in the neighbourhood of the once famous tea country of Whey-chow where he procured seeds which he sent to the late Mr. Standish of Ascot, the first received in this country. Mr. Fortune afterwards saw this Cypress in China further west where it is more common, occurring "frequently in clumps on the sides of the hills where it had a most striking and beautiful effect on the

* Communicated by Mr. Crombie, Powerscourt Gardens, Co. Wicklow, and Mr. Garland, Killerton Gardens, Exeter.

landscape."* The geographical distribution of *Cupressus funebris* is but imperfectly known: the recorded habitats are few, but there are indications of its having an extensive range in the south-west provinces whence it has been introduced and planted around temples in Nepal, Sikkim and Bhotan. In the Himalayan valleys up to 6,000 feet it attains a large size; one tree measured by Sir Joseph Hooker had a girth of 16½ feet at five feet from the ground and was apparently 90 feet high.†

The expectation that *Cupressus funebris* would prove as hardy as the Cryptomeria and the Indian Deodar has not been realised. The occasional recurrence of exceptionally severe winters has proved fatal to it over the greater part of Great Britain. In Devon and Cornwall and in parts of Wales and Ireland where this extreme severity is rarely or ever felt there are specimens from 25 to 30 feet high but they are all of the fastigiate or columnar form, and only in a few instances as at Killerton in Devonshire and at Powerscourt in Wicklow do the oldest trees show signs of assuming the pendulous habit which characterises the species in China and India.

Cupressus Goveniana.

"A tree occasionally 50 feet high with a short trunk 2 feet in diameter and slender, erect or spreading branches; usually much smaller, often shrubby in habit." Outer bark dark brown, fissured and peeling off in shreds exposing a chocolate-red inner cortex. Branches spreading or ascending, covered with smooth red-brown bark and much ramified towards the extremities. Branchlets slender, numerous and close-set, tetrastichous on the axial growths and densely ramified in the same manner. Leaves on the axial shoots ovate, acute, closely appressed or concrescent at the base, free at the apex; on the slender lateral shoots much smaller, scale-like, concrescent or imbricated, all of a bright shade of green peculiar to this species. Staminate flowers usually with six stamens, four-angled, light yellow. Strobiles often in dense clusters, shortly pedunculate, globose, 0·75—1 inch in diameter, composed of four decussate pairs of dark brown scales each with a short pyramidal umbo and bearing from twelve to eighteen seeds.

Cupressus Goveniana, Gordon in Journ. Hort. Soc. Lond. IV. 295, with fig. (1849); and Pinet. ed. II. 83. Carrière, Traité Conif. ed. II. 170. Parlatore, D. C. Prodr. XVI. 472. Brewer and Watson, Bot. Califor. II. 114. Masters in Journ. R. Hort. Soc. XIV. 205; and Journ. Linn. Soc. XXXI. 346, with fig. Sargent, Silva N. Amer. X. 107, t. 527.

Cupressus Goveniana was discovered by Theodor Hartweg in the neighbourhood of Monterey in 1846 associated with *Pinus muricata*, while collecting plants and seeds for the Horticultural Society of London; it was subsequently distributed from the Society's gardens at Chiswick. Its geographical range is confined chiefly to the Californian coast region from the plains of Mendocino to the mountains

* Gardeners' Chronicle, 1850, p. 228. † Himalayan Journals, Vol. I. p. 336.

of San Diego, frequently ascending the cañons of the mountain chains of central California to nearly 3,000 feet elevation and attaining its largest size near mountain streams. It covers in Monterey and Mendocino counties extensive tracts of sandy barrens or rocky slopes extending inland a few miles from the coast, growing as a low bush frequently only a few inches high.*

In Great Britain *Cupressus Goveniana* is hardy but comparatively short lived; it thrives best in the western and south-western counties of England and in Wales and Ireland. Like all the cultivated Cypresses it assumes two distinct habits, the spreading and the fastigiate; the oldest trees of spreading habit rarely exceed 20—25 feet in height, oftener much less, and have a trunk usually divided near the ground and a broad umbrella-like crown; the fastigiate form has a more slender trunk with ascending branches and attains a height of 30—35 feet. In the early spring this Cypress is covered with innumerable yellow staminate flowers, and so plentifully is the pollen produced that when shed, the ground beneath the trees appears covered with yellow dust. It is also extremely prolific; cones are produced from an early age, and after a few years the trees become so loaded with them that their vitality is eventually exhausted.

The species was named in compliment to Mr. James Robert Gowen, a prominent horticulturist of his time and Secretary to the Horticultural Society of London at the date of its introduction.

Cupressus Lawsoniana.

The tallest of all Cypresses, at its greatest development attaining 200 feet high with a trunk 12 feet in diameter near the abruptly enlarged base and free of branches for over 100 feet; the general height ranges from 120 to 150 feet. Bark remarkable for its thickness, being more than a foot thick on old trees, reddish brown with two distinct layers, the inner being darker and more compact than the outer which is divided into great broad-based rounded ridges separated on the surface into small, thick, closely appressed scales; on young stems and on the branches, the bark is thin and slightly scaly.† In Great Britain a medium-sized or tall tree with a stoutish trunk tapering from a swollen base and covered with cinnamon-brown bark which peels off in thickish flakes.‡ Branches short, mostly horizontal, sometimes more or less curved, terminating in leafy, frondose expansions. Branchlets with lateral ramification, slender, often flexible and sub-pendulous. Leaves in decussate pairs, bright dark green, occasionally glaucescent, on the axial growths ovate-oblong, acuminate, adnate at the base, free at the apex, and persisting three—four years; on the lateral and younger shoots scale-like, triangular-ovate, concrescent and glandular. Staminate flowers small, cylindric, crimson, with 12—16 anthers. Strobiles globose, 0·25—0·4 inch in diameter, composed of eight sub-quadrate scales, the lower four fused together at their base, each scale except the uppermost pair bearing two—five seeds.

* Silva of North America, Vol. X. p. 107. † *Idem.* p. 119.

‡ Occasionally with two—five secondary trunks that have arisen from the lowermost branches from which roots were emitted while the trees were still young.

Cupressus Lawsoniana, Murray in Edinb. new Phil. Journ. n. s. I. 292, with fig. (1855). Hooker fil in Bot. Mag. t. 5581 (1866). Hoopes, Evergreens, 342 with fig. Lawson, Pinet. Brit. III. 191. with figs. Gordon, Pinet. ed. II. 86. Masters in Journ. R. Hort. Soc. IV. 205; and Journ. Linn. Soc. XXXI. 353. Sargent, Silva N. Amer. X. 119, t. 531.

C. attenuata, Gordon, Pinet, ed. II. 79 (1875).

Chamæcyparis Lawsoniana, Parlatore, D. C. Prodr. XVI. 464 (1868). Brewer and Watson, Bot. Califor. II. 114. Beissner, Nadelholzk. 70. with fig.

C. Boursieri, Carrière, Traité Conif. ed. II. 125.

Eng. Lawson's Cypress. Amer. Port Orford Cypress. Fr. Cyprés de Lawson. Germ. Lawson's Lebensbaumcypresse. Ital. Cipresso di Lawson.

The abnormal forms of *Cupressus Lawsoniana* that have originated in seed beds or from "branch sports" (Sportzweige), and which have been named and distributed by horticulturists, are exceedingly numerous. Those described in the following pages are more or less distinct and highly appreciated as decorative plants for the lawn and small gardens; they admit of being grouped into two series, of which one is characterised by difference in habit and the other by colour, but as difference in habit is sometimes accompanied by difference in colour, there are forms which may be placed with equal right in either series.

Varieties distinguished chiefly by habit.

var.—Allumi (syn. *Fraseri*).

A slender but dense columnar form with short branches and rigid erect branchlet systems clothed with glaucous green foliage with a steel-blue tint peculiar to this variety. It is a modification of an older variety named *stricta*.

var.—Bowleri.

The branchlets and their ramifications more slender, more pendulous and of a darker green than the common form; habit dense and compact.

var.—compacta.

A dwarf, dense, conical low tree or shrub with decurved glaucous terminal growths; one of the most distinct of the dwarf varieties.

var.—erecta.

A dense fastigiate form with a tapering or flame-shaped outline; all the branches erect and much crowded, the lateral branchlets much shorter in proportion to their axial growths than in the common form. **erecta viridis** has the branchlet systems and foliage of a lighter and brighter green.

var.—ericoides.

The branchlets and young growths very slender and of a bright grass-green; the small scale-like leaves free and erect, simulating the foliage of some of the Cape Heaths.

var.—filifera.

The terminal growths of the youngest branchlet systems greatly elongated and attenuated at the extremity; the lateral branchlets more sparingly ramified.

var.—filiformis.

A singular variety in which the branches are excessively elongated at the expense of the lateral growths which are distant and much shortened. Of sub-pendulous habit, simulating the *Whipcord* Thuia.

var.—gracilis pendula.

More slender in all its parts, the branches long in proportion to height of trunk and pendulous. **gracilis pendula aurea**—all the growths of the current season golden yellow changing in autumn to bright grass-green, and in the succeeding season to the normal dark green of the species.

var.—intertexta.

More robust in all its parts, with more distant arching branches and more divergent ramification; foliage usually paler than in the common form.

var.—juniperina.

The youngest growths very slender with minute leaves resembling those of a Savin Juniper; the axial growths of the branchlet systems conspicuous by their yellowish tint.

var.—nana.

A diminutive form of slow growth, dense globose habit and deep green colour. **nana alba** has the whole of the current season's growth yellowish white, and that of **nana glauca** bluish green.

var. pendula vera.

The primary branches and their appendages bent downwards towards the ground. In another form the primary branches are short, rigid and horizontal, and the secondary branches with their branchlet systems are strictly pendulous.

var.—Shawii.

A globose shrub with slender branchlets and light glaucous green foliage. Of larger size and more open habit than the variety *compacta*, and with foliage of a deeper shade of green.

var.—Wisselii.

A so-called "plumose" variety of dense dwarf habit, with erect branches on which the branchlets are much crowded and the branchlet systems appears tufted like those of *C. thyoides leptoclada.* Leaves free at the apex and bright grass-green.

var.—Youngi.

Branchlets stout and spreading, the branchlet systems fern-like and of a rich dark green like those of *C. obtusa filicoides* which this variety simulates both in habit and colour.

Varieties distinguished by the colour of the foliage.

var.—alba spica.

The terminal growths and tips of the branchlets cream-white. Of more rapid growth and less dense in habit than the common form. **alba spica nana** is a dwarf compact sub-variety of this.

var.—albo-variegata (syns. *albo-maculata* and *albo-picta*).

Branchlet systems and foliage deep green profusely spotted and checkered with white. Of broadly conical or spreading habit.

var.—argentea (syn. *glauca*).

Branches shorter and more slender, sometimes sub-pendulous. Branchlets and foliage very glaucous, almost of silvery whiteness, sometimes with a steel-blue reflection.

var.—aureo-variegata (syn. *aurea spica*).

Many of the youngest branchlets bright yellow. Of conical or pyramidal habit.

var.—darleyensis.

The current year's growths bright golden yellow: the coloured shoots more numerous than in the variety *aureo-variegata*, and of a darker shade than in the variety *lutea*. Of broadly conical or pyramidal habit.

var.—lutea.

The whole of the young growths light yellow which subsides to golden yellow in winter and to the normal green of the species in the succeeding season. Of medium growth and sub-fastigiate habit. **Silver Queen** is a cream-white variation of this.

var.—versicolor.

A parti-coloured form in which many of the leaves near the base of the lateral growths are cream-white, and those at the apical end sulphur-yellow on the under side and light green on the upper side.

var.—Westermanii.

Foliage light yellow changing to fulvous green in winter. Of broadly pyramidal habit with drooping branchlets.

Cupressus Lawsoniana is supposed to have been discovered by Jeffrey on the southern flanks of Mount Shasta while collecting for the Scottish Oregon Association in 1851—1852, but nothing certain was known of it till seeds were sent by William Murray in 1854 to the nursery of Messrs. Lawson at Edinburgh. It has a comparatively limited range in South Oregon and North California; it is abundant on the Oregon coast in the vicinity of Port Orford associated with *Thuia gigantea*, *Picea sitchensis*, *Abies grandis* and *Abietia Douglasii* where "it forms one of the most prolific and beautiful coniferous forests of the continent, unsurpassed in the variety and luxuriance of its undergrowth of Rhododendrons, Vacciniums, Raspberries, Buckthorns and Ferns. It attains its largest size on the western slopes of the coast-range foot-hills between Port Gregory and the Coquille river, where it is the principal tree in a nearly continuous forest-belt about twenty miles in length and twelve in width."*

The aspect of *Cupressus Lawsoniana* in its old age in its native forests is very different from the tall piles of verdant foliage with which it is clothed in this country; its tall trunk is without branches for two-thirds

* Silva of North America, Vol. X. p. 120.

Cupressus Lawsoniana at Castlewellan, Co. Down, Ireland.

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of its height when it diminishes rapidly in girth and often becomes tortuous; the branches are few, irregularly disposed, sparingly ramified and furnished with a scanty foliage only at the extremities.*

For British gardens, *Cupressus Lawsoniana* possesses almost every quality that renders a coniferous tree valuable. As an ornamental tree it is one of the handsomest. It is perfectly hardy; the severest winters that have occurred since its introduction have scarcely affected it. It thrives in almost every description of soil, wet and cold peat alone being unfavourable for it. It is remarkably prolific, bearing seed in abundance even in its young state, which quickly germinates and thus it may be propagated with great rapidity. It is polymorphous, giving rise to varieties so distinct from the normal form, and so varied in habit and outline, that several of them are justly ranked among the best of subjects for the geometrical or formal flower garden, both in summer and winter. It may be used for almost every purpose for which Conifers are planted—as a single specimen for the lawn or park, in groups of its own kind, or intermixed with other trees or shrubs, for evergreen hedges, or as a funereal or cemetery tree. It grows freely, forming a stout trunk in a comparatively short period, a circumstance together with the known excellence of its timber, highly suggestive of its use for forestry purposes in many places.

The wood of *Cupressus Lawsoniana* is light, hard, strong and very close-grained, abounding in fragrant resin, very durable in contact with the soil, easily worked and susceptible of receiving a beautiful polish. It is much used in indoor joinery, flooring, fence-posts, ship and boat building, etc.† From an economic standpoint the Port Orford (Lawson's) Cypress is one of the most important timber trees of North America. The species was named in compliment to the late Mr. Charles Lawson of Edinburgh.

CHARLES LAWSON (1794—1873) was the son of Peter Lawson, the founder of the seed and nursery firm of Peter Lawson and Son that became well known not only in Scotland but throughout the world. In 1821 he succeeded his father in the sole management of the business, and the energy and intelligence which he brought to bear on its affairs soon placed the firm in a prominent position. In 1833 he introduced the Italian Rye-grass, two years later the Austrian Pine, and in 1854 the Cypress that bears his name. Agriculturists are indebted to him for the "Agrostographia or Book of Grasses" which passed through many editions, and for the "Agriculturist's Manual," also a work of great usefulness. He originated the "Pinetum Britannicum," an elaborate and costly folio devoted to the description and illustration of the hardy coniferous trees cultivated in Great Britain which after many interruptions and under different editors was brought to an end in 1884. He withdrew from active participation in the business of his firm in 1850 and afterwards took a leading share in the public affairs of his native city, Edinburgh, of which he became Lord Provost in 1862. His latter years were clouded with misfortune owing to the ill success that attended the management of his firm after his withdrawal and which in 1873 was handed over to a limited liability company.—*The Garden*, XI. (1877).

Cupressus lusitanica.

A medium-sized tree 40 — 50 feet high, in places considerably more, of variable habit, sometimes sub-pyramidal in outline, sometimes with a dense broadly conical or umbrella-like crown, and many intermediate forms. Primary branches irregularly disposed, close-set or distant, spreading, sub-pendulous or ascending, covered with reddish brown bark and much ramified at the distal end. Branchlets with

* Mayr, Waldungen von Nordamerika, 317. † Silva of North America, *loc. cit.*

tetrastichous ramification, the herbaceous (youngest) shoots more or less crowded, pinnately divided, recurved or arching, four-angled, bright or glaucous green, in particular trees the glaucescence greatly heightened. Leaves dimorphic: on the axial growths broadly ovate or ovate-oblong, acuminate, appressed, free at the acute tip; on the lateral shoots scale-like, deltoid-ovate, sub-acute, convex and glandular at the back, imbricated or concrescent. Staminate flowers very numerous, club-shaped, four-angled, light sulphur-yellow and composed of six—eight

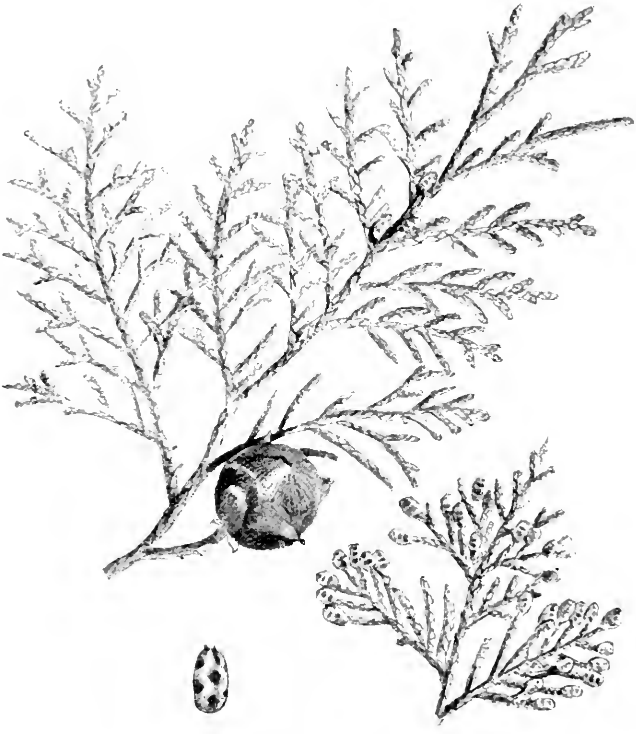


Fig. 60. *Cupressus lusitanica.*

anther-scales in decussate pairs. Strobiles shortly pedunculate, solitary or in twos and threes at or near the base of two-years-old lateral branchlets, globose or ovoid-globose, 0·5—0·75 inch in diameter; scales six—eight, sub-quadrate, prominently umbonate, very glaucous before maturity.*

Cupressus lusitanica. Miller. Dict. ed. VIII. (1768). Lambert. Genus Pinus. ed. II. Vol. I. t. 65. Loudon. Arb. et Frut. Brit. IV. 2477, with figs. Forbes. Pinet. Woburn. 187. t. 62. Carrière. Traité Conif. ed. II. 153. Gordon. Pinet. ed. II. 89. Masters in Journ. R. Hort. Soc. XIV. 206; and Journ. Linn. Soc. XXXI. 331.

C. glauca, Lamarck, Encycl. II. 243 (1786—1790). Endlicher. Synops. Conif. 58. Parlatore. D. C. Prodr. XVI. 470. Brandis, Forest Fl. N.W. Ind. 534. Hooker fil. Brit. Ind. V. 645. Masters in Gard. Chron. X. ser. 3 (1891), p. 761, with fig.

Eng. Cedar of Goa. Fr. Cédre de Goa.

* Communicated by the late M. Charles Naudin from the Villa Thuret Botanic garden, Antibes, and by Mr. F. W. Moore, Keeper of the Royal Botanic Gardens, Glasnevin, Dublin.

There is probably no existing coniferous tree whose origin is involved in so much uncertainty and whose claim to specific rank rests on such debatable ground as that described above.*

The earliest mention of *Cupressus lusitanica* occurs in a Portuguese poem entitled "Solidades de Busaco" by Ferreiro de Lacada, and published in 1634, at which date the tree must have been well established in Portugal, and since that epoch it has been cultivated not only in Portugal but also in the south of Europe generally, and where cultivated frequently spreading spontaneously, but nowhere is it believed to be indigenous. In the earliest systematic account of the flora of Portugal by Brotero published in 1804, it is stated that this Conifer using Lamarck's name *(Cupressus glauca)* was in cultivation at Busaco near Coimbra† and other places, and that it had been formerly introduced from Goa in India whence it obtained the vernacular name of "Cedar of Goa," a name still in use but which is altogether misleading, for the tree is not a Cedar at all, nor has it any direct connection with Goa, it having been ascertained by the Indian botanists that no Cypress grows wild anywhere near that place. The belief in its Indian origin, therefore, rests on no secure foundation, although it has been planted in many Indian gardens, both native and European, just as it is planted in gardens in Australia and other sub-tropical countries. Inferences drawn from a comparison of structural and morphological characters of *C. lusitanica* with those of its nearest affinities, *C. torulosa*, *C. sempervirens* and *C. Benthami*, are equally inconclusive, and the origin of the species, if species it is, still remains undetermined.

Ample evidence is afforded by herbarium specimens and by literary records that *Cupressus lusitanica* was cultivated in Great Britain in the seventeenth century, by Bishop Compton at Fulham, by the Duchess of Beaufort at Badminton, and by others, but it is not known from what source they obtained their plants. In the following century it was definitely named *C. lusitanica*, in reference to its supposed Portuguese origin, by Miller in the eighth edition of his Dictionary published in 1768, and although rare in England at the time, mention is made by him of large trees that had been killed in severe winters, notably those in the Bishop's garden at Fulham Palace, and one in the garden of the Duke of Richmond at Goodwood in Sussex, which had been growing there many years uninjured. From its first introduction this Cypress has been proved time after time to be too tender for the British climate generally, but there are still living some good specimens in the south and west of England and in Ireland, which attest its great beauty as an ornamental tree; especial mention may be made of one over 35 feet in height in perfect health and vigour, growing in the grounds of Mr. Thomas Acton at Kilmacurragh in the county of Wicklow, where it is associated with some of the rarest and most beautiful Conifers to be seen in Great Britain.

* The circumstances of its history here related are almost wholly derived from an interesting paper on "The Cedar of Goa," by Dr. Maxwell Masters in the "Journal of the Royal Horticultural Society," Vol. XVII.

† The finest specimens of *Cupressus lusitanica* are still to be seen at Busaco where there are upwards of 5,700 trees, among which more than 500 range from 50 to 250 years old, including one of colossal growth which is nearly 100 feet high, and its trunk has a girth of 12 feet at three feet from the ground.

Cupressus Macnabiana.

A medium-sized tree rarely exceeding 30 feet high, with a short trunk 12—15 inches in diameter; often a shrub with numerous stems 6—12 feet high forming a broad, open, irregular head. Bark cinnamon-brown broken into broad ridges. Branchlets slender with orange-red bark which soon changes to dark brown. Leaves dimorphic; on the axial shoots more or less elongated, concrescent but free at the acute tip; on the short lateral growths minute, scale-like, ovate-subulate, acute, light bluish green. Staminate flowers with six—eight very minute

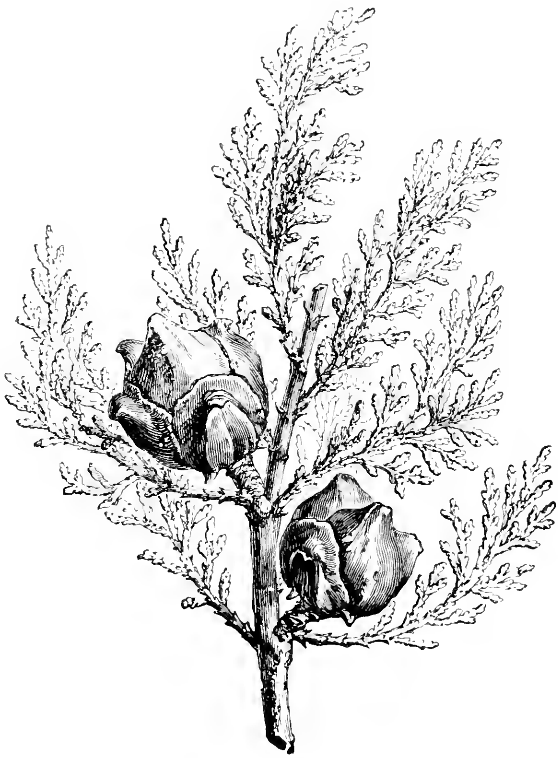


Fig. 61. *Cupressus Macnabiana.*
(From the *Gardeners' Chronicle.*)

stamens. Strobiles on short peduncles, sub-globose, 0·75 — 1 inch in diameter, composed of six—eight rugose, pale brown scales mostly of oblong shape, each with a prominent conical umbo and bearing numerous seeds furnished with narrow wings.

Cupressus Macnabiana, Murray in Edinb. New Phil. Journ. I. 293, t. 11 (1855). Lindley in Gard. Chron. 1855, p. 420. Carrière, Traité Conif. ed. II. 165. Parlatore, D. C. Prodr. XVI. 473. Gordon, Pinet. ed. II. 90. Brewer and Watson, Bot. Califor. II. 114. Masters in Gard. Chron. IX. ser. 3 (1891), p. 403, with fig. (Nabiana); Journ. R. Hort. Soc. XIV. 206; and Journ. Linn. Soc. XXXI. 347, with fig. Beissner, Nadelholzk. 100. Sargent, Silva N. Amer. X. 109, t. 528.

Cupressus Macnabiana was discovered by William Murray in 1854 while collecting seeds for Messrs. Lawson of Edinburgh in California, at the southern base of Mount Shasta, it is said, but this locality is doubted as it has not since been found there; it has recently been reported from the Shasta region, if the identification is correct, growing in groups near the highest limit of arborescent vegetation, at 15,000 feet elevation.* Its known habitat is, however, very restricted, being confined to a few dry slopes on the mountains south and west of Lake Clear.

> On the eastern slopes of Red Mountain is a stretch of *Cupressus Macnabiana* about half a mile square, scarcely mixed with any other tree. The trees are only from 12 to 20 feet high, but all have the appearance of great age. They are gnarled, twisted, covered with moss and with limbs broken, looking like an old forest of Cedar of Lebanon on a small scale; a fire has swept through one side, and the old stumps standing black and naked, aid the deception. On the western slope the aspect is not less curious; here the Cypress forms a dense thicket 6 to 8 feet high on the exposed hills, and 15 feet high in the gullies. Where the fires have occurred, seedlings are coming up, but not in great profusion; the little seedlings having the soil to themselves are of a fresh green, are quite shapely, and many of them grow into handsome trees. A few seeds carried down the stream to the gravelly flats in the valley have formed a grove of specimens of perfect pyramidal shape, as handsome as any in a park.†

In Great Britain this Cypress has been much neglected, doubtless from the same cause that has affected the cultivation of *Cupressus Goveniana*; it grows but slowly, and is not often so shapely as it is said to be in its native home; it is, however, quite hardy and readily distinguishable from every other species. It commemorates the horticultural and botanical labours of the late Mr. James McNab, for many years Curator of the Royal Botanic Gardens at Edinburgh.

JAMES MCNAB (1810—1878), one of the best practical gardeners of his time, was born at Richmond in Surrey, but his parents removed to Edinburgh within a few weeks after his birth. During the twelve years prior to 1834 he served as an apprentice and foreman in the Royal Botanic Gardens at Edinburgh, devoting much of his spare time to the study of Botany and to drawing plants; many of his drawings were reproduced in Sweet's "British Flower Garden," and other publications. In the year mentioned he travelled in Canada and the United States, and in 1835 he was appointed Curator of the Caledonian Horticultural Society's experimental garden at Inverleith, a situation which he held till 1849, in which year he succeeded his father as Curator of the Royal Botanic Gardens at Edinburgh. During his long tenure of the Curatorship many important additions were made to the gardens, including a space for Coniferæ, a Rock Garden, an Arboretum, etc., all of which were laid out by him. Besides his extensive practice in gardening, he was a frequent contributor to horticultural literature. He was one of the founders of the Edinburgh Botanical Society, of which he was President in 1872; he also took an active part in the affairs of the Scottish Oregon Association, through whose agency thousands of fine coniferous trees now flourishing in various parts of Scotland were introduced.

* C. H. Shinn in Garden and Forest, II. (1889), p. 598.
† Carl Purdy in Garden and Forest, IX. (1896), p. 233.

Cupressus macrocarpa.

A tree 50—70 feet high with a trunk 3—4 feet in diameter covered with thickish bark fissured into broad ridges, the branches stout and spreading, in old age becoming tabuliform like those of a Cedar of Lebanon. In Great Britain a rapidly growing tree, varying in habit from broadly pyramidal with long spreading branches to strictly fastigiate with erect branches, forms intermediate between these extremes being far more frequent than either. Trunk mostly simple in the fastigiate forms, often more or less divided in the spreading and intermediate forms. Bark thin, reddish brown, peeling off in longitudinal shreds. Branches numerous, thickly set and much ramified, the branchlets slender with orange-brown bark and tetrastichous (four-ranked) ramification, the herbaceous shoots similarly ramified. Leaves bright grass-green, dimorphic; on the axial growths oblong, acute, concrescent except at the acute tip; on the lateral growths smaller, deltoid-acicular and imbricated. Staminate flowers about one-eighth of an inch long, four-angled, consisting of eight stamens in decussate pairs each with an ovate connective bearing four—five anther cells. Strobiles sub-globose, 1—1·5 inch in diameter, in clusters of five—nine or more on short stout peduncles and composed of eight—ten decussate pairs of rhomboidal, striated scales thickened at the centre into an obtuse umbo, of which the upper and lowermost pairs are sterile, the fertile scales bearing from twelve to twenty seeds each.

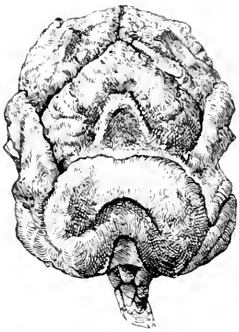


Fig. 62. Strobile of *Cupressus macrocarpa*.

Cupressus macrocarpa, Hartweg in Journ. Hort. Soc. Lond. II. 187 (1847). Gordon, Idem, IV. 296, with fig. (1849); and Pinet. ed. II. 91. Parlatore, D. C. Prodr. XVI. 473. Brewer and Watson, Bot. Califor. II. 113. Lawson, Pinet. Brit. II. 195, tt. 32, 33. Hooker fil in Gard. Chron. XXIII. (1885), p. 176, with fig. Sargent in Garden and Forest. VII. (1894). p. 241, with fig.; and Silva N. Amer. X. 103, t. 525. Beissner, Nadelholzk. 103. Goldring in The Garden, L. (1896), p. 140, with fig. Masters in Journ. R. Hort. Soc. XIV. 206; and Journ. Linn. Soc. XXXI. 342.

C. Lambertiana. Carrière, Traité Conif. ed. I. 124 (1855); and ed. II. 166 (1867).
C. Hartwegii. Carrière, Traité Conif. ed. II. 168.

Eng. and Amer. Monterey Cypress. Lambert's Cypress. Fr. Cyprès à grands fruits. Germ. Grossfrüchtige Lebensbaum Ital. Cipresso a grosso frutto.

var.—Crippsii.

A so-called "plumose" form, the leaves instead of being appressed are more or less spreading; the branchlets shorter, more rigid, with the tips of all the youngest growths light yellow.

var.—lutea.

Also a "plumose" form with the whole of the current season's growths light yellow which changes to the normal green of the species in the second year.

The habitat of *Cupressus macrocarpa* is extremely restricted: it is known to grow spontaneously only on a small area south of

Monterey in California. The trees occur in small groups or solitary in a narrow belt about two miles long and scarcely more than two hundred yards wide, extending along the coast from Cypress Point southwards to Carmel Bay, mingling gradually with *Pinus radiata* inland.

This very restricted habitat is ascribed to the gradual drying of the Californian climate and to the direct action of forest fires which are

Fig. 63. Old Cypresses (*Cupressus macrocarpa*) near Monterey, South California. (From the *Gardeners' Chronicle*.)

almost of annual occurrence towards the end of the hot dry summers of South California. One bad forest fire would sweep away every existing Cypress tree in the grove. Few seedlings are to be seen; animals are allowed to browse at will in the grove and destroy all seedlings as they spring up, and by impoverishing the soil hasten the decay of the older trees.* Here is portrayed a condition of things that clearly forebode the extinction of the tree in its native habitat, but such a catastrophe would be but an episode in its history, and would

* Garden and Forest, VII. (1894), p. 241.

by no means result in the fate which threatens its near neighbour, *Abies bracteata*. *Cupressus macrocarpa* has been planted in thousands throughout the Pacific States, in the warmer parts of Europe and even in Australia, and produces seeds freely, so that its disappearance from the rocky shore of Monterey would in no way affect its perpetuation in other localities.

According to Gordon the introduction of this beautiful Cypress into British gardens took place in this wise:—

"In 1831 Mr. Lambert gave the Horticultural Society of London a few seeds of a Cypress without any name or indication of origin, and from these seeds plants were raised which in due course were seen to be distinct from any previously known species. The name *Cupressus Lambertiana* was applied to them in compliment to Mr. Lambert but not published. Nothing was ascertained concerning its native country till two or three years afterwards when plants of the same kind were observed in Mr. Low's nursery at Clapton which had been raised from seeds received from Dr. Fischer, Director of the Imperial Botanic Garden at St. Petersburg, as a new species of Cupressus from California. The tree was re-discovered by Hartweg in 1846 near Monterey and named by him *Cupressus macrocarpa* in reference to its large fruits."*

Large trees of *Cupressus macrocarpa* ranging from 50 to over 80 feet high are scattered over the country from Perthshire to Cornwall and also throughout Ireland. And even in Orkney it is reported to be one of the most valuable Conifers that have been tried in the island, standing the strong winds without any signs of injury.† Although generally speaking it is hardy in the climate of Great Britain, the fact that many fine specimens have been killed or greatly injured in exceptionally severe winters as that of 1860–1861, should not be overlooked, and therefore it is inadvisable to plant it in situations too exposed. It is one of the best of Conifers for parks and gardens near the sea except along the east coast; under the influence of the sea air it grows rapidly into dense pyramidal or columnar piles of the brightest green. Very different from these is the aspect of *Cupressus macrocarpa* in its native home, where, on the rocky granite shore of South California, it is constantly exposed to the strong westerly winds which sweep with full force over the Pacific Ocean. These winds prevent the development of branches except in a horizontal direction, so that under their influence all old trees assume a form such as that shown in the accompanying figure which represents a sketch of a group of trees made by Sir Joseph Hooker in September 1877. Many visitors to South California who have seen the Cypresses near Monterey have been struck by their close resemblance to old Cedars of Lebanon in Europe.

Cupressus nootkatensis.

A large tree with an erect trunk often attaining a height of 80—120 feet with a diameter of 3—4 feet: at its northern limit and highest vertical elevation reduced to a small shrub or low contorted tree. Bark greyish brown, irregularly fissured into loose thin plates which on being peeled off expose a bright cinnamon-red inner cortex. Primary

* Journal of the Horticultural Society of London, *loc. cit. supra*.
† Dunn's Census in the Report of the Conifer Conference at Chiswick, p. 526.

branches spreading, often ascending at the tips and covered with smooth brown bark. Branchlets stoutish, distichous and alternate, their ramification similar and three or four times repeated. Leaves in decussate pairs; on vigorous branchlets, ovate, acute, free at the apex, 0·25—0·5 inch long; on the younger lateral branchlets broadly subulate, imbricated or concrescent, one-eighth of an inch long, light glaucous green; where shaded, dark lustrous green. Staminate flowers small, oblong, composed of four—five pairs of pale sulphur-yellow stamens. Strobiles sub-globose, about 0·5 inch in diameter, consisting of six—eight scales each with a pointed umbo and bearing two—four seeds.

Cupressus nootkatensis, Don in Lambert's Genus Pinus, II. 18 (1824). Hooker, Fl. Amer. Bor. II. 165 (nutkaënsis). Hoopes, Evergreens, 345. Gordon, Pinet. ed. II. 94. Lawson, Pinet. Brit. II. 199, t. 34. Masters in Journ. R. Hort. Soc. XIV. 206; and Journ. Linn. Soc. XXXI. 352. Sargent, Silva N. Amer. X. 115, t. 530.

Chamæcyparis nutkaënsis, Spach, Hist. Veg. Phan. XI. 333 (1842). Endlicher, Synops. Conif. 62 (1847). Carrière, Traité Conif. ed. II. 127. Parlatore, D. C. Prodr. XVI. 465. Syme in Gard. Chron. XI. (1879) p. 560. Beissner, Nadelholzk. 79, with figs.

Thujopsis borealis, Fischer, ex Carrière, Traité Conif. ed. I. 113.

Eng. Nootka Sound Cypress. Amer. Yellow Cypress, Sitka Cypress. Fr. Cyprès de Nutka. Germ. Nutka-Lebensbaum. Ital. Cipressa di Nootka.

Although as long and almost as assiduously cultivated in this country as the closely allied species *Cupressus Lawsoniana*, *C. nootkatensis* has shown but little tendency to sport into abnormal forms; it has for the most part preserved under cultivation a constancy in form and colour as remarkable, relatively speaking, as the ever varying divergencies occurring in *C. Lawsoniana*. The following are the most noteworthy varieties occasionally met with in British gardens.

Varieties distinguished by habit.

var.—compacta.

Of dwarf dense growth, the short trunk much divided and much branched, the branchlet systems smaller and less flaccid than in the type.

var.—gracilis.

A small tree or shrub, usually the latter, much branched and of globose outline; the branchlets and terminal growths more slender than in the type.

var.—pendula vera.

In this form the primary branches are more distant, and with their appendages all more or less depressed, more slender and more elongated, and occasionally quite pendulous.

Varieties distinguished by colour.

var.—argenteo-variegata.

In this variety many of the youngest branchlet systems or parts of them are cream-white, affording a strong contrast to the dark green of the other parts.

var.—aureo-variegata.

Similar to the preceding except that the youngest branchlet systems or parts of them are bright golden yellow instead of cream-white.

var.—lutea.

In this variety the whole of the current year's growth is at first light yellow which changes gradually towards the end of the summer to bright grass-green.

Cupressus nootkatensis was originally discovered by Archibald Menzies in 1793, from whose herbarium specimens gathered on the shore of Nootka Sound it was first described by David Don in Lambert's "Genus Pinus." It was introduced into European gardens through the Imperial Botanic Garden at St. Petersburg about the year 1850, and became distributed under the unpublished name of *Thujopsis borealis*. It is essentially a northern tree, inhabiting a maritime region of considerable extent in north-west America. From Sitka it spreads southwards through the islands and along the coast range of Alaska and British Columbia from sea-level up to 2,000—3,000 feet elevation. It is abundant in Queen Charlotte's Island, on the Olympian mountains in Washington and on the slopes of Mount Raines, but becomes quite rare as it approaches its southern limit in Oregon. It is one of the most valuable timber trees in the region over which it is spread, being unsurpassed by any other North American tree for the manufacture of household furniture and indoor carpentry. "The wood is light and hard, close-grained, exceedingly durable in contact with the soil, easily worked and susceptible of receiving a beautiful polish."*

As a tree for British lawns and pleasure grounds *Cupressus nootkatensis* is one of the most appreciated, being perfectly hardy and thriving in any ordinary soil not too dry. None of the forms into which it has sported under cultivation surpasses in effectiveness the originally introduced type, which is so well marked by its broadly conical outline and deep green foliage† that it may be distinguished without difficulty from *C. Lawsoniana*, for which it is occasionally mistaken. The two species are also further distinguished thus:—*C. nootkatensis* rarely, if ever, grows into the dense columnar or tower-like shape so common to *C. Lawsoniana*; the frondose, leafy branchlets of the former are shorter, stouter and frequently more pendulous; the staminate flowers are sulphur-yellow, not crimson as in *C. Lawsoniana*, and the strobiles are larger, usually with one more pair of scales that have a sharper umbo.

* Silva of North America, Vol. X. p. 116.

† Strikingly beautiful are the fine specimens of this form standing on each side of the drive leading to Streatham Hall, Exeter, the residence of Mr. R. Bowerman West. The trees, 25 to 30 feet in height, are twenty-four in number, of which twelve have their branchlets more pendulous than the others. Many more equally good are standing in different parts of the grounds.

Cupressus obtusa.

A tall tree, attaining a height of 70—100 or more feet, with a straight trunk 2·5—3 feet in diameter near the ground, denuded of branches for one-half or more of the height, often with a rounded top and sub-pendulous branches, the trunk covered with reddish bark. In Great Britain the oldest trees have a broadly pyramidal outline; the bark of the trunk thin, peeling off in longitudinal flakes exposing a cinnamon-brown inner cortex. Primary branches close-set, spreading, often more or less curved, the lowermost depressed at the outer extremity. Ramification of branchlets distichous and repeated three times in a tri-pinnate manner; bark reddish brown, slightly verrucose, that of the younger

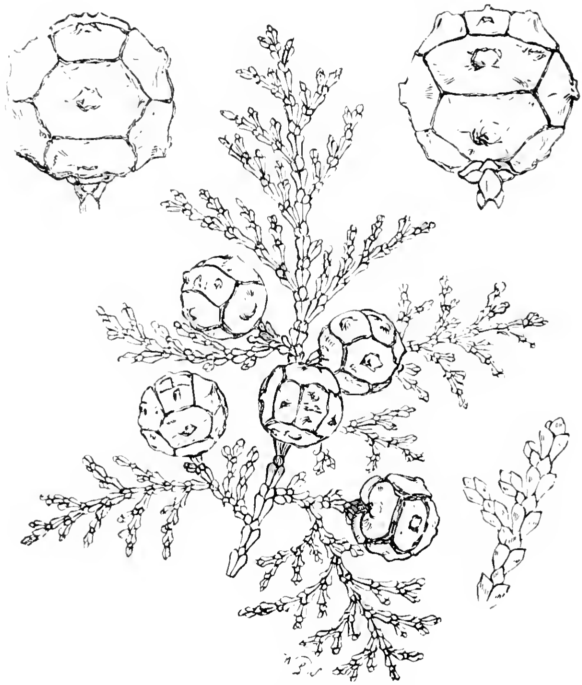


Fig. 64. *Cupressus obtusa.*
(From the *Gardeners' Chronicle.*)

shoots orange-brown. Leaves persistent on the axial growths four—five years, ovate-oblong, sub-acute, concrescent, in decussate pairs, the smaller dorsiventral pair flat, the larger lateral pairs keeled and often glandular; both pairs greatly elongated on fast-growing shoots and free at the acute tip, dark lustrous green. Staminate flowers oval or sub-cylindric, pale yellow. Strobiles solitary on the ends of short lateral branchlets, globose, about 0·5 inch in diameter and composed of eight, rarely ten sub-ligneous brown scales each with a short umbo and bearing two—six seeds.

Cupressus obtusa, Koch, Dendrologie. II. 168 (1873). Masters in Journ. R. Hort. Soc. XIV. 207; and Journ. Linn. Soc. XXXI. 355.

Chamaecyparis obtusa, Endlicher, Synops. Conif. 63 (1847). Parlatore, D. C. Prodr. XVI. 466. Carrière, Traité Conif. ed. II. 129. Beissner, Nadelholzk. 92, with fig.

Retinispora obtusa, Siebold et Zuccarini, Fl. Jap. II. 38, t. 121 (1842). Gordon, Pinet. ed. II. 367 (Retinospora).* Syme in Gard. Chron. V. (1876). p. 235, with figs. Kent in Veitch's Manual, ed. I. 245, with fig.

Thuya obtusa, Masters in Journ. Linn. Soc. XVIII. 491, with fig.

Eng. Japanese Cypress. Fr. Cyprès japonnais. Germ. Sonnencypresse. Ital. Cipresso giaponese. Jap. Hi-no-ki.

Amongt the many varieties and sub-varieties of *Cupressus obtusa* which have originated under cultivation either in Japan or in European gardens† the following retain their distinctive character more or less permanently. They are all better known in British gardens as Retinosporas and in continental gardens as Chamæcyparis forms.

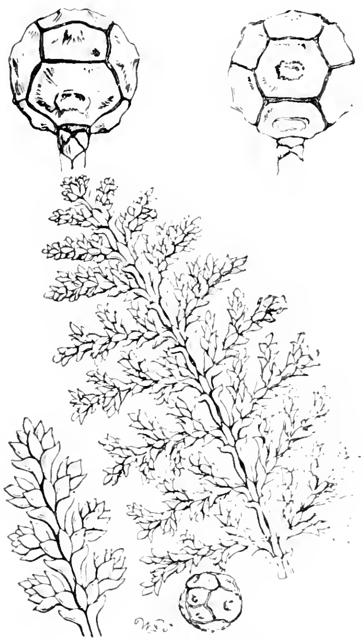


Fig. 65. *Cupressus obtusa*, var. *filicoides*.

var.—aurea.

Of smaller dimensions and more slender habit than the species; branchlets and foliage of a deep golden yellow which is usually highly developed during the growing season and which changes to dark green in the second year.

var.—compacta.

A robust, dwarf form in which the stem is much divided at the base, the branches short, numerous and crowded, and the branchlet systems somewhat smaller in all their parts.

var. filicoides.

Of dwarfer and denser habit than the common form. The branches are thickly furnished with short fern-like opposite branchlet systems of nearly equal size. The leaves are closely imbricated in four rows, thick in texture and of a rich deep green colour. **filicoides aurea** (syn. *tetragona*)—of slower growth and dwarfer habit than *filicoides*, and with all its branchlet systems rich golden yellow.

C. obtusa filicoides, *supra*. Retinispora filicoides, Gordon, Pinet. ed. II. 361. Syme in Gard. Chron. V. (1876). p. 235, with fig. Thuya obtusa filicoides, Masters in Journ. Linn. Soc. XVIII. 491.

To this form probably belongs *Chamaecyparis breviramea*. Maximowicz in Bull. Acad. St. Petersb. X. 489 (1866).‡

* Retinospora errore auctorum fere omnium nisi Endlicher.

† Beissner enumerates and describes upwards of twenty, Nadelholzkunde, pp. 93—97.

‡ Seen by him cultivated in gardens around Tokio and on the north coast of the island of Kiusiu mixed with the normal *Cupressus obtusa*.

var.—Keteleerii.

As seen in British gardens—of denser habit and more regular outline than the typical form; the branchlets and foliage of a deeper green with many of the terminal growths light yellow.

var.—lycopodioides.

A low tree of conical, but sometimes of irregular outline, with thicker branches and branchlets, the latter numerous and irregularly arranged on all sides of the axial growth, more closely set at the extremities where they are frequently more or less fasciated; leaves crowded, thickened, closely adpressed and of a deep green colour.

C. obtusa lycopodioides, *supra*. Retinispora lycopodioides, Gordon, Pinet. ed. II. 364. Chamæcyparis obtusa lycopodioides, Carrière, Traité Conif. ed. II. 132.

var.—Mariesii.

Differs from the typical form in having all the terminal growths of the current year light yellow or cream-white.

var.—pendula.

A pendulous variety with long stoutish spreading branches and slender, elongated pensile branchlets which originated from Japanese seed sown in the garden of Prince Lobkowitz at Eisenberg in Bohemia.*

C. obtusa pendula, *supra*. Chamaecyparis obtusa pendula, Beissner. Nadelholzk. 96.

var.—pygmæa (syn. *nana*).

A singular little bush rarely exceeding a foot high: it spreads horizontally on all sides forming a dense tuft of green sprays as ornamental as it is curious.

Cupressus obtusa is one of the few instances occurring in the Coniferæ whose native country is unquestioned but whose existence in the wild state is either altogether unknown or involved in much uncertainty. It is undoubtedly endemic in Japan, but the presence of a dense population with its constantly recurring need of timber for constructive purposes, for which that of *C. obtusa* is one of the very best the country produces, has long since brought about the destruction of every accessible wild tree. Two potent causes have, however, contributed to preserve the species from extinction:—The tree is held sacred by the followers of the Shinto faith whose temples are built exclusively of its timber, but at the same time it is always planted in numbers around them and these trees are carefully guarded from injury:—its timber is the best in the country for the interior of the more expensively furnished houses, being strong, fragrant, fine in grain and susceptible of a high polish.† It

* Probably not identical with the *Cupressus obtusa pendula* of Maximowicz seen by him in Japanese gardens around Tokio, but not known to be in cultivation in Europe.

† Sargent. Forest Flora of Japan, p. 73. The palaces of the Mikado at Kioto are built of the wood of *Cupressus obtusa*.

is also the best to lacquer, a process carried to great perfection in Japan, and to secure a supply of its valuable wood, *C. obtusa* has been for ages past and is still being extensively planted on the lower slopes of the mountains in the interior of Hondo up to 3,000 feet elevation. It has also been cultivated by the Japanese for the decoration of their gardens from time immemorial, and many distinct varieties of it have been obtained by them: amongst these are the forms described above under the names of *aurea*, *filicoides*, *lycopodioides* and *pygmaea*, all of which were introduced along with the species in 1861. They clip, contort and dwarf plants of this species and *C. pisifera* into many grotesque and monstrous shapes; the illustration represents a plant of great but unknown age so treated.

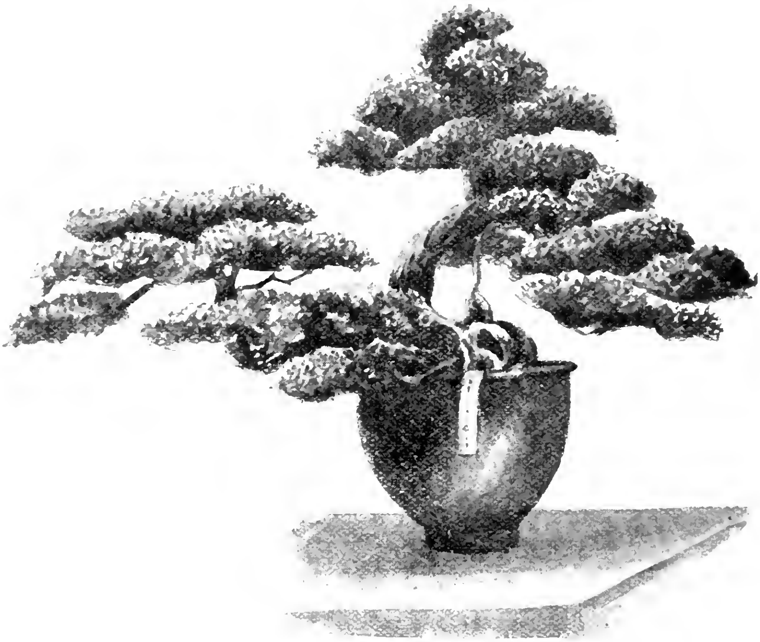


Fig. 66. A Japanese specimen of a dwarfed plant of *Cupressus obtusa* or *C. pisifera*.

Cupressus obtusa has its homologue in *C. Lawsoniana* of western America, but unlike that species when transplanted to British gardens it will not grow everywhere. It forms handsome specimens in good retentive soils with a porous substratum such as are found in the sandy loams of Gloucestershire and Devonshire, in the Kentish rag around Maidstone, on the Wealden clay generally, and in the light loams of Dumbarton, Midlothian, County Down and other parts of Scotland and Ireland; in chalk soils and soils with a limestone substratum it usually fails entirely.

Cupressus pisifera.

A smaller and more slender tree than *Cupressus obtusa* with which it is everywhere associated in Japan, and generally with a more open crown and the trunk covered with darker bark which (in England) peels off in longitudinal flakes exposing a cinnamon-brown inner cortex. Primary branches slender, spreading or more or less depressed and sparingly ramified except at the distal end; secondary branches and branchlets ramified as in *C. obtusa*. Leaves persisting green (ex Siebold) five years, in England becoming effete in the third, rarely in the

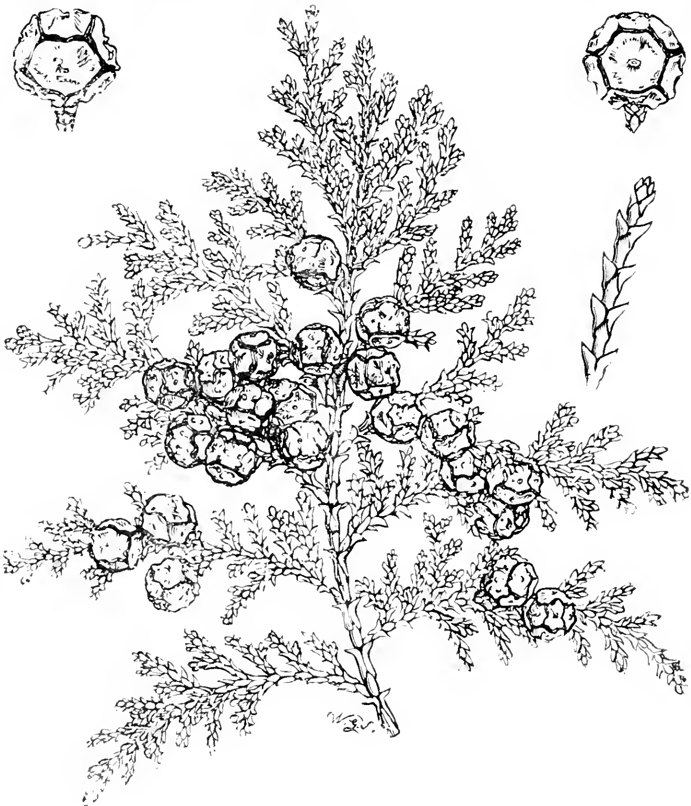


Fig. 67. *Cupressus pisifera.*
(From the *Gardeners' Chronicle.*)

fourth year, ovate-oblong, acute, elongated on the axial growths, imbricated or concrescent, free at the apex, dark green, but during the growing season with a decided yellow-brown tint where fully exposed to the sun, marked with white marginal lines on the under side of the branchlets. Staminate flowers cylindric, obtuse with eight—ten stamens in decussate pairs. Strobiles sub-globose, not larger than an ordinary garden pea,* composed of ten—twelve scales obscurely five or

* Whence the specific name *pisifera* (pea-bearing).

six-angled in outline, slightly depressed and with a minute umbo in the centre of the exposed surface.

Cupressus pisifera, Koch, Dendrologie. II. 170 (1873). Masters in Journ. R. Hort. Soc. XIV. 207; and Journ. Linn. Soc. XXXI. 355.

Chamaecyparis pisifera, Endlicher, Synops. Conif. 64 (1847). Carrière. Traité Conif. ed. II. 132. Parlatore, D. C. Prodr. XVI. 465. Beissner, Nadelholzk. 83, with figs.

Thuya pisifera, Masters in Journ. Linn. Soc. XVIII. 489 (1881).

Retinispora pisifera, Siebold and Zuccarini, Fl. Jap. II. 39, t. 122 (1842). Gordon, Pinet. ed. II. 369 (Retinospora). Syme in Gard. Chron. V. (1876), p. 235, with fig.

Eng. Pea-fruited Retinispora or Japanese Cypress. Fr. Cyprès à fruit de pois. Germ. Erbsenfrüchtige Cypresse. Jap. Sa-wa-ra.

Fig. 68. *Cupressus pisifera*, var. *filifera*.

A large number of deviations from the normal form have appeared both in Japanese and European gardens, of which only those that are constant in their most obvious varietal character are here described.

var.—aurea.

This has the whole of the growths of the current season rich golden yellow which changes to the normal green of the species in the following year. It is quite distinct from the variety *plumosa aurea* described below. **sulphurea** is similar, but of a much paler yellow.

var.—filifera.

A low tree or sub-prostrate shrub in which both the primary branches and the axial growths of the branchlet systems are greatly elongated at the expense of the lateral shoots which are distant, short and sparsely ramified. Leaves more distant, more acute and less appressed than in the type, and fulvous green in colour. **filifera aurea** has all the terminal growths light golden yellow; **filifera gracilis** is a dwarfer form with more slender terminal shoots.

C. pisifera filifera, Masters in Journ. R. Hort. Soc. XIV. 207. Chamæcyparis pisifera filifera, Beissner, Nadelholzk. 90, with fig. Retinispora filifera, Gordon, Pinet. ed. II. 364. Syme in Gard. Chron. V. (1876), p. 235. Chamæcyparis pendula, Maximowicz in Bull. Acad. Sc. Petersb. X. 489.

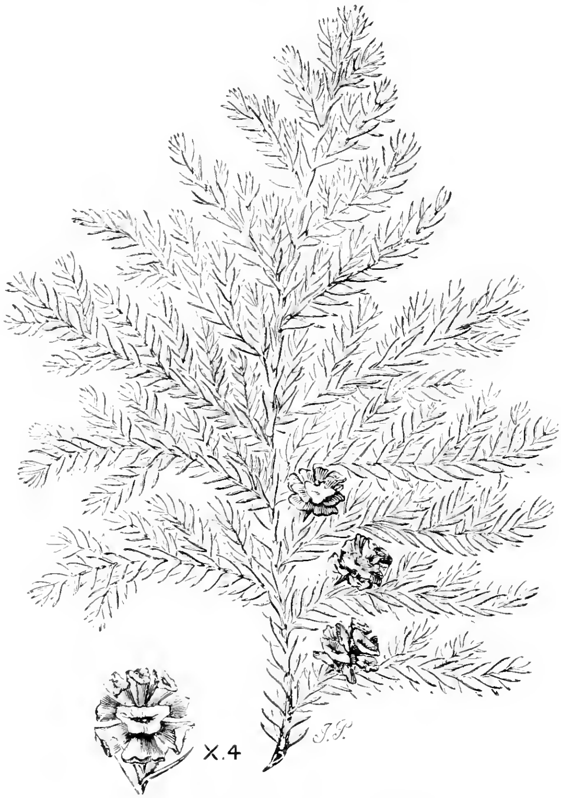


Fig. 69. *Cupressus pisifera*, var. *squarrosa*.

var.—plumosa.

A smaller tree of denser habit and more strictly conical outline, with numerous short ascending branches thickly furnished with lateral shoots; branchlet systems decurved at the distal end. Leaves awl-shaped, more or less spreading, dark green. **plumosa albo-picta** has the tips of the branchlets cream-white, imparting to the plant a speckled and spotted appearance. **plumosa argentea** has nearly the whole of the young growths cream-white which becomes green in the following season. **plumosa aurea** has its terminal shoots with their foliage light golden yellow which gradually subsides to deep green as the season advances, and is succeeded in the following year by a renewal of the yellow growth.

C. pisifera plumosa. Masters in Journ. R. Hort. Soc. XIV. 207; and Journ. Linn. Soc. XXXI. 358. Chamaecyparis pisifera plumosa. Beissner, Nadelholzk. 87. Retinispora plumosa, Gordon. Pinet. ed. II. 370. Syme in Gard. Chron. V. (1876), p. 235. with fig.

var.—squarrosa.

A low tree, sometimes taking the form of a large bush of irregular outline. Trunk usually divided and forked near the base, the branches much ramified; branchlets spreading and furnished with short flattened acicular leaves in decussate pairs and of almost silvery whiteness.

C. pisifera squarrosa. Masters in Journ. R. Hort. Soc. XIV. 207; and Journ. Linn. Soc. XXXI. 358. Chamaecyparis pisifera squarrosa. Beissner, Nadelholzk. 85, with fig. Retinispora squarrosa. Siebold and Zuccarini. Fl. Jap. II. 40. t. 123. Carrière. Traité Conif. ed. II. 137. Gordon. Pinet. ed. II. 371.

Fig. 70. Clipped trees of *Cupressus obtusa* or *C. pisifera* near Tokio, Japan.

The notes relating to the habitat of *Cupressus obtusa* and the uses to which it is applied in Japan are equally applicable to *C. pisifera** except that the latter is not held sacred by the Japanese in so high a degree as the former and that its timber is not so valuable. Although almost always found growing together and in old age scarcely distinguishable from each other, they have long been recognised as distinct species by the Japanese who designate each by different vernacular names, calling *C. obtusa* Hi-no-ki and *C. pisifera* Sa-wa-ra. *C. pisifera* and all its varieties of Japanese origin that are in cultivation in this country were introduced by the late Mr. John Gould Veitch in 1861.

* The habitat of *Cupressus pisifera* is probably not confined to Japan; it was gathered by Dr. Anderson in the Chinese province of Yun-nan in 1870—1871, but whether wild or cultivated is not stated.

Comparing *Cupressus pisifera* with *C. obtusa*.—In Japan the latter is the larger tree, in Great Britain this proportion is thus far reversed, *C. pisifera* being the taller and freer grower. Both in habit and aspect the two species may be readily distinguished from each other: *C. obtusa* has a more regular outline; it is denser in aspect and deeper in colour: in *C. pisifera* the branches both primary and secondary are usually longer and more slender, and what is of more value in a botanical sense, the cones are much smaller with differently shaped scales, and the scale-like leaves are more acute, more distinctly free at their apical end and are marked with white lines on the under side of the branchlets.

The varieties of *Cupressus pisifera* are among the most ornamental of trees and shrubs, and are especially suitable for small gardens; they thrive in a greater variety of soils and situations than the varieties of *C. obtusa* and will often grow where the latter fail. *Plumosa* and its coloured sub-varieties are transitional or intermediate forms between the primordial and adult states; they take the highest rank as horticultural plants among the so-called "plumose" forms; they are not only in general use in several departments of out-of-door gardening but they are also much cultivated in pots for windows in London and other large towns. The variety *squarrosa*, a remarkably distinct one, was first seen in cultivation around Tokio by Siebold and afterwards by Maximowicz, both of whom described it as a distinct species, its real origin being unknown to them. As pointed out by Beissner, it is a "Jugend-form" that has been perpetuated from cuttings of *C. pisifera* with primordial leaves only. Since its introduction into Great Britain sterile cones have been occasionally produced which are identical in structure with those of the parent. More rarely branch-sports (Sportzweige) have appeared with the adult foliage of *C. pisifera*, thus confirming its origin.

Cupressus sempervirens.

A tree of variable height and habit but usually recognisable in two distinct forms: the one with spreading branches and of broadly pyramidal or conical outline, but in old age with an open head and of irregular outline; the other with upright branches more or less appressed to the trunk and to each other, forming a flame-shaped or columnar tree of dense aspect. Branches terete with smooth reddish brown bark much ramified at the distal end; ramification tetrastichous (four-ranked), the herbaceous shoots short, pinnately branched and falling off in the third or fourth year. Leaves on the axial growths broadly ovate or ovate-oblong, obtuse or abruptly mucronate, concrescent, rarely free at the apex, becoming effete the second or third year; on the lateral and herbaceous shoots much smaller, scale-like, broadly ovate or rhomboid-oblong, closely imbricated and marked with a gland on the back. Staminate flowers oblong, about one-eighth of an inch long, pale orange-yellow, containing ten—twelve anthers in decussate pairs. Strobiles mostly in clusters of two—five, rarely solitary, subsessile or shortly pedunculate, very variable in size and shape, composed of eight—twelve subquadrate or obscurely pentagonal scales, smooth or slightly rugose, and with a rather blunt pyramidal umbo.

Cupressus sempervirens, Linnaeus. Sp. Plant. II. 1002 (1753.) Pallas. Fl. Ross. I. 11. t. 53 (1784). L. C. Richard. Mém. sur les Conif. 50 (1826). London, Arb. et Frut. Brit. IV. 2464, with figs. (1838). Parlatore. D. C. Prodr. XVI. 468. Gordon. Pinet. ed. II. 95. Boissier. Fl. orient. V. 705. Hooker fil. Fl. Brit. Ind. V. 645. Beissner. Nadelholzk. 102, with fig. Masters in Journ. R. Hort. Soc. XIV. 208; and Journ. Linn. Soc. XXXI. 325. And many others.

C. horizontalis. Miller. Dict. ed. VIII. (1768). Endlicher. Synops. Conif. 56. Carrière. Traité Conif. ed. II. 144.

C. sempervirens horizontalis. Parlatore. D. C. Prodr. *loc. cit.* Gordon. Pinet. ed. II. 96.

C. fastigiata. De Candolle. Flore Française. V. 336. Endlicher. Synops. Conif. 57. Carrière. Traité Conif. ed. II. 146.

C. sempervirens stricta. London, Arb. et Frut. Brit. IV. 2465.

C. sempervirens fastigiata. Beissner. Nadelholzk. 102.

C. Whittleyana. Gordon. Pinet. ed. II. 102.

Eng. Roman Cypress. Fr. Cyprès commun. Germ. Echte Cypresse, Säulenförmige Cypresse. Ital. Cipresso columnare. κυπάρισσος of Homer.

Cupressus sempervirens is common throughout the Mediterranean region from Portugal to Syria, the fastigiate form being often seen in striking contrast to its surroundings and not infrequently a conspicuous feature of the landscape. It also occurs wild in Asia Minor and northern Persia, and planted in north-west India where it sometimes attains a height of 100 feet with a trunk nine feet in girth near the ground. An hypothesis, strongly supported by circumstantial evidence, has been advanced that the common Cypress, although growing spontaneously in many parts of southern Europe, is really of eastern origin, and that it has spread westwards chiefly through human agency. The two forms have been known from time immemorial, and whilst some authors have adopted the fastigiate one as the type and the horizontal-branched as a variety, others have adopted a reversed view, and others again have described them as distinct species. From analogy with fastigiate forms of other species as *C. macrocarpa*, *C. Lawsoniana* and even the common oak whose origin is known, it would be safest to infer that the fastigiate is a divergence from the horizontal-branched form. That the two are not specifically distinct we have the authority of Parlatore for stating that upright and spreading branches have been observed on the same tree, and that the two are connected by intermediate forms in which the gradation from one to the other is plainly perceptible.* Both on the continent of Europe where sufficiently hardy, and also in Great Britain, horticulturists have always preferred the fastigiate form and many remarkable arboricultural effects have been produced by it, especially in Italy. *C. sempervirens* was cultivated in Great Britain prior to 1548 in which year it was included by Turner in his "Names of Herbes."

The Cypress is mentioned by many ancient authors from the poet Homer downwards to the end of the classic period, sometimes in connection with funeral rites and sometimes in reference to rural

* De Candolle's Prodromus. Vol. XVI. p. 469.

economy; its name also occurs in Holy Writ. In the Middle Ages the Cypress became associated in the south of Europe with cemeteries and places of worship, much in the same way as the Yew in more northern countries; and later when horticulture became more generally practised, it was, and is still much used in terrace and other gardens laid out and planted to enhance architectural effect. In the Mediterranean region it lives to a great age, and frequently attains a large size. There are in France and Italy ancient Cypresses of historic interest, and others associated with illustrious names in literature and art. The Cypress of Somma in Lombardy, figured by Loudon, is one of the most famous; "besides its great age it is remarkable for having been wounded by Francis I., King of France, who is said to have struck his sword into it in his despair at losing the battle of Pavia; and for having been respected by Napoleon, who, when laying down the plan for the great road over the Simplon, diverged from the straight line to avoid injuring this tree."* Three Cypresses of the fastigiate form in the garden of the Convent of the Chartreuse at Rome, planted by Michael Angelo (1474—1563), are still standing, one in a state of decay, the other two in robust health. One of the oldest and largest Cypresses in France is standing near St. Remy in Provence, and is supposed to be upwards of four hundred and fifty years old; and Carrière gives the dimensions of a venerable tree standing near Montpellier supposed to be eight hundred years old and known to the inhabitants of the neighbourhood as "L'arbre de Montpellier."†

The economic value of *Cupressus sempervirens* is restricted to the amount of timber available for use which does not appear to be very considerable. The wood is virtually indestructible by ordinary agents except fire; this remarkable durability was known to the Greeks and Romans who employed Cypress-wood in the construction of various articles of furniture, also for vine-props, posts and palisades, and especially for coffins which were found to resist decay for ages after being buried in the earth.

Cupressus thurifera.

A tree 50—60 feet high with spreading branches, the lower ones reflexed at the apex.‡ Branchlets slender, the axial growths at first pale green but changing to orange-brown in the second year; ramification tetrastichous, the herbaceous growths very slender and bipinnately branched, light green. Leaves in decussate pairs, oblong-lanceolate, acuminate, imbricated and free at the acute tip; on the axial growths longer, glandular on the back, concrescent to beyond the middle and becoming effete in the second or third year. Staminate flowers numerous, oblong, obtuse, with eight—ten anthers. Strobiles globose or sub-globose, somewhat less than an inch in diameter, composed of six ligneous scales in decussate pairs each bearing two—three wingless seeds.

* Arboretum et Fruticetum Britannicum, IV. 2471.

† Traité Général des Conifères, ed. II. p. 149.

‡ Ex Kunth, *loc. cit.* Hartweg reported that he saw *Cupressus thurifera* near Real del Monte, 120 feet high. Transactions of the Horticultural Society of London, ser. II. Vol. III. p. 124.

Cupressus thurifera, Humboldt, Bonpland and Kunth, Nov. Gen. et Sp. II. 3 (1815). Schlechtendal in Linnæa, XII. 493 (1838). Parlatore, D. C. Prodr. XVI. 473. Gordon, Pinet. ed. II. 100. Masters in Journ. Linn. Soc. XXXI. 349.
C. lusitanica Benthamii, Carrière, Traité Conif. ed. II. 155.
Chamæcyparis thurifera, Endlicher, Synops. Conif. 62.

Cupressus thurifera was originally discovered by Humboldt at the beginning of the nineteenth century near Tasco and Tehuantepec in Mexico. It has since been reported from other localities mostly alpine or sub-alpine at a considerable elevation but its geographical limits are not yet accurately known. It is cultivated in botanic gardens in the south of Europe, notably in that of the Marchese Hanbury at La Mortola whence were received the materials on which the above description is chiefly founded. Although not hardy in Great Britain, notice is taken of it here for the purpose of completing the monograph of the genus.

Cupressus thyoides.

A tall slender tree with a trunk frequently 70—80 feet high and 2—3 feet in diameter, with thickish light red-brown bark and short, slender, spreading branches forming a spire-like crown. Branchlets with smooth, reddish brown bark and ramified distichously, each ramification terminating in flat fan-like leafy expansions; in poorly growing trees in Great Britain, in pseudo-corymbose tufts. Leaves in decussate pairs, small, scale-like, ovate, acute, closely imbricated and glandular on the back; on the axial growths longer, the lateral pairs keeled, more acute and free at the apex, dull bluish green turning to rusty brown in winter. Staminate flowers four-angled with five—six pairs of stamens each with an oval connective bearing two anther-cells. Strobiles very numerous, globose, about 0·25 inch in diameter, composed of six glaucous green imbricated scales each bearing one—two seeds.

Cupressus thyoides, Linnæus, Sp. Plant. II. 1003 (1753). Michaux, Hist. Arb. Amer. III. 20, t. 2 (1813). Loudon, Arb. et Frut. Brit. IV. 2475, with figs. Hooker, W. Fl. Bor. Amer. II. 165. Hoopes, Evergreens, 314, t. 55. Kent in Veitch's Manual, ed. I. 238. Masters in Journ. R. Hort. Soc. XIV.; and Journ. Linn. Soc. XXXI. 352. Sargent, Silva N. Amer. X. 111, t. 529.
Chamæcyparis sphæroidea, Spach, Hist. Veg. Phaner. XI. 331 (1842). Endlicher, Synops. Conif. 61. Carrière, Traité Conif. ed. II. 121. Parlatore, D. C. Prodr. XVI. 464. Gordon, Pinet. ed. II. 71. Beissner, Nadelholzk. 65, with fig.
Thuya sphæroidalis, L. C. Richard, Mém. sur les Conif. 45 (1826).
T. sphæroidea, Macoun, Cat. Canad. Plants, 46.
Eng. and Amer. White Cedar. Fr. Cédre blanc. Germ. Weisse-Ceder, Ceder-Cypresse. Ital. Cedro bianco.

var.—ericoides.

A juvenile form (Jugendform) of somewhat rigid columnar habit, the foliage consisting entirely of primordial linear, close-set leaves, glaucous green above, and with two stomatiferous lines beneath. In winter the branchlets with their foliage change to a reddish brown or reddish violet colour.

C. thyoides ericoides, Masters in Journ. Linn. Soc. *loc. cit.* Chamæcyparis sphæroidea ericoides, Beissner, Nadelholzk. 67, with fig. Juniperus ericoides, Hort. Retinispora ericoides, Hort.

var.—leptoclada.

A low tree of fastigiate or columnar habit with dimorphic, primordial and adult foliage of a bluish grey colour, the former soon disappearing. Branches numerous, close-set, erect, much ramified and terminating in flattened, fan-shaped leafy expansions that are often clustered in a corymbose manner.

C. thyoides leptoclada, Masters in Journ. Linn. Soc. XXXI. 352. Chamæcyparis sphæroidea andelyensis, Carrière. Traité Conif. ed. II. 123. Retinispora leptoclada, Hort.

var.—variegata.

Of dwarfer and denser habit than the common form, from which it further differs in having more than one-half of its youngest branchlets light yellow.

Other deviations from the common type have been named respectively *atrovirens glauca* (syn. *Kewensis) fastigiata, nana, pendula, pygmæa,* names sufficiently indicative of their distinctive character.

Cupressus thyoides inhabits the cold swamps of the Atlantic and Gulf coast plains, usually immersed during several months of the year, frequently covering them at the north with pure dense forests, or at the south, mingling with the deciduous Cypress, *Taxodium distichum.* Rarely extending far inland, it ranges from Maine southwards to northern Florida, and westwards to the valley of the Pearl river in Mississippi.*

The White Cedar, according to Aiton, was introduced into Great Britain about the year 1736 by Peter Collinsun, but there is evidence that it was cultivated by Bishop Compton many years earlier. Prior to the discovery and introduction of the north-west American and Japanese Cypresses it was in cultivation generally throughout the country, but during the last half century it has gradually receded from view, a circumstance due more to local causes than to any other, for although a distinct and beautiful tree when in health and vigour, the White Cedar does not flourish, as might be expected from the localities it affects in North America, except in constantly damp or wet soils.

Of the varieties described above, *ericoides* is a "juvenile" form rarely exceeding 2 to 3 feet high, well distinguished by its glaucous foliage which in winter changes to violet-brown; in dry soils, for which it is unsuited, it loses its dense habit and the branchlets become much tufted. *leptoclada* is by far the most useful and the most generally cultivated of all the *Cupressus thyoides* forms; it originated many years ago in a French nursery and was subsequently exhibited under the name of *Chamæcyparis sphæroidea andelyensis*, the name by which it is still known in many continental gardens. The original plant was acquired by Messrs. Henderson of Maida Vale, by whom the variety was propagated and distributed under the name of *Retinispora leptoclada.*†

The wood of *Cupressus thyoides* is light, soft, not strong, close-grained, easily worked, slightly fragrant and very durable in contact with the

* Silva of North America, X. 112.

† The varietal name *andelyensis* has priority of *leptoclada* but as the latter has been in continuous use in this country for upwards of forty years, it is inexpedient to alter it.

soil; it seasons rapidly and perfectly without warping, and is largely used for boat-building, cooperage, telegraph and fence-posts, railway ties, and wherever durable wood is desired. The importance of the White Cedar in the Atlantic States is increased by the fact that, attaining its greatest proportions in situations where no other useful timber tree can flourish, it gives value to lands which without it would be worthless.

Cupressus torulosa.

A large tree attaining a height of 70–80 or more feet with a girth of trunk of 6–8 feet, and occasionally larger. Bark thin, peeling off in numerous long, narrow, dark grey strips, the inner cortex reddish brown. Branches spreading horizontally, forming a broad pyramidal crown which in old age is flattened or round-topped. Under cultivation in Great Britain, a sub-fastigiate or flame-shaped tree with all the primary branches more or less ascending and much ramified at the apical end. Branchlets tetrastichous or distichous, very slender, drooping and much divided, the ultimate growths short, straight and parallel. Leaves in decussate pairs, on the axial growths oblong-deltoid, acute; glandular, appressed, often free at the tip; on the slender lateral growths, minute, scale-like, triangular-ovate, and concrescent. Staminate flowers club-shaped and tetragonal, about 0·35 inch long, composed of two–three pairs of pale yellow anthers. Strobiles clustered or solitary, globose, 0·5–0·75 inch in diameter, on short footstalks produced on branchlets two to three years old, and consisting of four, rarely five, decussate pairs of ligneous, rugose-umbonate, oblong or oblong-rhomboidal scales of which the upper and lowermost pairs are usually sterile. Seeds five–seven to each scale, small, compressed with a narrow orbicular wing.

Fig. 71. *Cupressus torulosa.*

Cupressus torulosa, Don, Prodr. Fl. Nep. 55 (1825). Lambert, Genus Pinus, ed. 2, Vol. II. 113 (1828). Loudon, Arb. et Frut. Brit. IV. 2478, with figs. (1838). Endlicher, Synops. Conif. 57 (1847). Carrière, Traité Conif. ed. II. 150. Parlatore, D. C. Prodr. XVI. 469. Gordon, Pinet. ed. II. 97. Lawson's Pinet. Brit. II. 201, t. 35. Brandis, Forest Fl. N.W. India, 533. Hooker fil. Fl. Brit. Ind. V. 645. Masters in Journ. Linn. Soc. XXXI. 335; and Journ. R. Hort. Soc. XIV. 208.

var.—Corneyana.

Branches and branchlets pendulous, the latter more distant and covered with minute, concrescent, scale-like leaves that are not free at the apex: strobiles larger, often of oval shape with the umbo of the scales less or not at all developed.*

C. torulosa Corneyana, Carrière, Traité Conif. ed. II. 151. Kent in Veitch's Manual, ed. I. 239. Masters in Journ. Linn. Soc. XXXI. 336. C. Corneyana, Parlatore, D. C. Prodr. XVI. 470.

var.—kashmiriana.

Branchlets very slender, elongated and pendulous; branchlet systems more slender in all their parts and the ramifications more distinctly tetragonous. Leaves as in the type but all free at the acute tip.

C. torulosa kashmiriana. *supra.* C. cashmeriana, Royle ex Carrière, Traité Conif. ed. II. 161.

Cupressus torulosa was first discovered by Dr. Buchanan-Hamilton during his journey through Nepal in 1802—1803, and from his specimens it was described by David Don in the "Prodromus Floræ Nepalensis," published in 1825. Seeds were first sent to England in 1824 by Dr. Wallich, and consignments of them have reached this country from time to time ever since. According to Sir Dietrich Brandis, *C. torulosa* is found only on the outer Himalayan range from Nepal to Chamba at about 75° east longitude, mostly, but not always on dry slopes, more local and much less common than other Himalayan Conifers; its vertical range is from 3,500 to 8,000 feet. The wood is white tinged with red or yellow, deeper in the centre, even grained, easy to work but not strong: it is occasionally used for joinery and indoor fittings.†

On Cheena, in Kumaon, at an altitude of upwards of 8,000 feet and where the rainfall exceeds 150 inches annually, *Cupressus torulosa* is a strikingly handsome tree attaining a height of 150 feet with a trunk 15 feet in circumference near the ground, and much resembling in habit the Japanese species *C. obtusa* and *C. pisifera*. In the cemetery near the foot of the mountain are preserved many superb specimens which once formed a part of the forest that covered the district.‡

The Himalayan Cypress cannot be called a satisfactory tree for arboricultural purposes in this country, for although it is sufficiently hardy to withstand average winters, it succumbs to exceptionally severe ones so that very few trees more than twenty years old are now to be seen in Great Britain. Those that survive are all of the fastigiate or sub-fastigiate form of which there are beautiful specimens at Bicton and Killerton in Devonshire, Tortworth Court in Gloucestershire, and other places in the south-west of England.

The variety *Corneyana* was in cultivation prior to 1850 by Messrs. Knight and Perry of the Royal Exotic Nursery, Chelsea, who supposed it to be a native of Japan or North China which has not been verified. The variety *kashmiriana*, a very beautiful one, is in cultivation in the Temperate House at Kew and a few other places.

* Communicated from the Royal Gardens at Kew, and the Marchese Hanbury's garden at La Mortola.

† Forest Flora of North-west India, p. 534.

‡ Maries in the Journal of the Royal Horticultural Society, Vol. XXII. p. 462.

THUIA.*

Linnæus, Sp. Plant. II. 1002 (1753, Thuja). Endlicher, Synops. Conif. 50 (1847). Parlatore, D. C. Prodr. XVI. 456 (1868, Thuya). R. Brown of Campster in Trans. Bot. Soc. Edinb. IX. 358 (1871). Bentham and Hooker, Gen. Plant. III. 426 (1881, Thuya in part). Masters in Journ. Linn. Soc. XXX. 19 (1893). Eichler in Engler and Prantl, Nat. Pfl. Fam. 97 (1887. Thuja). Including Biota. Endlicher. Synops. Conif. 46; and Thujopsis. Siebold and Zuccarini, Fl. Jap. II. 32.

The Thuias with one exception, *T. gigantea*, are medium-sized or low evergreen trees of narrowly conical outline; or dense globose, fastigiate or dwarf shrubs that have deviated under cultivation from the ordinary habit of the species. As here understood, the genus includes five species inhabiting a belt in the north temperate zone extending with interruptions through North America and Asia between the 30th and 50th parallels of north latitude.

The essential characters are:—

Flowers monœcious. Staminate flowers terminal on lateral branchlets of the previous year. Stamens usually six, in decussate pairs, the anthers with a sub-orbicular connective bearing two—four cells.

Strobiles maturing in one season, solitary at the end of short branchlets, pendulous (except in *Thuia orientalis*), composed of eight—twelve imbricated scales in decussate pairs of which the one or two larger pairs only are fertile, each bearing two—five seeds at the base.

In their vegetation, the following characters are common to all the Thuias:—

Branches short and much ramified; branchlets flattened, usually in one plane; foliage dimorphic.

Leaves persistent; on adult plants, adnate to or concrescent with their axial growths, scale-like, ovate—or obovate—oblong, or some modification of that form, in four ranks in decussate pairs.

Two of the Asiatic species do not quite conform to the American type, *Thuia occidentalis*, in the structure of their fruits and in some other minor particulars, and they have, in consequence, received separate generic rank under the names of Biota (Endlicher) and Thujopsis (Siebold and Zuccarini). The characters relied on to separate them from Thuia proper are scarcely of sufficient value to justify their retention as separate genera; their divergence from the type is, however, too significant to be neglected, and the characters which were used to distinguish them as genera afford data for sectional divisions;

* The name Thuja was adopted by Linnæus from Tournefort's Thuya which by general consent is formed from θυα or θυΐα (Theophrastus) the name of a tree or shrub that cannot be identified but is supposed to be the North African Cypress, *Callitris quadrivalvis* (Endl.) = *Tetraclinis articulata* (Mast.). As the earliest authoritative nomenclature recognised in this work is the Species Plantarum of Linnæus published in 1753, the mediæval orthography of Tournefort, resuscitated by L. C. Richard and afterwards by Parlatore, and accepted by many recent authors is here inadmissible, but following Endlicher the Linnæan Thuja in its classical form Thuia is adopted.

we have thence three sections distinguished by the structure of the fruit:—

EUTHUIA, strobiles pendulous, scales not thickening upwards and bearing two—three winged seeds. *T. occidentalis*, *T. gigantea* and *T. japonica*.

BIOTA, strobiles erect with thickened scales prolonged at the apex into a curved or horn-like process, and bearing two wingless seeds. *T. orientalis*.

THUIOPSIS, strobiles sub-pendulous, with scales much thickened at the apex and bearing four—five winged seeds. *T. dolabrata*.

All the Thuias are hardy in Great Britain: they are among the most useful of Conifers on account of the numerous purposes for which they may be planted and the variety of soils and situations in which they will grow, but in these respects the following circumstances should be noted:—The American species mostly inhabit low-lying moist situations as the banks of rivers and streams and around lakes; the Japanese species are sub-alpine, but always where the annual rainfall is almost double that of the greater part of England. *T. orientalis* is cultivated in China and Japan under many varied conditions of climate and environment, but thrives best where the climate is most humid. These facts go far to explain how it is that in retentive loams with a naturally drained subsoil, or where the supply of moisture at the roots is not intermittent during the growing season, the Thuias attain their best development, form handsome specimens for the decoration of the garden and retain their foliage and leafy branchlet systems longest.

Thuia dolabrata.

A tree or undershrub according to situation or altitude; in its arborescent form occasionally rising to a height of 40—50 feet with a relatively slender trunk covered with light red bark. In Great Britain it usually has the aspect of a dense pile of foliage of broadly conical outline, the trunk covered with chocolate-brown bark peeling off in longitudinal shreds. Primary branches close-set in pseudo-whorls or scattered, slender, spreading horizontally or depressed by the weight of their appendages; secondary branches distichous, ramified at the extremities into the frondose branchlet systems common throughout the genus. Leaves persistent five—seven years, four-ranked in decussate pairs; on the principal axis ovate, obtuse, free at the apex; the dorsiventral pair on the lateral growths, obovate-oblong, keeled and concrescent, except at the apex, the lateral pair dolabriform (hatchet-shaped) acute; yellowish green on the upper side of the branchlets where fully exposed to direct sunlight; darker with a white stomatiferous band on the under side. Staminate flowers about 0·25 inch long, bearing 12—20 anthers with orbicular imbricated connectives in decussate pairs. Strobiles broadly ovoid, 0·75 inch long, composed of eight—ten ligneous, imbricated, rhomboidal scales thickened at the apical end, each bearing five winged seeds or less by abortion.

Thuia dolabrata, Linnaeus, Suppl. Syst. 420 (1781), Thuja). Thunberg, Fl. Jap. 266 (1784). Don in Lambert's Genus Pinus, ed. I. vol. II. App. 2, fig. 1 (1828). Masters in Gard. Chron XVIII. (1882), p. 556, with fig. Journ. Linn. Soc. XVIII. 486; and Journ. R Hort. Soc. XIV. 251 (Thuya).
Thujopsis dolabrata, Siebold and Zuccarini, Fl. Jap. II. 34. tt. 119, 120 (1842). Endlicher, Synops. Conif. 53 (Thuiopsis). Carrière, Traité Conif. ed. II. 118 (Thuiopsis). Parlatore, D. C. Prodr. XVI. 460 (Thuyopsis) Gordon, Pinet. ed. II. 398 (Thuiopsis). Beissner, Nadelholzk. 51, with figs. (Thuyopsis).
Eng. Japanese Thuia. Fr. Thuia du Japon. Germ. Beilblättriger Lebensbaum. Ital. Thuia giapponese. Jap. Asu-Naro.

var.—lætevirens.

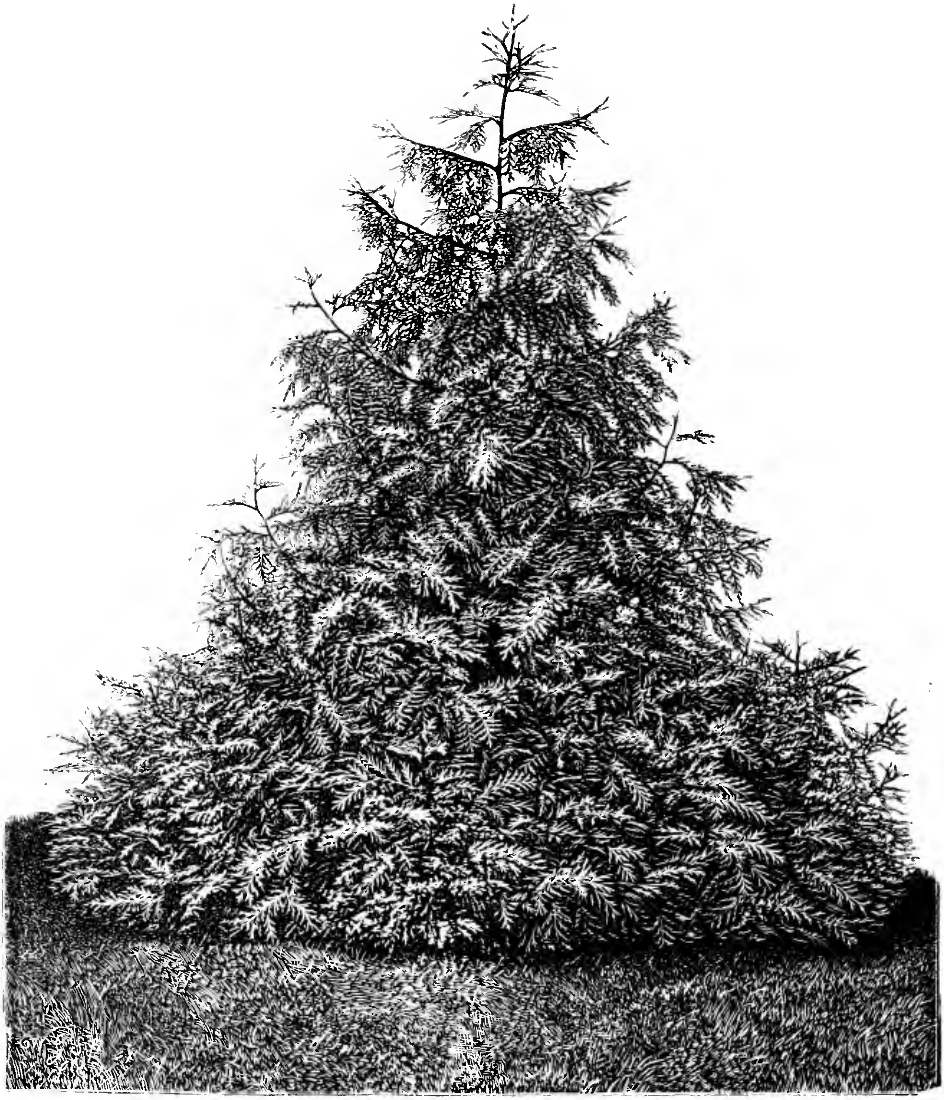
A dwarf spreading shrub with more slender and more divided branchlets, the leaves smaller and of a brighter green.

T. dolabrata lætevirens, Masters in Journ. Linn. Soc. XVIII. 486. Thuiopsis lætevirens, Lindley in Gard. Chron. 1862. p. 428. T. dolobrata nana. Gordon, Pinet. ed. II. 399.

var.—variegata.

A picturesque variety resembling the species in habit, but differing from it in having the tips of many of the branchlets pale yellow or cream colour.

Thuia dolabrata first became known to Europeans through the Swedish botanist, Thunberg, who gathered specimens during his brief sojourn in Japan in 1776, which he communicated to Linnaeus, by whom this conifer was first authoritatively named. These specimens subsequently became the property of the Linnean Society of London, and were described by David Don in Lambert's "Genus Pinus" *loc. cit. supra*, published in 1828. The first living plant received in England was sent to the Veitchian nursery at Exeter by Thomas Lobb in 1853 from the Botanic Garden at Buitenzorg, in Java; the plant arrived in an exhausted condition, and all attempts to save it proved fruitless. Shortly afterwards a plant was brought from Japan by Captain Fortescue, which was planted in the garden at Castle Hill, in Devonshire, the seat of his relative, Earl Fortescue, and is still living. From this plant a few others were propagated and presented to prominent amateurs of Coniferæ, but it was not till after 1861, in which year the late Mr. John Gould Veitch and Mr. Robert Fortune sent from Japan a supply of seeds to the Chelsea and Ascot nurseries respectively, that this beautiful Thuia became generally distributed over Great Britain. In its native country the habit and dimensions of *T. dolabrata* vary considerably; on the mountain slopes in central Japan at 5,000 to 7,000 feet elevation it is a straggling shrub seven to ten feet high forming an undergrowth in the shade of dense forests of *Tsuga diversifolia* and other coniferous trees, and not infrequently mixed with Rhododendrons and dwarf Maples; lower down and in the plains it takes an arborescent form with stouter branchlets and larger leaves. The wood is said to be very durable and is used in boat and bridge-building.



Thuia dolobrata.
(From the *Gardeners' Chronicle.*

As an ornamental tree in this country *Thuia dolabrata* takes a high rank; its growth in its young state whether raised from seed or from cuttings is slow, but when established in a moist loamy soil and protected from piercing winds its progress is satisfactory, and under such conditions it is one of the most beautiful of lawn trees. Many fine specimens scattered over the south and west of England and Ireland generally attest this. The largest trees known to the author are at Panjerrick, near Falmouth, which is upwards of 40 feet high, and at Killerton, near Exeter, which is nearly of the same dimensions: the last named is an offspring of the plant brought from Japan by Captain Fortescue.

Thuia gigantea.

A lofty tree attaining at its greatest development a height of 150—200 feet, with a trunk tapering from a broadly buttressed base 5—6 feet, in diameter at 12—15 feet from the ground, and covered with thin cinnamon-red bark irregularly fissured into long, narrow, plate-like scales. In Great Britain a stately tree of narrowly conical or spire-like outline clothed with branches from the base. Bark of trunk irregularly fissured longitudinally and peeling off in flakes, exposing a red-brown inner cortex. Primary branches close-set, spreading, and much ramified at the distal end. Branchlets slender, often zig-zag or curved, at first green, changing to reddish brown in the third year and ramified in the manner described under the type species, *Thuia occidentalis*. Leaves in decussate pairs, persisting on the axial growths several years after becoming effete; on vigorous shoots ovate or deltoid, acuminate, glandular on the back, adnate to beyond the middle, free at the apex; on lateral and younger branchlets much smaller, ovate, apiculate, concrescent and scarcely glandular; yellowish green on the upper exposed side, much darker on the under side of the branchlets. Staminate flowers small, composed of six—eight stamens arranged like the leaves. Strobiles very numerous, clustered near the ends of the branchlets, ovoid-cylindric, 0·5 inch long, consisting of eight—ten elliptic-oblong scales of which the larger middle ones are fertile, each bearing two—three small seeds with notched wings.

Thuia gigantea, Nuttall in Journ. Phil. Acad. VII. 52 (1834). Hooker, W. Fl. Bor. Amer. II. 165 (1840). Endlicher, Synops. Conif. 52 (1847). Parlatore, D. C. Prodr. XVI. 457. Hoopes, Evergreens, 315. Gordon, Pinet. ed. II. 402. Nicholson in Woods and Forests, 190 (1884), with figs. Brewer and Watson, Bot. Califor. II. 115. Macoun, Cat. Canad. Plants, 460. Sargent in Garden and Forest, IV. (1891), p. 109, with fig.; and Silva. N. Amer. X. 129, t. 533. Beissner, Nadelholzk. 46, with fig. Masters in Journ. R. Hort. Soc. XIV. 25.

T. plicata, Don in Lambert's Genus Pinus, ed. I. Vol. II. 19 (1824); and ed. II. Vol. II. 114 (1837). Endlicher, Synops. Conif. 51 (1847). Carrière, Traité Conif. ed. II. 166. Masters in Gard. Chron. XXI. ser. 3 (1897), p. 214.*

* Dr. Masters has here conclusively shown that Don's *Thuia plicata* and Nuttall's *T. gigantea* are synonymous; the former therefore is the older name. Unfortunately Don's name, *plicata*, became applied to a variety of the type species, *T. occidentalis*, and has been in use for it during many years. As Nuttall's *gigantea* too has been in continuous use for more than fifty years, setting aside *T. Menziesii* (Doug.) and *T. Lobbi* (Hort.) which are only *nomina nuda*, it is here retained on the ground of expediency, and moreover the inconvenience of changing a name so long established is too great to admit of much probability of the substituted name being adopted in forestry and horticulture.

T. Menziesii, Douglas ex Carrière, Traité Conif. ed. II. 107 (1867). Gordon, Pinet. ed. I. 323.

T. Lobbi, Hort.

Eng. Lobb's Arbor Vitæ. Amer. Western Arbor Vitæ, Red or Canoe Cedar of Oregon. Fr. Thuia Géant de Californie. Germ. Riesens-Lebensbaum. Ital. Albero de la Vita di Lobb.

var.—aurea.

A large proportion of the foliage and young growths light yellow, the colour being most conspicuous in the short lateral growths of the terminal shoots and in the basal half of the branchlet systems next below them. The *aureo-variegata* and *aurescens* of continental gardens are apparently modifications of this variety.

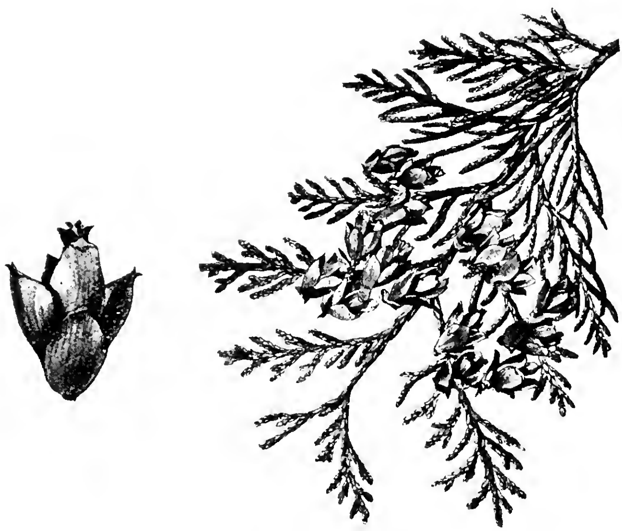


Fig. 72. Fruiting branchlet of *Thuia gigantea* reduced. Strobile slightly enlarged.

var.—gracilis.

A smaller tree with more slender branches and branchlets, especially the latter, which are clothed with smaller scale-like leaves of a paler green.

Thuia gigantea is widely distributed over a large area extending in a meridinal direction from southern Alaska at about latitude 55° north, along the coast range and islands of British Columbia to north California, and laterally from the Rocky Mountains to the Pacific Ocean. It attains its greatest development in the valley of the Columbia river and around Puget Sound where trees have been seen towering to a height of 150 to 200 feet, "sending up a mighty shaft free of branches for upwards of 100 feet, from an enormously enlarged base tapering gradually until at twice the height of a man from the ground, its diameter may not be more than a dozen feet.

Beside these giants the other Arbor Vitaes of the world are but pygmies."* It constantly diminishes in size in proceeding eastwards to the slopes of the Rocky Mountains, dwindling to a low shrub at its highest vertical limit.

The botanical history of *Thuia gigantea* is somewhat complicated. The earliest mention of it occurs in James Donn's "Hortus Cambridgiensis," ed. IV. published in 1807, under the name of *Thuja plicata* without description, but with the information that the species was discovered by Nees at Nootka Sound. Nees was a Frenchman, naturalised in Spain, who accompanied Malaspina in his voyage round the world (1789—1794), and his original herbarium specimen of this Thuia is still preserved in the Natural History Museum at South Kensington. Nees was closely followed by Archibald Menzies who accompanied Vancouver's expedition as botanist (1790—1796), and he also brought home specimens gathered at Nootka Sound in 1795. The species was first described from Menzies' materials by David Don in the second volume of Lambert's "Genus Pinus" published in 1828 under James Donn's name of *T. plicata.*† About this time, or a little earlier, Thomas Nuttall, who was preparing a continuation of Michaux' great work on North American trees, received specimens from the Flat Head river and gave the tree the name of *T. gigantea*, but his description was not published till 1834. It was next met with by David Douglas while collecting for the Horticultural Society of London in the region of the river Columbia (1825—1827), who at first took it for the eastern species, *T. occidentalis*, but afterwards named it *T. Menziesii* in compliment to his distinguished countryman; Douglas' name, however, remained a MS. name only. It was shortly afterwards gathered by Mertens near its northern limit on the island of Sitka, from whose herbarium specimens it was described as a new species by Bongard in his "Observations sur la Végétation de Sitka" under the name of *T. excelsa*, but this name was not taken up by any subsequent author. Nearly a quarter of a century had still to elapse before this valuable tree was introduced to British gardens;‡ the first consignment of seed was received at the Veitchian nursery at Exeter in 1853, whence it was subsequently distributed under the name of *Thuia Lobbii*, Nuttall's name of *T. gigantea* being at that time misapplied to *Libocedrus decurrens*, and Don's *T. plicata* being in use for a variety of *T. occidentalis.*

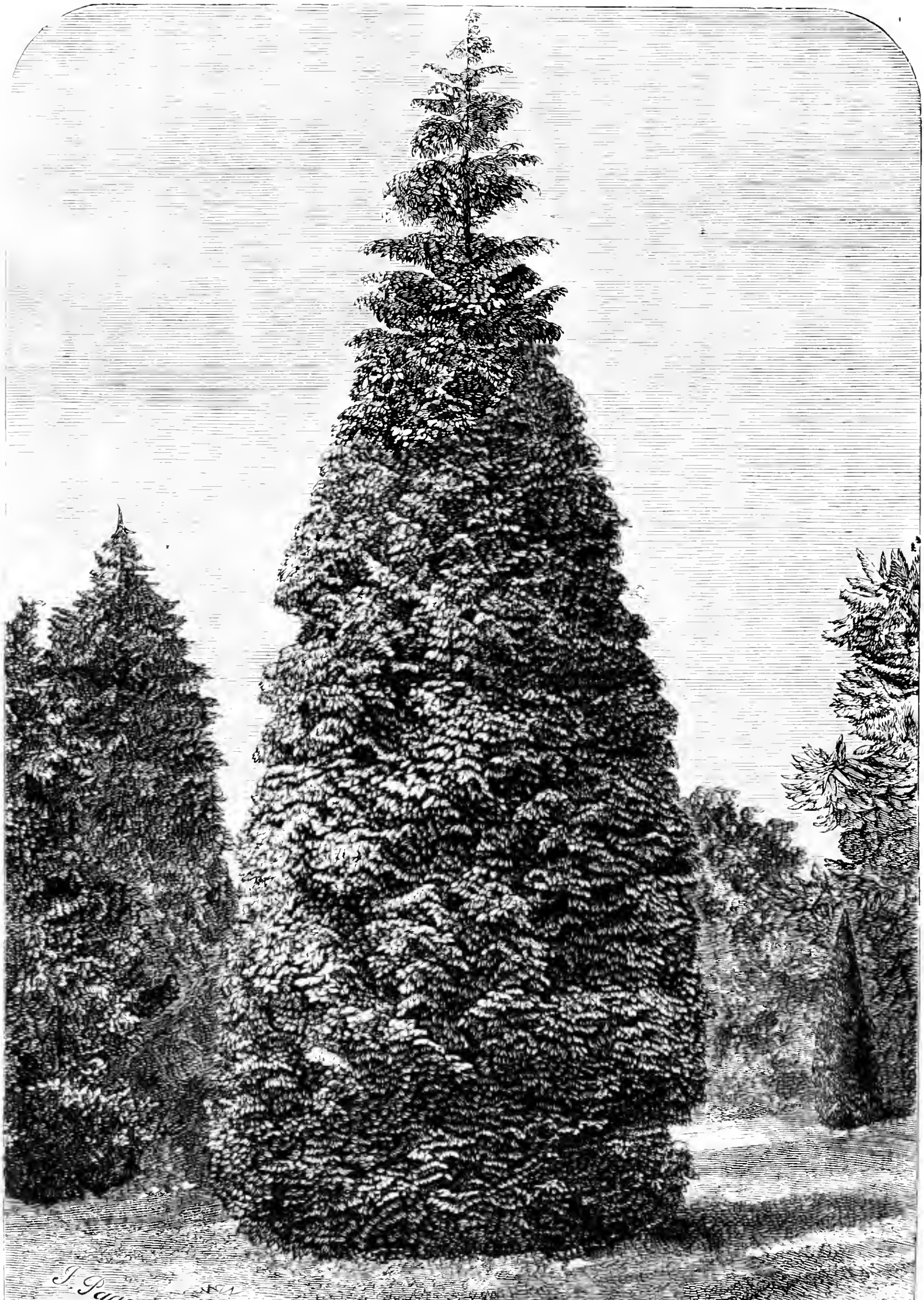
In British gardens and pineta *Thuia gigantea* is one of the handsomest of Conifers; it forms an elongated cone of foliage, in some places at the present time 70 to 80 feet high, 50 to 60 feet high being by no means uncommon.§ Its tall straight trunk is feathered

* Professor Sargent in Garden and Forest, IV. 109, the author adding "There are not many of them now." The same author also states that *Thuia gigantea* is rapidly disappearing with the spread of the forest fires which, burning through the thin bark, soon kills these trees.—Silva of North America, *loc. cit.*

† Gardeners' Chronicle, XXI. ser. 3 (1897), pp. 101 and 214.

‡ It is highly probable that the cultivated plant alluded to by David Don and included in James Donn's list of plants in the Cambridge Botanic Garden, was a variety of *Thuia occidentalis*, a point that may never be cleared up.

§ The largest specimens known to the author in England are at Penjerrick, Falmouth; Eastnor Castle, Linton Park, Dropmore, and Monk Coniston. In Scotland at Poltalloch, Argyllshire; Murthly Castle and Dupplin Castle, Perthshire. In Ireland at Woodstock, Kilkenny; Hamwood, Co. Meath; Powerscourt, Co. Wicklow; Fota Island, Cork.



Thuia gigantea at Linton Park, Maidstone.

with branches from the base upwards, the lowermost showing no signs of becoming effete except where they have been brought into contact with other trees. The length of the lowermost branches of the largest specimens ranges from 12 to 15 feet, so that a space with a radius greater than these dimensions should be allowed for trees intended for the decoration of the lawn and park. It thrives in most kinds of soils and in diverse situations; the rate of growth is influenced to some extent by the average temperature and rainfall of the locality; under the most favourable conditions it adds from 25 to 30 inches to its height yearly during the first fifteen to twenty years of its life, a fact that should strongly recommend it to the attention of the forester; in drier situations the annual rate of growth is considerably less. No stronger proof of its acclimatisation can be adduced than the circumstance of its producing seeds freely, from which, in many places, seedlings have sprung up spontaneously around the parent tree.

The great economic value of *Thuia gigantea* in its native region was first discovered by the Red Indians; they make their canoes of its timber which is easily worked, and also various household utensils; they manufacture the thin fibrous inner bark which strips off in ribbon-like bands, into mats, bags, baskets, cordage and even articles of clothing. Nor has the white settler been slow to avail himself of the advantages offered by the timber of this exceptionally valuable tree; the timber of the larger trees is absolutely free from knots and can be split into shingles with unerring exactness; these shingles neither warp nor split from the action of the weather, and are much preferred for doors, window-sills and other constructions exposed to sun, wind and rain; Thuia wood is also much used for indoor carpentry and fittings, for cooperage and the coarser kinds of furniture.

For a long time after its introduction *Thuia gigantea* was better known in British gardens as *T. Lobbii*; this name had been given to it from a desire to pay a well-merited tribute to the exertions of William Lobb through whom it had been introduced. That Lobb's name is worthy of being held in remembrance will be seen from the following sketch of his life and labours as a plant collector.

William Lobb (1809—1863) was born in the eastern division of Cornwall. The place is unknown, nor is anything known of his early life. When a young man, he applied himself to gardening, and obtained a situation as gardener to Mr. Stephen Davey, of Redruth, whose horticultural establishment appears to have been on a modest scale, but which, under Lobb's management, became thoroughly efficient. After remaining in the service of Mr. Davey a few years, Lobb entered the nursery of Mr. Veitch, at Exeter, for the purpose of improving his knowledge of plants. For a long time previous he had cherished an ardent desire for travel and adventure; he was quick of observation, ready in resources, and practical in their application; he had also devoted much of his leisure time to the study of botany, in which he acquired considerable proficiency. Mr. Veitch, finding him thus qualified, proposed that he should go on a mission to South America for the purpose of collecting plants in that rich quarter of the globe, an offer which Lobb gladly accepted. He sailed from Plymouth in 1840 for Rio Janeiro. On his arrival in Brazil he first proceeded to the Orgãos Mountains, where he met with several beautiful Orchids at that time extremely rare in English gardens; he then proceeded to Chile by crossing the great Pampas of the Argentine Republic and the Chilian Andes. Continuing his journey southwards he penetrated the great Araucaria forests, where he collected a large quantity of seeds of *Araucaria imbricata*; he was thus instrumental in bringing this remarkable Conifer into general use for ornamental planting. He returned to England in 1841, renewed his engagement with Mr. Veitch, and sailed again for Brazil in April of the following year. After sending home from Rio Janeiro a consignment of plants which he had collected in southern Brazil, he proceeded to Valparaiso, for the purpose of exploring southern Chile, at that time but little known to Europeans, except along the coast. Here a rich harvest awaited him. Among his earliest successful introductions from this region were *Lapageria rosea*,* *Escallonia macrantha*,† *Embothrium coccineum*,‡ *Philesia buxifolia*,§ and *Desfontainea spinosa*.‖ Following up these brilliant achievements, he continued his explorations in Valdivia, Chiloe, and northern Patagonia, where he collected seeds and plants of *Libocedrus tetragona*, *Fitzroya patagonica*, *Saxe-Gothæa conspicua*, and *Podocarpus nubigenus*, "four most interesting Conifers for this country, after *Araucaria imbricata*, that South America produces."¶ Nor must mention be omitted of *Berberis Darwinii*,** which was first introduced to British gardens by him during the same expedition. Lobb returned to England in 1848. The wonderful Conifers discovered by Douglas in California and Oregon were then still very scarce in England, and young plants of most of the species could scarcely be bought with money;†† it was therefore decided that he should proceed to California with a view of obtaining seeds of all the most important kinds known, and to discover others, if possible. He landed at San Francisco in the summer of 1849, and at once made arrangements for exploring southern California. One of the first fruits of the expedition was the successful introduction of *Abies bracteata*. During the years 1850—1851 he sent home consignments of cones and seeds of *Pinus radiata*, *P. muricata*, *P. Sabiniana*, *P. Coulteri* and *P. tuberculata*; also of many shrubs and flowering plants, some of which were quite new to British gardens. In the autumn of 1851 he extended his operations further north, and collected cones and seeds of the Redwood (*Sequoia sempervirens*), *Pinus Lambertiana*, *P. monticola*, etc. In 1852 he made an excursion to the Columbia river and Oregon where he succeeded in obtaining seeds of *Abietia Douglasii* and *Abies nobilis*, still rare at that time in England, and the beautiful Thuia provisionally named after him. Returning through North California, he collected seeds of *Abies grandis*, *A. magnifica* which he sent home under the name of *A. amabilis*, believing it to be the *A. amabilis* of Douglas, *A. concolor* (var. *Lowiana*) the first received in England of that fine Fir, *Juniperus californica*, *Pinus ponderosa*, etc. In 1853 he explored the Sierra Nevada, whither he was led by the reports of the discovery of trees of extraordinary magnitude which he had the good fortune to find, and to secure the first cones and seeds of the Wellingtonia received in England. He brought these home at the end of the year, and with them two living plants which were afterwards planted out in the Exeter Nursery, where they survived but three or four years. Lobb returned to California in the autumn of 1854, and from that time up to the end of 1856 he continued to send home consignments of plants and seeds. In 1857 his engagement with Mr. Veitch terminated. He remained, however, in California, and sent collections of seeds to England from time to time. In 1863 he was seized with paralysis, and lost the use of his limbs; he died at San Francisco in the autumn of the same year, and was buried in Lone Mountain Cemetery.

Thuia japonica.

A conical tree 20—30 feet high with a slender tapering trunk clothed with reddish brown bark that peels off in longitudinal shreds. Primary branches short, spreading horizontally and ramified irregularly at the distal end into branchlet systems as in *Thuia occidentalis*. Leaves persistent three — four years, changing to red-brown on the axial growths before disappearing, arranged in decussate pairs, the lateral pair conduplicate with a sharp keel, longer and more acute than the flat, ovate, concrescent, dorsiventral pair, but on the younger and lateral growths nearly equal to them, light fulvous green and with a small gland at the apex on the exposed or upper side of

* Bot. Mag. 4447. † *Idem*, 4473. ‡ *Idem*, 4856. § *Idem*, 4738. ‖ *Idem*, 4781. ¶ *Idem*, 4616. ** *Idem*, 4590.

†† Loudon, Arboretum et Fruticetum Britannicum, pp. 2249, 2251, 2266, 2344.

the branchlets, paler with white triangular spots and markings on the under side. Staminate flowers as in *T. gigantea*. Strobiles composed of four decussate pairs of imbricated scales of which the two middle pairs are fertile.

Thuia japonica, Maximowicz in Bull. Acad. Sc. Petersb. X. 190 (1866). Masters in Journ. Linn. Soc XVIII. 186 ; Journ. R. Hort. Soc. XIV. 252 ; and Gard. Chron. XXI. ser. 3 (1897), p. 258, with figs.
T. Standishii, Carrière, Traité Conif. ed. II. 108 (1867). Gordon, Pinet. ed. II. 408. Beissner, Nadelholzk. 19.
T. gigantea, Parlatore, D. C. Prodr. XVI. 457 (not Nuttall).
T. gigantea var. japonica, Franchet et Savetier, Enum. Plant. Jap. I. 169.
Thuiopsis Standishii, Hort.
Eng. Japanese Arbor Vitæ. Standish's Arbor Vitæ. Fr. Thuia de Japon. Germ. Japanischer Lebensbaum.

A species of much interest, first discovered by Fortune in cultivation around Tokio during his mission to Japan in 1860 — 1861 and introduced by him to the nursery of the late Mr. Standish at Ascot, who subsequently distributed it under the name of *Thuiopsis Standishii*. In 1864 or 1865 it was seen by the Russian botanist Maximowicz also in cultivation around Tokio, and was afterwards described by him in the publication quoted above under the name of *Thuia japonica*, which is the oldest authoritative published name. No evidence of its being endemic was forthcoming until it was discovered growing wild on the mountains of Nikko in central Japan by Maries while collecting for the Veitchian firm in 1877 — 1879. Quite recently it was found by Professor Sargent and Mr. James H. Veitch on the shores of Lake Yumoto in the Nikko mountains at 4,000 — 5,000 feet elevation, where it appears to be quite rare.

As an ornamental tree for British gardens, *Thuia japonica* may be recommended for retentive loamy soils; it then forms a shapely low tree with a narrowly conical or columnar outline. In dry soils it becomes thin and indifferently furnished, especially near the ground. It is easily distinguished from the American Thuias by its thicker, less sharply pointed leaves, which on the under side of the branchlets are marked with whitish spots and lines, and which when bruised emit an unpleasant odour very different from the strong fragrance given forth by the bruised leaves of *T. occidentalis* and *T. gigantea*.

Thuia occidentalis.

A tree of variable height according to locality; at its greatest development 50—60 feet high with a trunk 2—3 feet in diameter; oftener 30—40 feet high, the trunk sometimes dividing into two or three upright secondary stems furnished with short branches which turn upwards and form a rather compact head.* In Great Britain a tree of narrowly conical or columnar outline, in dry soils rather sparsely ramified, rarely exceeding 30 feet high, with a slender trunk covered

* Silva of North America, X. 126.

with smooth brown bark and frequently dividing at a greater or less distance from the ground into two or more secondary stems. Branches short, spreading, sometimes curved or tortuous, covered with smooth reddish brown bark, and terminating in flat branchlet systems in which the ramification of the axial shoots is distichous and alternate, this branching being repeated three times, and the latest growths almost always on the anterior side of the next older. Leaves persistent on the axial growths three — four years, becoming effete in the second and third years, ovate, acute, closely imbricated and often glandular; on the lateral growths smaller, the lateral pairs compressed and sharply keeled, the dorsiventral pairs flat, concrescent and mostly glandular; the young branchlets and their appendages light dull green, changing to yellowish brown in winter and emitting a strong aromatic odour when bruised. Staminate flowers with four anthers. Strobiles about 0·5 inch long, composed of eight — ten ovate, obtuse scales, of which the larger middle pairs are fertile, each scale bearing two seeds, the seeds bordered by a thin wing on each side.

Thuia occidentalis. Linnaeus, Sp. Plant. II. 1002, exclu. hab. Siberia (1753). Michaux, Hist. Arbr. Amer. III. 29, t. 3 (1813). L. C. Richard, Mém sur les Conif. 43 (1826). Loudon, Arb. et Fru. Brit. IV. 2454, with figs. Endlicher, Synops. Conif. 51. Carrière, Traité Conif. ed. II. 108. Parlatore, D. C. Prodr. XVI. 438 (Thuya). Hoopes, Evergreens. 317, with fig. Gordon, Pinet. ed. II. 403. Macoun, Cat. Canad. Plants, 459. Beissner, Nadelholzk. 32, with fig. Masters in Journ. R. Hort. Soc. XIV. 76; and Gard. Chron. XXI. ser. 3 (1897), p. 213, with figs. Sargent, Silva N. Amer. X. 126, t. 532. And many others.

Eng. Arbor Vitae. Amer. White Cedar. Fr. Arbre de Vie. Germ. Lebensbaum. Ital. Albero della Vita.

Very many deviations from the common form have appeared under cultivation either in seed beds or as branch-sports and have received distinctive names at the hands of horticulturists, but it is extremely doubtful whether the greater part of them can be now identified. The following varieties are the most distinct still met with in British gardens; they are highly useful decorative plants for the lawn and small gardens, being for the most part of better habit and colour than the common form.

var.—dumosa (syn. *pygmaea*).

One of the dwarfest of Thuias; a dense little confused bush seldom growing more than 2 to 3 feet high, with branchlet systems and foliage of a decided brown tint much like those of the variety *plicata*.

var.—Ellwangeriana.

A dwarf or medium-sized shrub with numerous erect or sub-erect branches and slender branchlets at first clothed with dimorphic (juvenile and adult) foliage; the primordial leaves linear, acute, spreading; the adult leaves scale-like and concrescent as in the type. It is a transitional form connecting the variety *ericoides* with the type.

var.—ericoides.

A dwarf globose or sub-pyramidal bush with slender branchlets clothed with linear primordial spreading leaves only, somewhat distantly arranged in decussate pairs on their stems, and which in winter assume a brownish tint like the adult leaves.

T. occidentalis ericoides, Beissner. Retinispora dubia, Carrière.*

var.—lutea (syn. *elegantissima*)

A low tree of pyramidal or columnar habit in which the branchlet systems of the current year with their foliage are bright yellow above and orange-yellow below; it differs in habit and colour from the variety *Vervaeneana*. **lutea nana** is a diminutive sub-variety of the same colour.

T. occidentalis lutea, Hort. George Peabody's Arbor Vitæ, Hort. Amer.

var.—pendula.

In this variety the primary branches are more slender than in the common form and bent downwards at a short distance from their insertion, and the branchlets much tufted.

var.—plicata.

A smaller and denser tree with shorter branches; branchlet systems rigid, and taking an erect and parallel position like those of *Thuia orientalis*; the foliage distinctly glandular, and of a brownish green tint almost peculiar to this variety. **plicata argenteo-** and **aureo-variegata** are variegated forms, the first with white, the second with yellow branchlets.

T. occidentalis var. plicata, Masters in Gard. Chron. XXI. ser. 3 1897 p. 258, with figs. T. plicata, Parlatore, D. C. Prodr. XVI. 457 (not Don). Beissner, Nadelholzk. 44 (not Don).

var.—Spaethii.

A monstrous form in which the youngest branchlets are much crowded and clothed with primordial leaves thicker in texture than the ordinary ones; these branchlets are succeeded by acutely tetragonous branchlets sparsely ramified and clothed with scale-like, sharply-pointed leaves.

T. occidentalis var. Spaethii, Hort. Ruppel *fide* Spath. in Cat.

var.—Vervaeneana.

A smaller and denser tree than the common form and one of the most distinct and ornamental of all the varieties of the American Arbor Vitæ. During the growing season, all the branchlets, which are more slender than in the species, are tinged with a deep golden-yellow, which changes in winter to a brownish-orange, and finally to the normal green of the species, when they are succeeded by a new growth of yellow sprays.

var. Wareana.

A low tree of denser habit than the type with short branches that are at first horizontal, then ascending; branchlets numerous with close-set ramifications, frequently erect and parallel as in *Thuia orientalis*; foliage of a deeper, brighter green than that of the common form. **Wareana aurea** (syn. *plicata aurea*) has many of the youngest

* *Thuia occidentalis ericoides*, which should not be confounded with *Cupressus thyoides ericoides*, has probably disappeared from British gardens. It originated in a nursery at Frankfort, and is still cultivated in Germany. *Ex Beissner.*

branchlets bright golden yellow which changes to light green in winter.*

T. occidentalis var. Wareana, Masters in Gard. Chron. XXI. ser. 3 (1897), p. 258. T. Wareana. Hort. T. occidentalis var. robusta. Carrière, Traité Conif ed. II. 109.

The geographical range of *Thuia occidentalis* may be roughly stated as extending over the eastern portion of the North American continent from Nova Scotia westwards to Lake Winnipeg and meridionally from James Bay to southern Virginia. It is very common in the great areas of swamp land in Canada and the north-eastern United States, becoming less abundant southwards, and dwindling to a small scrubby bush at its northern limit.

Thuia occidentalis was probably the first American coniferous tree cultivated in Great Britain; it was introduced prior to 1597 in which year it was mentioned by Gerrard in his "Historie of Plants." Originally planted as an ornamental tree when the species of evergreen trees for garden decoration were few in number, it receded in time before the more attractive Conifers subsequently introduced, and it is now for the most part relegated to such uses as the formation of high hedges where the soil is sufficiently moist, or associated with other common Conifers for belts and screens. On dry and sandy soils *Thuia occidentalis* grows slowly and becomes too thin and unfurnished to be of any ornamental value; in the humid climate of Perthshire, the west of Scotland and Ireland handsome well-furnished specimens may frequently be seen.

The wood is soft, light and brittle, rather coarse-grained and very fragrant; it is remarkable for durability, of which many striking instances are recorded, and on this account it is much used for outdoor carpentry, as fencing, bridges, railway ties, etc.

Thuia orientalis.

A low tree of columnar or pyramidal habit, often a dense shrub of broadly conical or globose outline, the arborescent form rarely exceeding 20—25 feet in height with a much-branched trunk covered with thin reddish brown bark that peels off in longitudinal shreds. Primary branches first spreading, then ascending; in the shrubby forms, crowded, erect or ascending; secondary branches numerous, erect or ascending, terminating in vertical branchlet systems distichously ramified. Leaves in decussate pairs; on the older axial growths acicular, free at the apex; on the lateral ramifications scale-like, ovate, acute, concrescent or imbricated, bright green in summer, brownish in winter. Staminate flowers globose with eight—twelve anthers in decussate pairs. Strobiles ovoid-oblong, about an inch long, composed of six, rarely eight ovate, thickish, imbricated scales terminating above in a horn-like process, the uppermost pair much smaller than the others and sterile, each fertile scale bearing one—two wingless seeds.

* The distinction made in the text between the varieties *plicata* and *Wareana* is not always very obvious; the two forms are nearly identical in habit, but *plicata* has a decided brownish tint even in summer which distinguishes it from the bright green of *Wareana*. There are, however, in cultivation, intermediate forms that may with equal right be referred to either.

Thuia orientalis, Linnaeus, Sp. Plant. II. 1002 (1753). Thunberg, Fl. Jap. 266 (1784). L. C. Richard, Mém. sur les Conif. 40 (1826). Siebold and Zuccarini, Fl. Jap. II. 31, t. 118 (1842). Loudon, Arb. et Frut. Brit. IV. 2459, with figs. Masters in Journ. Linn. Soc. XVIII. 488; and Journ. R. Hort. Soc. XIV. 252 (Thuya).

Biota orientalis, Endlicher, Synops. Conif. 47 (1847). Carrière, Traité Conif. ed. II. 93. Parlatore, D. C. Prodr. XVI. 461. Boissier, Fl. orient. V. 701. Beissner, Nadelholzk. 54, with figs.

Eng. Chinese Arbor Vitae. Fr. Thuia de la Chine. Germ. Morgenländisher Lebensbaum. Ital. Albera della Vita chinese. Jap. Kinote-gashiwa.

The note under *Thuia occidentalis* respecting the numerous deviations from the common form which have appeared under cultivation is equally applicable to *T. orientalis*. This species has also proved to be very polymorphous, a circumstance that has been fruitful, not only in the multiplication of varietal names,* but also in the creation of many so-called species. The following are the most distinct and ornamental met with in British gardens.

var. argenteo-variegata.

This differs from the common form in having many of its branchlets cream-white. The variegation is somewhat inconstant, and not infrequently disappears altogether in vigorous subjects.

var. aurea.

A dwarf dense globose shrub in which the youngest growths are golden yellow in spring, gradually changing with age to the bright green of the species.

T. orientalis aurea, *supra*. T. aurea, Hort. Biota orientalis aurea, Carrière, And others.

var. aureo-variegata.

This has about one-half of the youngest branchlet systems light yellow; it resembles the common form in habit, and is quite distinct from the variety *aurea*.

var. decussata.

A dwarf shrub usually with several erect stems that are densely ramified, the primary and the secondary branches also erect. The foliage is protomorphic only, the acicular leaves greyish green in summer, changing to dull brown in winter.

T. orientalis decussata, *supra*. Biota orientalis decussata, Beissner, Nadelholzk. 58, with fig. Retinispora juniperoides, Carrière, Traité Conif. ed. II. 140. R. squarrosa dubia, Hort.

var. elegantissima.

A dwarf variety of fastigiate habit: the branchlet systems usually more rigid than in the type, and of a fine golden yellow which is retained throughout the summer months.

var. funiculata (syn. *intermedia*).

This differs from the common form in its youngest branchlet systems which are ramified from all sides of the axial growths (not distichous): the branchlets slender, elongated: the leaves ovate-lanceolate, acute, and adnate at the base only.

* Carrière has described twenty one varieties of *Thuia orientalis* and Beissner twenty-five excluding six of Carrière's.

var.—japonica (syn. *falcata*).

In this form the lowermost branches are spreading and the tree has a broadly pyramidal outline, the spread of the lower branches nearly equalling the height of the principal stem.

var.—meldensis.

A low columnar tree with ascending branches often so flexible as to bend in any direction. The leaves are protomorphic, acicular, acute, bluish glaucous green, changing to reddish brown in winter; in vigorous plants sometimes passing into the normal scale-like form of the type.

T. orientalis meldensis, *supra*. Biota orientalis meldensis, Beissner, Nadelholzk. 58, with fig. B. meldensis, Carrière, Traité Conif. ed. II. 102. Retinispora meldensis, Hort. Thuia hybrida, Hort.

var.—pendula.

This is the greatest divergence from the type yet seen. The branches are elongated into flexible, pensile, cord-like appendages very sparsely ramified; the branchlets are produced in tufts of five — twenty at irregular intervals along the axial growths and clothed with subulate acuminate leaves more distantly inserted than in the normal form.

T. orientalis pendula, Masters in Journ. R. Hort. Soc. XIV. 252. T. pendula, Lambert, Genus Pinus, ed. II. Vol. II. p. 115. Siebold and Zuccarini, Fl. Jap. II. 30, t. 117. T. filiformis, Lindley in Bot. Reg. (1842), t. 20. Biota pendula, Endlicher, Synops. Conif. 49. B. orientalis pendula Carrière, Traité Conif. ed. II. 100. B. orientalis filiformis, Beissner, Nadelholzk. 63. And many others.

var.—pygmæa.

The most diminutive of all the varieties of *Thuia orientalis*; it forms a small hemispherical bush a few inches high which has a yellowish brown tint. It is also known in gardens under the name of *Biota dumosa*.

The habitat of the Chinese Arbor Vitæ cannot be stated with certainty, but from its hardiness it may safely be assumed to have a northern origin that may hypothetically be referred to the botanically unexplored regions in southern Mongolia, northern China and parts of Thibet. The statement of Thunberg and others that it occurs wild in the central mountains of Japan has not been confirmed by later investigation, and it is now generally believed to be an introduced plant in that country. The geographical range of *Thuia orientalis* must, however, be very extensive, since Boissier's statement that it has been found wild at Asterabad in north-east Persia and also in the Persian province of Khorassan is doubtless well authenticated.

The date of introduction of *Thuia orientalis* into Great Britain is unknown. According to Aiton* it was cultivated by Philip Miller in the "Physic" garden at Chelsea in 1752, and was believed to have been first sent to Europe by French missionaries. On account of its hardiness and distinctness as an ornamental tree requiring but little space for its development, it has always been one of the most appreciated of Conifers.

* Hortus Kewensis, ed. II. Vol. V. p. 322.

and prior to the introduction of the western American and Japanese Cupressineæ many varieties were in cultivation which have since disappeared. Of the varieties described above *decussata* is a "juvenile" form of distinct and even picturesque aspect when seen at its best; its origin is not accurately known; *funiculata* and *meldensis* are transitional forms in which the adult foliage predominates in the former and the primordial leaves in the latter; *funiculata* is also intermediate in habit between the variety *pendula* and the common form; *meldensis* originated at Meaux in France and was at first supposed to be a hybrid between *Thuia orientalis* and *Juniperus virginiana*; but seeds having been produced by a tree growing under favourable conditions and the seedlings from these having for the most part reverted to the normal *Thuia orientalis* its hybrid origin is thence dispelled.* *Pendula*, the most remarkable of all the varieties and long believed to be a distinct species, is now known to have originated from the common form: it was first met with in Japan by Thunberg (1776–1777) and subsequently by other travellers in that country and also in China; forms perfectly identical have since been raised in Italy, France and England. It was first cultivated in this country by Mr. Aylmer Lambert in his conservatory at Boyton in 1832; his plant, the only one then known, had been previously acquired from Messrs. Loddiges of Hackney.

Although *Thuia orientalis* and its varieties grow in diverse soils and situations, they attain their best development in a retentive loam with a porous but not too free sub-soil and in places not too much exposed to north and north-east winds; under such conditions the branches are stouter, the branchlet systems more rigid and their colour brighter; they are rarely killed by our severest winters.

LIBOCEDRUS.

Endlicher, Synops. Conif. 42 (1847). Parlatore, D. C. Prodr. XVI. 453 (1868). Bentham and Hooker, Gen. Plant. III. 426 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 95 (1887). Masters in Journ. Linn. Soc. XXX. 19 (1893).

A genus of evergreen trees of Thuia-like aspect, mostly with spreading branches and flattened branchlet systems, distinguished by the following characters:—

Leaves dimorphic, scale-like in four ranks decussately arranged, the larger lateral pairs compressed, imbricated, with a decurrent base and sharply keeled; and almost covering the smaller, concrescent, dorsiventral pairs.

Flowers monœcious. Staminate flowers terminal, sub-globose or four-sided, composed of eight–twelve or more stamens, arranged like the leaves, each with a broadly ovate or sub-orbicular connective bearing four anther cells.

Strobiles terminal on short lateral branchlets, composed of four–six valvate scales of which the uppermost pair and also the lowermost when there are six, are sterile and much smaller than the fertile pair, each of which bear one–two winged seeds.

Libocedrus is thence separated from Thuia by little else than the greater number of stamens in the male flower and the fewer number of scales in the fruit; but besides being fewer in number the scales of the

* Beissner, Nadelholzkunde, p. 58.

fruit are also of unequal size and in the closed fruit meet at their edges (that is to say—they are placed in a valvate position). In Thuia the scales of the fruit are of equal size or nearly so and overlap (imbricated). This difference in the structure of the fruit is by far the most important distinction, and is admitted by all authors since the genus was founded by Endlicher, to be sufficient for its retention.

Eight species of Libocedrus are known to science; their habitats are widely remote from each other, except in the case of two inhabiting Chile and two in New Zealand; one is a native of California, one of southern China; one has been discovered in New Guinea, and one in New Caledonia. All the species that have been applied to any economic use yield highly valuable timber; the wood is durable, straight-grained and fragrant, and is suitable for many constructive purposes whether exposed to the weather or within doors.

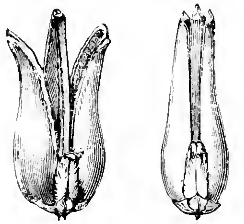


Fig. 73. Open and closed strobile of *Libocedrus decurrens*.

Libocedrus is derived from λίβανος, the name of a tree from which the ancients obtained frankincense but which has not been satisfactorily identified by modern botanists, and κέδρος, cedar, juniper.

Libocedrus chilensis.

A medium-sized tree of pyramidal outline, the trunk usually free of branches near the ground and covered with roughish, fissured, dark brown bark. In Great Britain the oldest trees have a broadly columnar habit, the outer bark of the trunk peeling off in small flakes and exposing a light brown inner cortex. Branches with smooth reddish brown bark, ascending and much ramified at their distal end; branchlets slender, distichously ramified into frondose systems similar to those in Thuia. Leaves of the axial growths linear and adnate except at the acute, inflexed tip; of the lateral growths the dorsiventral pairs scale-like; the lateral pairs oblong, acute with a white stomatiferous band on both sides. Staminate flowers with eight ten anthers. Strobiles usually solitary, terminal, composed of four ovate-oblong scales of which the fertile two are twice as broad as the sterile two, and bear one two seeds each.

Libocedrus chilensis. Endlicher, Synops. Conif. 44 (1847). Gay. Fl. Chil. V. 406 (1849). Lindley in Gard. Chron. 1850 p. 439, with fig. Carrière, Traité Conif. ed. II. 89. Parlatore, D. C. Prodr. XVI. 455. Gordon. Pinet. ed. II. 180. Masters in Journ. R. Hort. Soc. XIV. 42.

Thuia chilensis Don in Lambert's Genus Pinus. ed. I., Vol. II. 19 (1824). Hooker. W. in Lond. Journ. Bot. II 199, t. 4.

Eng. Chilian Arbor Vitae. Fr. Thuia de Chile. Ital. Albero della Vita di Chile. Chil. Ciprès de Araucano.

Libocedrus chilensis is common in some of the valleys and along the lower slopes of the Chilian Andes from Valparaiso southwards to Valdivia. The wood is soft and easy to work, and is highly valued by the inhabitants for indoor carpentry on account of its fragrance.

The earliest published notice of this tree occurs in Lambert's "Genus Pinus," *loc. cit. supra*, where a brief description is given by David Don from materials found in the herbarium of the Spanish botanists, Ruiz and Pavon, which had been acquired by Mr. Lambert. Many years afterwards the species became better known from herbarium specimens communicated to Sir William Hooker by Dr. Gillies, of Mendoza,* by Bridges, and by Mr. James Veitch, Senr., of Exeter, through his collector, William Lobb. It was introduced by Messrs. Low, of Clapton, in 1847; *Libocedrus chilensis* must, however, be pronounced an unsatisfactory tree for the British climate; it loses its lower branches at an early age, and even in sheltered situations rarely escapes injury in severe winters.

Libocedrus decurrens.

A lofty tree 100—150 feet high with the trunk sometimes 7—8 feet in diameter, covered with loose, fibrous, cinnamon-red bark and sparingly furnished along the upper portion with stout branches that are at first horizontal, but soon turn upwards and form secondary stems that are similarly branched. In Great Britain a tall tree of columnar habit, the trunk large in proportion to its appendages and covered with reddish brown bark that peels off in longitudinal shreds. Primary branches short, spreading or ascending; ramification of secondary branches mostly lateral, the bark marked by a pale ring at every branching; in the branchlet systems the distichous branching is constant and in one plane. Leaves persistent three—four years, glandular, narrowly oblong, acute, decurrent and adnate except at the acute tip, the larger and longer lateral pairs sharply keeled and nearly covering the smaller dorsiventral pair, dark glossy green, of a shade almost peculiar to this species. Staminate flowers small, club-shaped, composed of twelve—sixteen stamens each with a suborbicular connective. Strobiles pendulous, ovoid-cylindric, about an inch long, consisting of six scales, the lowermost pair much the smallest, the fertile middle pair as large again as the upper two which are connate. Seeds in pairs at the base of the two larger scales each with a hatchet-shaped membraneous wing.

Libocedrus decurrens, Torrey, Plant. Fremont, Smiths. Contrib. VI. 7. t. 3 (1850). Lindley in Gard. Chron. (1853) p. 695. Parlatore, D. C. Prodr. XVI. 456. Murray in The Garden, II. (1872), p. 540, with figs. Nicholson in Woods and Forests (1884), p. 190. Brewer and Watson, Bot. Califor. II. 116. Hoopes, Evergreens, 309, with fig. Gordon, Pinet. ed. II. 181. Beissner, Nadelholzk. 28, with fig. Masters in Journ. R. Hort. Soc. XIV. 219. Sargent, Silva N. Amer. X. t. 534.

Thuia gigantea, Carrière in Van Houtte's Fl. des Serres, IX. 199, with fig.; and Traité Conif. ed. I. 105; ed. II. 112 (in part, not Nuttall).

T. Craigiana, Murray in Rep. Oreg. Exped. 2, t. 5.

Heyderia decurrens, Koch, Dendrol. II. 179.

Eng. Californian Incense Cedar. Amer. White Cedar, Bastard Cedar, Post Cedar. Fr. Cèdre blanc de Californie. Germ. Californische Flusseeder. Ital. Cedro bianco della California.

Libocedrus decurrens is widely distributed along the western slopes of the Cascade and Sierra Nevada Mountains between 3,000 and 7,500 feet elevation from Oregon to near the Mexican boundary; also along the Californian coast range and southwards into the peninsula of Lower California. It nowhere forms pure forests, but occurs scattered

* His name is commemorated by the Liliaceous genus Gilliesia.

singly or in small groves amongst the other coniferous trees of the region. Its timber is highly valued: the wood is light, durable and close-grained, but not very strong: it is used for a great variety of purposes, including house furniture and indoor carpentry.*

The Californian Incense Cedar was originally discovered by Col. Fremont† near the upper waters of the Sacramento river in 1846. His botanical collections were placed in the hands of Dr. Torrey for determination, and this tree was described by him in the "Smithsonian Contributions to Knowledge" in 1850 as *Libocedrus decurrens*. Two years later, John Jeffrey who had been sent to north-west America by the Scottish Oregon Association, sent home specimens and seeds from South Oregon, and from these the tree was named *Thuia Craigiana* in compliment to Sir W. Gibson Craig, a prominent member of the Association, and the seedlings were subsequently distributed under this name. The confusion in name thus created was further complicated by Carrière who described the species from herbarium specimens sent by Boursier to the Muséum d'Histoire Naturelle at Paris in several publications‡ under the name of *Thuia gigantea*, on the assumption that it was the same tree that Nuttall had published under that name. Unfortunately, Carrière's name was taken up by horticulturists generally both in England and on the Continent, so that for a time scarcely any other pair of coniferous trees has been surrounded by more confusion than Torrey's *Libocedrus decurrens* and Nuttall's *Thuia gigantea*.

The introduction of *Libocedrus decurrens* enriched British gardens with one of the most beautiful and distinct of the Conifers of western North America. Stately columnar trees from 30 to 50 or more feet high now adorn the lawns and pleasure grounds of numerous country seats throughout Great Britain and Ireland. It is perfectly hardy; it grows satisfactorily in almost any description of soil not marshy or water-logged, increasing in height annually from 9 to 15 inches, the rate of growth corresponding nearly with the range of annual rainfall.

Libocedrus Doniana.

A lofty tree with a straight naked trunk sometimes 100 feet high and 2–5 feet in diameter, the old bark falling away in long thin ribbons. Branches few; branchlets distichous, alternate and flattened, but becoming four-angled in old trees. Leaves variable in form and arrangement at different stages of growth: the primordial leaves of young plants narrowly linear and spreading: on the adult tree dimorphic, arranged in decussate pairs; the lateral pairs compressed, acute, sharply keeled and attached by broad bases; the dorsiventral pairs concrescent, small, rhomboidal. Staminate flowers with eight—ten anthers. Strobiles composed of four ligneous scales each with a curved

* Silva of North America. X. 136.

† His name is commemorated by the beautiful monotypic Malvaceous shrub *Fremontia californica*.

‡ Revue Horticole 1854), p. 224. Van Houtte's Flore des Serres. IX. 199. Traité Général des Conifères. ed. I. 105. etc.

spine at the back; the fertile scales bearing two seeds each with an oblique membraneous wing. Kirk, *Forest Flora of New Zealand*, p. 157, t. 82.

Libocedrus Doniana, Endlicher, Synops. Conif. 43 (1847). Carrière, Traité Conif. ed. II. 85. Parlatore, D. C. Prodr. XVI. 454. Hooker fil. Handb. N. Zeal. Fl. 256. Gordon, Pinet. ed. II. 182.
Thuia Doniana, Hooker, W. in Lond. Journ. Bot. I. 571. t. 18 (1842).

Although not hardy in this country, this beautiful tree claims notice on account of its being in cultivation as a conservatory plant in botanic and occasionally in private gardens. Its habitat is restricted to a small area in the northern portion of the North Island of New Zealand, but it has now become extremely rare in many districts. The wood is of great beauty, straight in grain, and of great strength: it is highly valued for the manufacture of house furniture and ornamental woodwork. The species is dedicated to the Scottish botanist, David Don.

Closely resembling *Libocedrus Doniana*, and from which it is not separated by any marked distinctive characters, is a form or variety which has received the name of *L. Bidwillii*. It is described as being "smaller in all its parts" than *L. Doniana*, and is spread generally over New Zealand from Harauk's Gulf southwards to Catlin's River, showing a preference for mountain and hilly districts, ascending in places to 4,000 feet above the level of the sea.*

David Don (1800—1840) was a native of Forfar. His father, the proprietor of a nursery at that place, was well known as a good, practical botanist, and thence able to impart to his son an elementary scientific knowledge of the plants of his native country. One of David's earliest publications was the description of a number of plants which were either entirely new or had been only found in a few localities where they had been collected by his father; this was a valuable contribution to the botany of our native country, and which soon brought the author under the notice of the leading naturalists of that period. He then published in the Transactions of the Linnean Society a monograph of the genus Saxifraga, and was shortly afterwards appointed Librarian to the Society. In 1836 he succeeded Professor Burnett in the chair of botany at King's College, London, a position which he held till his death. His numerous works are sufficient proof of his industry; among them are his papers in the "Transactions of the Linnean Society," in one of which he described for the first time *Abies bracteata* and three Pines from South California from materials collected by Dr. Coulter; and in another he founded the genera Cryptomeria and Athrotaxis. He rendered much assistance to Mr. Lambert in the preparation of the later editions of his "Genus Pinus," in which he published for the first time descriptions of several coniferous trees previously unknown, including *Cupressus nootkatensis, Thuia plicata* (*gigantea*), *Libocedrus* (*Thuia*) *chilensis, Juniperus recurva* and three or four species of Podocarpus. Towards the end of 1840 a malignant tumour appeared on his lip which caused his death at the early age of forty.

Libocedrus macrolepis.

A tree of which the dimensions attained by it have not been published. Branchlets elongated, ramified distichously and alternately into frondose branchlet systems tri-pinnately divided. Leaves in decussate pairs, dimorphic; on the axial growths the lateral pairs linear, acute, strongly keeled, free at the tip; the dorsiventral pair much smaller, scale-like, triangular and almost concealed by the lateral pair; on the lateral and youngest growths much smaller and sub-equal, the lateral

* Kirk, Forest Flora of New Zealand, pp. 160, 161.

pair boat-shaped, conduplicate and sharply keeled; the dorsiventral pair obovate, concrescent and glandular. Staminate flowers four-angled, composed of eight—ten stamens in decussate pairs. Strobiles conic-cylindric, about an inch long, consisting of six ligneous scales, the lowermost pair minute and reflexed, the middle fertile pair broadly oblong, the uppermost pair narrowly linear. Seeds one to each fertile scale, with an obovate-oblong, oblique wing.

Libocedrus macrolepis. Bentham and Hooker. Gen. Plant. III. 426 (1881). Masters in Journ. Linn. Soc. XVIII. 485.
Calocedrus macrolepis, Kurz in Journ. Bot. XI. 196, fig. 3 (1873).

This species was discovered in the Chinese province of Yun-nan by Dr. Anderson, who was attached as medical officer and naturalist to an expedition under Major Sladen, 1870—1871. The discovery was a remarkable one, as it extended the distribution of the genus into a region far remote from the species inhabiting California, Chile and New Zealand. It has since been gathered in the same province by Dr. Henry, and by the Veitchian collector, E. H. Wilson, but the attempts to introduce it into British gardens have thus far been unsuccessful.

Libocedrus tetragona.

A tree of variable height and habit, according to situation and environment; at its greatest development attaining a height of 60—80 feet but frequently much less; at its highest vertical range reduced to a dense bushy shrub. In the arborescent form the primary branches are stoutish, spreading or ascending, forming a conical or sub-pyramidal crown. In Great Britain of shrubby habit, 9—12 feet high, with erect or sub-erect branches densely ramified. Branchlets tetrastichous (four-ranked), the youngest shoots very short. Leaves on the axial growths broadly ovate, acute, adnate except at the tip, persistent four—five years; on the lateral shoots ovate-lanceolate, subtrigonal, acute, spreading, grass-green with a greyish triangular stomatiferous area on the flat dorsal side. Staminate flowers not seen. Strobiles subtended at the base by four subulate acute bracts, and composed of two decussate pairs of scales, each with an incurved mucro at the back, and of which the broader fertile pair bear one—two winged seeds.

Libocedrus tetragona, Endlicher, Synops. Conif. 44 (1847). Lindley in Paxton's Flower Garden, I. 46, with fig. Carrière. Traité Conif. ed. II. 86. Parlatore, D. C. Prodr. XVI. 454. Gordon, Pinet. ed. II. 183. Masters in Journ. R. Hort. Soc. XIV. 219.
Thuia tetragona, Hooker, W. in Lond. Journ. Bot. III. 141. t. 4.

Libocedrus tetragona inhabits the western slopes of the Andes of southern Chile, but very little is known of its actual distribution over that region, and the little that is known is confused by being mixed up with *Fitzroya patagonica*. Its northern limit may be placed at about the 35th parallel of south latitude, whence it spreads southwards to beyond the 45th parallel, and as some authors state, to the Straits of Magellan; but from Valdivia southwards it is either associated with, or its place is wholly taken by the Fitzroya which is known to be abundant on the Patagonian littoral and the adjacent hills.* Its vertical range according to Philippi is from 2,000 to 3,000 feet.

Libocedrus tetragona has long been supposed to yield the valuable Alerze timber of the Chilians. This timber is almost indestructible by the weather; boards and shingles that have been exposed for upwards of a hundred years have been observed to be worn quite thin but remaining perfectly sound; it is reddish in colour, easy to work, and is used for every description of carpentry. From the fibrous inner bark is obtained a kind of tow which is much used by the seafaring people of Chiloe and the adjacent coast for making the joints of their skiffs and small craft water-proof. From specimens received from several sources, Sir William Hooker identified the Alerze of the Chilians with *Libocedrus tetragona*, but this identification was called into question by Richard Pearce, who went to Chile in 1859 as a collector for the Veitchian firm. In a letter to the late Mr. James Veitch, dated from Valparaiso, he writes:—"It is *Fitzroya patagonica* which furnishes the timber known throughout Chile as Alerze, not *Libocedrus tetragona* which is everywhere known as Ciprès. It is the bark of the Fitzroya that the natives use to caulk their boats: the Libocedrus is a more elegant tree than the Fitzroya, although never attaining its dimensions; its bark is only about half-an-inch thick, whilst that of the Fitzroya is three inches thick, very tough, fibrous and deeply furrowed. The Libocedrus usually grows in swampy places in the hollows of the mountain valleys, Fitzroya on the rocky declivities."

Fig. 74. *Libocedrus tetragona.*

Libocedrus tetragona was introduced in 1849 by Messrs. Veitch through their collector William Lobb, but it has now become extremely rare in this country. The climate of the region it inhabits is one of the most equable and also one of the most humid in the world; for upwards of six months of the year rain falls daily, and on rainless days the sky is sometimes overcast for weeks together; the average summer temperature is about the same as that of Great Britain, but the mean winter temperature is higher. These climatic phenomena and the localities *L. tetragona* affects go far to account for its failure in Great Britain.†

* The foliage of old trees of *Libocedrus tetragona* so closely resembles that of *Fitzroya patagonica* that the two can scarcely be distinguished except by their fruits: it is thence not improbable that at the southern limit of the Libocedrus the one might be mistaken for the other.

† The best specimen known to the author is at Kilmacurragh in Co. Wicklow, Ireland, from which materials for description were communicated by Mr. Thomas Acton.

TRIBE—TAXODINEÆ.

Flowers monœcious, on different branches. Staminate flowers solitary, spicate, paniculate or umbellate; terminal or axillary; stamens spirally crowded. Scales of strobiles spirally arranged and composed of two structures at first distinct, the ovuliferous scale and a bract-like appendage which coalesces with it and becomes obliterated in the mature ligneous, seed-bearing scale. Ovules 2—9, erect or inverted.

Leaves homo- or heteromorphic, persistent.
  Staminate flowers solitary.
    Anther cells, 2. Strobiles globose with the scales ascending, sub-acuminate at the apex.
    Seeds 3—6 pendulous - - - - - - 6—Athrotaxis
  Staminate flowers spicate.
    Anther cells 3—5. Strobiles globose with the scales ascending, sub-peltate and acutely lobed at the apex.
    Seeds 4—5 erect - - - - - - - 7.—Cryptomeria.
    Anther cells 2—5. Strobiles cylindric with the scales horizontal and thickened into a rhomboidal apex with a transverse depression at the centre.
    Seeds 5—7 pendulous - - - - - - 8.—Sequoia.
Leaves homo- or dimorphic, deciduous.
  Staminate flowers paniculate or solitary.
    Anther cells 4—8. Strobiles globose or obovoid with the scales imbricated, rugose and obscurely mucronate.
    Seeds 2 erect - - - - - - - 9.—Taxodium.
Leaves dimorphic, squamiform and cladodiform (*i.e.*, deciduous scale-like leaves and persistent leaf-like structures that perform the functions of foliation).
  Staminate flowers umbellate.
    Anther cells 2. Strobiles ovoid-cylindric, the scales imbricated with a transverse ridge beyond the middle and not thickened at the apex.
    Seeds 7—9 erect - - - - - - - 10—Sciadopitys.

ATHROTAXIS.

D. Don in Trans. Linn. Soc. XVIII. 172, t. 14 (1839). Endlicher, Synops. Conif. 193 (1847. Arthrotaxis). Parlatore, D. C. Prodr. XVI. 433 (1868). Bentham and Hooker, Gen. Plant. III. 430 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 89 (1887). Masters in Journ. Linn. Soc. XXX. 21 (1893).

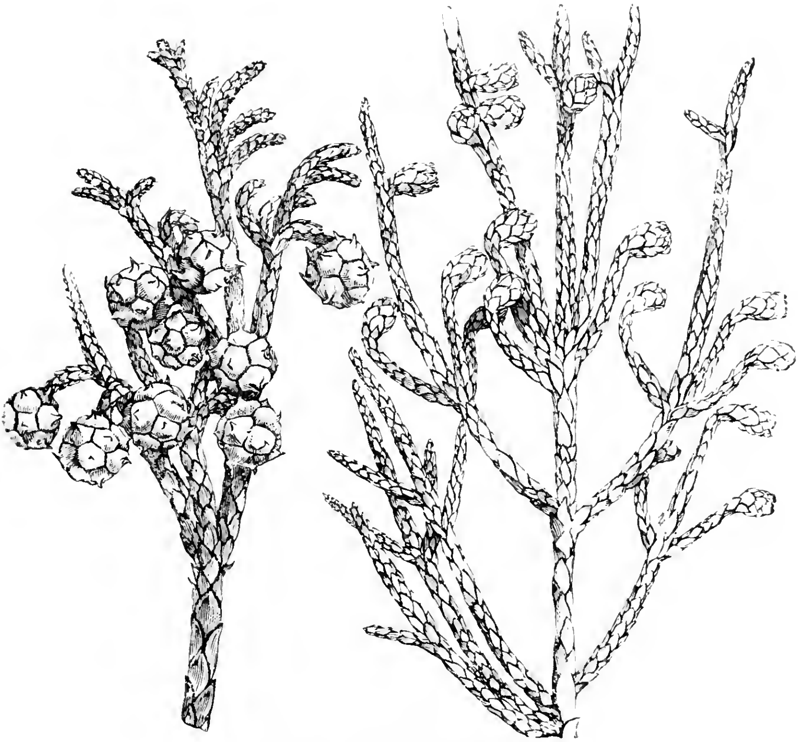


Fig. 75. *Athrotaxis cupressoides.*
(From the *Gardeners' Chronicle.*)

Athrotaxis* is a genus of much-branched evergreen trees of low or medium stature and of pyramidal or columnar habit, clothed with short, thick, homo- or dimorphic leaves which are either concrescent with their axes, adnate at the base and free at the apex, or slightly spreading and more or less incurved. It is further distinguished by the following characters:—

Flowers monœcious on different branches; the staminate flowers small, solitary and terminal on branchlets of the preceding year, with crowded, imbricated stamens subspirally arranged, each formed of a slender stipes expanded into a transverse peltate connective from which the two anther cells hang.

Ovuliferous flowers also terminal, nearly globose, composed of ten to

* Errore Arthrotaxis auctorum fere omnium.

twenty imbricated scales, having a thickened broad disk from which are suspended three—six ovules.

Strobiles ligneous, globose, from 0·5 to 1 inch in diameter; scales ovoid-rhombic, cuneate at the base, sub-acuminate or peltately dilated at the apex, ascending, each with three—six winged seeds.

The genus is the most restricted of the tribe in which it is included, as regards its geographical distribution, being confined to a few localities in Tasmania chiefly on the Western Mountains ascending in places to the summit which is about 4,000 feet above the level of the surrounding ocean.

As seen at their best development in Great Britain, the Athrotaxes are Cypress-like trees of distinct aspect and great beauty. They were introduced about the year 1857 by the late Mr. William Archer, of Cheshunt, and although fairly hardy in many parts of the country, they are only of value as decorative plants for the lawn and garden in the milder and more humid climate of Devon and Cornwall, parts of Wales, Ireland and similar places.

Fine specimens of Athrotaxis are growing at Menabilly, Cornwall *(A. laxifolia)*: Upcott near Barnstaple *(A. cupressoides)*: Castlewellan, Co. Down *(A. selaginoides* and *A. laxifolia)*: Powerscourt, Co. Wicklow *(A. cupressoides)*: and notably at Kilmacurragh in the same county where there is a tree of each species in robust health, from 25 to 30 feet high, all of columnar habit.

The generic name is from *ἀθρόος* (crowded), and *τάξις* (arrangement) in allusion to the crowded order of the scales of the fruit.

The nearest affinity is Cryptomeria, so near indeed that horticulturists sometimes avail themselves of it as a means of propagating the species of Athrotaxis.*

An especial interest is attached to the existing members of the Taxodineæ on account of the great antiquity of their ancestral forms, and of their intimate association with the vegetation of past ages. The striking resemblance of the species of Athrotaxis to the fossil remains of a Conifer found in the Upper Oolite (Mesozoic) of Solenhofen, and to other remains that have been found in Yorkshire, Argyllshire and the Thames Valley afford evidence that ancestral forms of Athrotaxis were widely distributed over the eastern hemisphere in remote epochs, and which have in the course of time succumbed to the ceaseless successive changes which have affected the Earth's surface and climate during geological ages, until they have receded to their last abiding place in the small island of Tasmania where they now exist in numbers so small that the individual trees could be counted. The fate of species so reduced in the number of the individuals comprising them is inevitable, although they may be preserved indefinitely by the hand of Man.

* The variety of *Cryptomeria japonica* with primordial leaves, known in gardens as *C. elegans*, is readily propagated from cuttings. These rooted cuttings are used as stocks for grafting scions taken from the species of Athrotaxis.

Athrotaxis cupressoides.

A conical tree 25—45 feet high with a trunk sometimes 1·5—2 feet in diameter near the ground. Bark reddish brown, peeling off in ribbon-like shreds exposing a cinnamon-brown inner cortex. Primary branches scattered, spreading or ascending, much ramified at the distal end. Branchlets in pseudo-whorls of five—seven, densely clothed with foliage. Leaves dimorphic, in decussate pairs, persistent several years and peeling off with the bark: on vigorous shoots oblong-acute, keeled, 0·5 inch long, appressed and imbricated; on the youngest shoots much smaller, scale-like, ovate-triangular, sub-acute, closely imbricated or concrescent with the stem, dark grass-green tinged with brown during the winter. Staminate flowers as described in page 259. Strobiles composed of five—six decussate pairs of scales, each with an acute pyramidal umbo and bearing three—five seeds.

Fig. 76.
Athrotaxis cupressoides.

Athrotaxis cupressoides, Don in Trans. Linn. Soc. XVIII. 173, t. 13, fig. 2 (1839). Hooker fil in Lond. Journ. Bot. IV. 148 (1845); and Fl. Tasman. I. 345. Endlicher, Synops. Conif. 196. Carrière, Traité Conif. ed. II. 205. Parlatore, D. C. Prodr. XVI. 433. Gordon, Pinet. ed. II. 47. Masters in Gard. Chron. XXIV. (1885), p. 273, with figs.; and Journ. R. Hort. Soc. XIV. 199.

Recorded localities.—Lake St. Clair, Pine River near Marlborough, and the Western Mountains.

Athrotaxis laxifolia.

A small tree 25—30 feet high with a slender trunk covered with reddish brown bark that peels off in longitudinal shreds. Primary branches scattered, close-set and spreading, ramification tetrastichous with occasional adventitious growths between the ranks. Leaves persistent several years, sub-spirally arranged or in decussate pairs, ovate-lanceolate, mucronate, more or less appressed to the stem, slightly incurved and attenuated from the base upwards, flat with two faint glaucous stomatiferous lines on the ventral side, convex-carinate and bright green on the dorsal side. Strobiles terminal, globose, about 0·75 inch in diameter, closely resembling those of *A. selaginoides* in structure but smaller in all their parts.

Fig. 77.
Athrotaxis laxifolia.

Athrotaxis laxifolia, Hooker, W. Icon. Pl. 573 (1843). Hooker fil in Lond. Journ. Bot. IV. 149 (1845); and Fl. Tasman. I. 354. Endlicher, Synops. Conif. 196. Carrière, Traité Conif. ed. II. 206. Parlatore, D. C. Prodr. XVI. 134. Gordon, Pinet. ed. II. 48. Masters in Gard. Chron. IX. ser. 3 (1891), p. 144, with fig.; Journ. Linn. Soc. XXII. 201, with fig.; and Journ. R. Hort. Soc. XIV. 199.
A. Doniana, Hort.

Recorded localities.—At the falls of the River Meander, and near the summit of the Western Mountains at about 4,000 feet elevation. This form is so nearly intermediate between *A. cupressoides* and *A. selaginoides* as to suggest the possibility of its being a hybrid between them.

Fig. 78. Fruiting branchlet of *Athrotaxis selaginoides*.
(From the *Gardeners' Chronicle*.)

Athrotaxis selaginoides.

Fig. 79.
Athrotaxis selaginoides.

A medium-sized tree attaining a height of 40—45 feet, the trunk covered with reddish brown bark (in Great Britain) peeling off in longitudinal shreds. Primary branches close-set, spreading, with tetrastichous ramification often much interrupted. Branchlets stoutish, similarly ramified. Leaves persistent four—five years, sub-spirally arranged, lax, incurved, subulate or subulate-lanceolate, mucronate with two glaucous stomatiferous bands on the ventral side, convex-carinate and bright green on the dorsal side, 0·25—0·5 inch long. Strobiles globose, about an inch in diameter, composed of numerous spirally crowded, broadly ovate scales, each with an acuminate point, and bearing three—six seeds.

Athrotaxis selaginoides, Don in Trans. Linn. Soc. XVIII. 172, t. 14. Hooker fil in Lond. Journ. Bot. IV. 148; and Fl. Tasman. I. 354. Endlicher, Synops. Conif. 194. Carrière, Traité Conif. ed. II. 203. Parlatore. D. C. Prodr. XVI. 134. Gordon, Pinet. ed. II. 48. Masters in Gard. Chron. IV. ser. 3 (1888), p. 545, with fig.; and Journ. R. Hort. Soc. XIV. 199.
A. Gunniana, Gordon, Pinet. ed. II. 47.
A. imbricata, Hort.

Recorded localities.—Falls of the Meander Rivulets, the Western Mountains, Cummings Head.

CRYPTOMERIA.

Don in Trans. Linn. Soc. XVIII. 166, t. 13, fig. 1 (1839). Endlicher, Synops. Conif. 71 (1847). Parlatore, D. C. Prodr. XVI. 437 (1868). Bentham and Hooker, Gen. Plant. III. 428 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 89 (1887). Masters in Journ. Linn. Soc. XXX. 23 (1893).

A monotypic genus inhabiting Japan, but now rarely seen wild in that country except in inaccessible spots on the lower mountain slopes in the central island, and which are believed to have been formerly covered with extensive forests of Cryptomeria till the presence of a dense population caused their destruction. There is also evidence of the Cryptomeria being indigenous in south-west China.* The generic characters are readily deducible from the description of the species.

Cryptomeria is a most interesting genus from a scientific point of view, it being one of a very few living representatives of a vegetation which has long since disappeared. At present confined to the Far East, except so far as it has been introduced into every other land in which horticulture is practised, there is abundant evidence in fossil remains to show that ancestral forms of the Cryptomeria had a wide distribution so early as Triassic and Permian times over a great part of Europe and northern Asia, the geological import of which is, that these ancestral forms were ingredients of the forests covering the northern part of the eastern continent countless ages prior to the appearance of Man. It is not improbable, too, that the nearest existing affinity of the Cryptomeria, the not less remarkable and interesting genus Athrotaxis, may have descended from these same ancestral forms, and which, during the lapse of æons and under the operation of the physical changes constantly but slowly affecting the Earth's surface, has gradually receded to the restricted insular area the species now inhabit.

Cryptomeria is from *κρυπτὸς* (hidden) and *μέρος* (a share or part), in reference to its obscure relationship to the Cedar.

Cryptomeria japonica.

A stately tree, attaining under favourable circumstances a height of 100—125 feet, usually divested of branches along the lower part of the trunk and crowned with a conical head; the trunk tapering somewhat abruptly from a broad base and covered with cinnamon-brown bark the exposed part of which (in Great Britain) peels off in long ribbon-like shreds. Primary branches irregularly disposed, close-set in young trees, the longest lowermost ones nearly always decumbent, those above horizontal or ascending; branchlets mostly lateral or sub-distichous. Leaves persistent four—five years, spirally arranged, linear-subulate, acuminate, four-angled, 0·25—0·5 inch long, straight or falcately curved towards the stem, bluntly keeled on the dorsal and sharply keeled on the ventral side, decurrent, dark lustrous green tinged with brown in winter. Staminate flowers numerous, collected in dense spikes about an inch long around the apical end and in the axils of the leaves of branchlets of the preceding year, cylindric, obtuse, 0·25 inch long, composed of numerous

* Dr. Henry in the Kew Bulletin, 1897, p. 409. Whether the Cryptomeria discovered by Dr. Henry in Yun-nan conforms to the Japanese type, or is specifically distinct, has not been determined.

spirally crowded stamens expanded at their apex into a broadly cordate connective from which depend three—five anther cells. Strobiles globose, solitary at the end of the branchlets or in pairs; scales obovate-cuneate, thickened at the extremity and more or less divided into sharply pointed lobes. Seeds three—five on each scale.

Cryptomeria japonica, Don in Trans. Linn. Soc. *loc. cit. supra.* Siebold and Zuccarini, Fl. Jap. II. 41, tt. 124, 125. Carrière, Traité Conif. ed. II. 191. Gordon in Journ. Hort. Soc. Lond. I. 57, with fig; and Pinet. ed. II. 73. Beissner, Nadelholzk. 141, with fig. Masters in Journ. Linn. Soc. XVIII. 497; and Journ. R. Hort. Soc. XIV. 203. And others.

Eng. Japanese Cedar. Fr. Cryptomeria du Japon. Germ. Japanische Cryptomerie. Ital. Cedro giapponese. Jap. Sugi.

var.—araucarioides.

A shrub or low tree not exceeding 5—7 feet high with deflexed branches and pendulous branchlets that are more distantly placed than in the common form. Leaves shorter, thicker and more closely imbricated.

C. japonica araucarioides, Siebold and Zuccarini. Fl. Jap. II. 52.

var.—elegans.

A smaller tree than the common form, with a robust trunk, short horizontal branches and branchlets decurved at the tip. Leaves primordial, linear, acuminate, decurrent, spreading or falcately curved and marked on both sides with a shallow median groove, bright green when first expanded changing to bronzy crimson towards the end of autumn.

C. japonica elegans, Masters in Journ. Linn. Soc. XVIII. 498. Beissner, Nadelholzk. 144, with fig. C. elegans, Carrière, Traité Conif. ed. II. 196. Gordon, Pinet. ed. II. 73.

var.—Lobbii.

A tall tree with an elongated spire-like outline and with a more compact habit than the type; branches shorter and more densely ramified; leaves longer, more closely appressed to the stems and of a darker green.

C. japonica Lobbii, Carrière, Traité Conif. ed. II. 192. Gordon, Pinet. ed. II. 76. C. Lobbii, Hort.

var.—nana.

A dwarf, dense, spreading shrub rarely exceeding a yard in height with much shortened, rigid branchlets clothed with close-set acicular spreading leaves about one-third the length of those of the type.

C. japonica nana, Siebold and Zuccarini, Fl. Jap. II. 52. Carrière, Traité Conif. ed. II. 193.

var.—sinensis.

Differs from the Japanese type in its more diffuse habit, deflexed branchlets, longer and more slender terminal growths, and its longer and more slender leaves.

C. japonica sinensis, Siebold and Zuccarini, Fl. Jap. II. 52. C. japonica Fortunei, Hort.

var.—spiralis.

A dwarf, spreading bush with more slender branches and branchlets to which the incurved leaves are so closely appressed as to simulate a spiral thread wound round them.

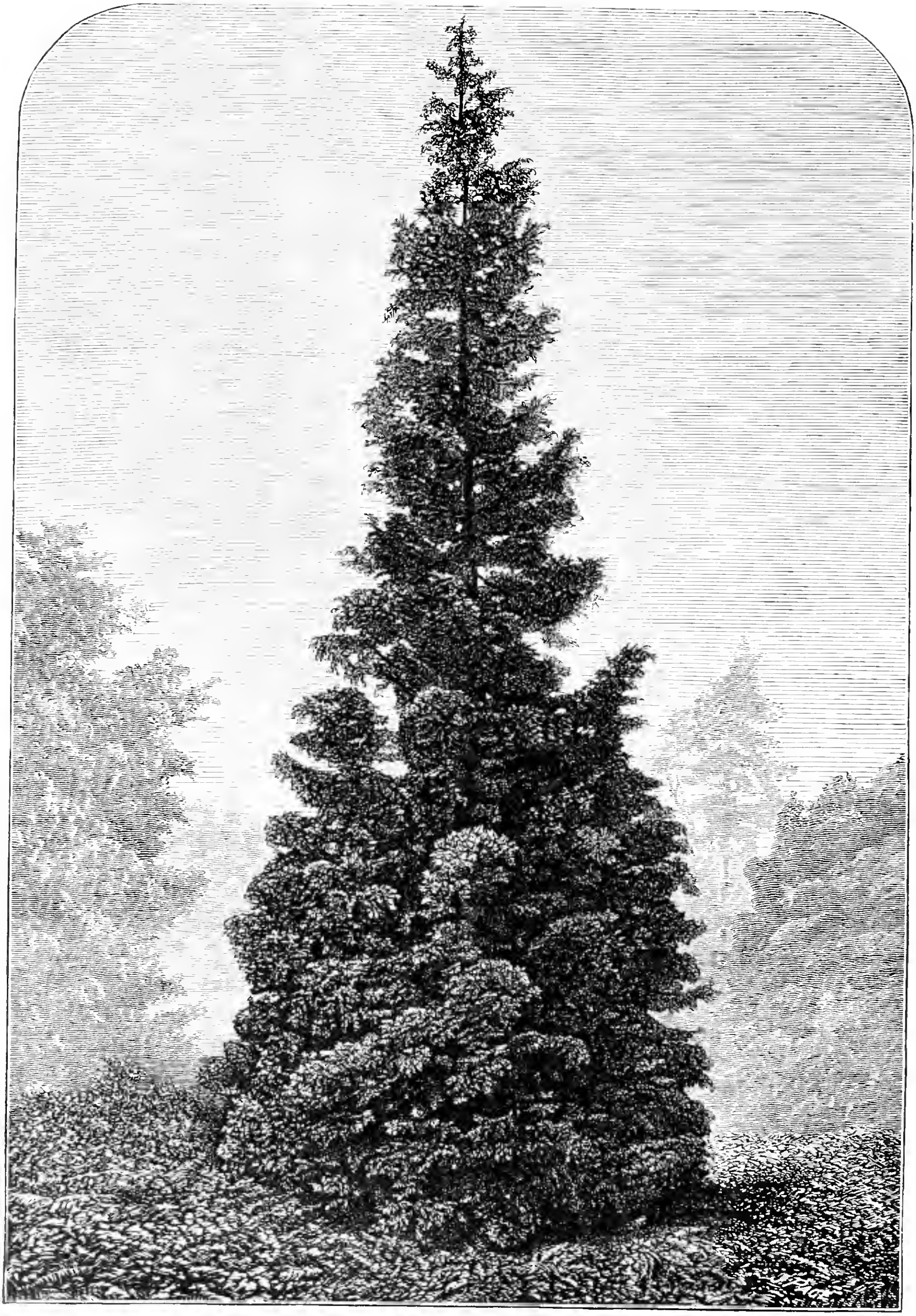
C. japonica spiralis, Siebold and Zuccarini, Fl. Jap. II. 72. Gordon, Pinet. ed. II. 423.

The Cryptomeria is one of the finest trees in Japan; it is seen almost everywhere throughout Hondo from north to south except on the highest part of the mountains; it is more used for reafforesting the denuded lands than any other tree, and extensive areas on the foot-hills and mountain slopes up to 3,000 feet elevation above sea-level have been planted with it for the sake of its timber alone, which is more used than that of any other coniferous tree: it is planted to form hedges and screens by the wayside; it has received assiduous attention from horticulturists for centuries past, and many curious and interesting varieties of it have been obtained by them; it is also planted to form avenues along the public roads, especially along the approaches to spots associated with eminent historic personages or events.


Fig. 80. *Cryptomeria japonica*, var. *elegans*.

In none of its aspects is the Cryptomeria more striking than in those avenues planted in localities most favourable for the development of the trees. An avenue of Cryptomerias seven miles in extent near Lake Hakone was passed through by Mr. James H. Veitch during his travels in Japan, which, when once seen, leaves an enduring impression; in this avenue the trees are more than 100 feet high, with perfectly straight trunks crowned with conical heads of foliage, the interval between them in the line rarely exceeding six feet. More remarkable and more impressive still is the great avenue leading from Utsunomiya to the celebrated shrines at Nikko, extending to a distance of over thirty miles; it is the wonder and admiration of all who have seen it; the trunks of the trees are as straight as an arrow and average more than 100 feet in height with a circumference of 12 to 15 feet near the base. "The planted avenue extends practically all the way from Tokio to Nikko, but it is only when the road reaches the foot-hills that it passes between two rows of Cryptomerias, the lower part being planted, as is the case with the other great highways in Japan, with Pine trees. Nor is the avenue continuous, for wherever a village occurs, or one of the roadside tea-houses which are scattered all along the road, there is a break in the rows of trees, and it is only in some particular spots that a long view of continuous trees is obtained. The trees are planted on high banks made by throwing up the surface soil from the roadway; they are usually planted in double rows, and often so close together that in places two or three trees have become united by a process of natural grafting."* The same author adds:—"Japan owes much of the beauty of its groves and gardens to the Cryptomeria. Nowhere is there a more solemn and impressive group of trees than that which surrounds the temples and

* Sargent, Forest Flora of Japan, p. 74.



Cryptomeria japonica, var. *Lobbii*, at Dropmore.

tombs at Nikko where they rise to a height of 100 to 125 feet; it is a stately tree which has no rival except in the Sequoias of California."

The chief factor in the preservation of the Cryptomeria and its luxuriant growth in Japan is unquestionably the climate which in the districts where the tree attains its greatest development is decidedly temperate. The annual isothermal line for 10° C. (50° F.) curves below the 40th parallel where it passes through Japan in the latitude of northern Hondo; and the annual isotherm for 15° C. (60° F.) curves below the 35th parallel, or below the latitude of Tokio, the capital, so that the average temperature of the Cryptomeria region ranges from 10° to 15° C. (50° to 60° F.). In Tokio the registered annual rainfall is about 70 inches with a gradual decrease northwards towards Yeso; southwards of Tokio it seldom sinks below 50 inches. These data show that the Cryptomeria thrives in a climate not very dissimilar from that in which the Californian Redwood attains its gigantic dimensions, and which corresponds nearly to that of the south-west of Ireland, but is somewhat warmer than that of Great Britain with nearly double its annual rainfall.

The Cryptomeria first became obscurely known to Europeans through Engelbert Kaempfer, who mentions it in his "Amœnitates Exoticæ" published in 1712.* It was next described by Thunberg in more distinct terms in his "Flora japonica" under the name of *Cupressus japonica*; Thunberg's dried specimens were communicated to the younger Linnæus and incorporated with his herbarium which was subsequently acquired by Sir J. E. Smith, the first President of the Linnean Society, and afterwards became the property of the Society. On these materials David Don, the Secretary of the Society, founded in 1839 the genus Cryptomeria which has since remained unchanged. The Cryptomeria was introduced into Great Britain by the Horticultural Society of London through their collector, Robert Fortune, who sent seeds from Shanghai in China in 1844; the Japanese type was introduced by the Veitchian firm through Charles Maries in 1879.

The Cryptomeria has now been a denizen of the parks and gardens of Great Britain for more than half a century, and although it has proved to be hardy, good specimens are by no means common. Where well-developed trees do occur, they have an elongated conical outline like that of the Wellingtonia, but generally a more open aspect on account of being more sparsely furnished. The Cryptomeria requires a deep, well-drained soil with abundance of moisture, of which the supply is not intermittent, and it must be protected from piercing winds; in such situations it develops the ornamental qualities which cause it to be so highly admired in its native country. A space having a radius of not less than 25 feet should be allowed for it.

All the varieties described above are of Japanese origin with the exception of *Lobbii* and *sinensis*. *Elegans* which was introduced by the late Mr. John Gould Veitch, is one of the most distinct additions to the British Pinetum ever made; this is chiefly due to the remarkable change in colour which the foliage and young shoots undergo in winter; it is a "juvenile" form with primordial leaves only. The illustration shows its

* San, vulgo Sungi. Cupresso-pinolus resinifera, fructu sphærali squamoso, pruni magnitudinis; seminibus paucis oblongis compressis, striatis, spadiceis (p. 883).

habit as usually seen, but in the warm and humid climate of Devon and Cornwall, so large a head is sometimes formed that the stem bends towards the ground under the weight of its appendages and is sometimes snapped off by the wind. *Lobbii* was introduced by the Veitchian firm shortly after Fortune's discovery through Thomas Lobb, from the

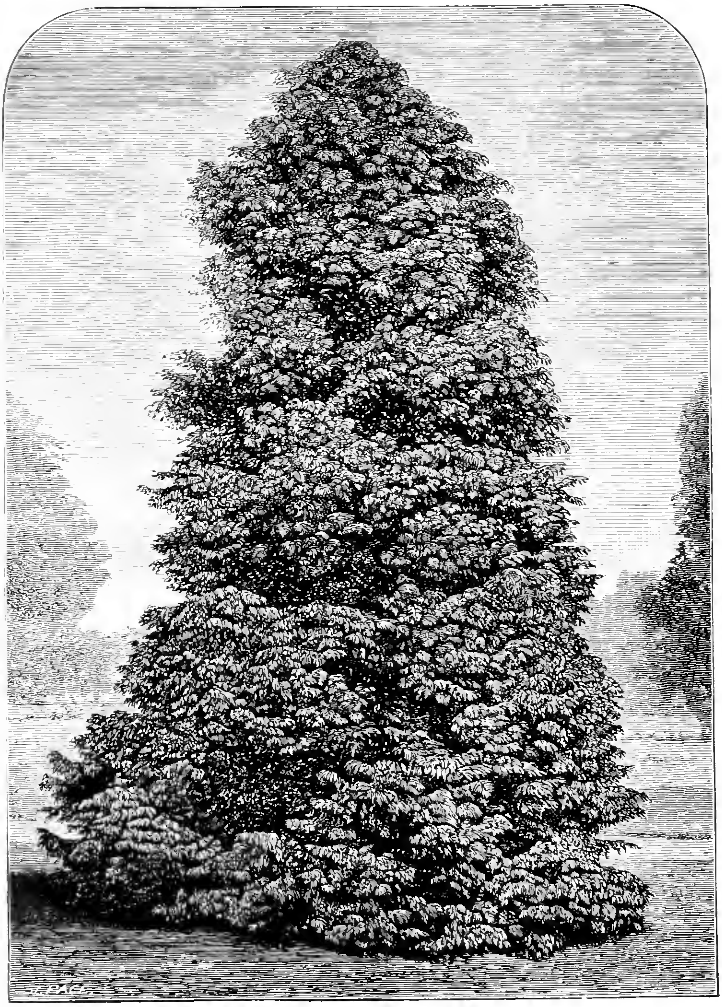


Fig. 81. *Cryptomeria japonica*, var. *elegans*.

Buitenzorg Botanic Garden whither it had been sent from Japan by Siebold twenty years earlier. *Nana* and *spiralis* are monstrous forms of dwarf and singular habit chiefly used for the rock garden; *sinensis* is the form originally introduced by Fortune; all the older arborescent Cryptomerias growing in Great Britain with the exception of the variety *Lobbii* are referable to this form.

SEQUOIA.

Endlicher, Synops. Conif. 197 (1847). Parlatore, D. C. Prodr. XVI. 435 (1868). Bentham and Hooker, Gen. Plant. III. 429 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 85 (1887). Masters in Journ. Linn. Soc. XXX. 22 (1893).

Different as the Redwood and Wellingtonia as seen in Great Britain appear to the ordinary observer, botanists are agreed that they must come under the same genus. The difference in habit and foliage, so manifest in this country, is, however, by no means so apparent in the full-grown trees in the Californian forests, and more than this, the structure of their staminate and ovuliferous flowers and their cones is identical. The genus therefore includes two species having in common the following essential characters:—

Flowers monœcious, solitary and terminal. Staminate flowers stipitate, ovoid-cylindric, surrounded at the base by numerous imbricated, involucral bracts. Stamens numerous, spirally crowded, with a short spreading filament dilated into a sub-peltate connective bearing two—five (usually three) anther cells.

Ovuliferous flowers ovoid-cylindric, composed of numerous spirally imbricated ovate bracts keeled at the back, the keel produced into a short elongated point; the bracts adnate to the shorter and thicker ovuliferous scales which bear five—seven ovules that are at first erect but which ultimately become inverted.

Strobiles sub-cylindric, pendulous, maturing the first year, composed of spirally arranged scales that are contracted at the base and clavately thickened upwards into a flattened rugose disk with a transverse median depression, each bearing five - seven pendulous seeds.

The Redwood was originally joined with Taxodium from which it was separated by Endlicher, who founded upon it the genus Sequoia, and Lindley proposed Wellingtonia for the "Big Trees" of the Sierra Nevada, but which was soon rejected when the reproductive organs became known. From Taxodium the Sequoias are clearly distinguished by their simple, not panicled staminate flowers, by the peltate form of their fruit scales which bear a larger number of seeds, and by their persistent foliage.

Besides their gigantic proportions, the Sequoias possess a separate and special interest in respect of their antiquity, and the far more important place they occupied in the arborescent vegetation of the Earth in past geological ages than at the present time. The earliest remains of the ancient Sequoias occur in the Lower Chalk formations; they became more plentiful in succeeding strata up to the Tertiary systems in which they are widely diffused. It is highly interesting to learn that in the earlier Tertiary formation termed the Eocene, the Sequoias were represented in Great Britain by more than one well-marked species. In the succeeding period termed the Miocene, their fossils are widely distributed over the eastern continent from high latitudes southwards to the great chains of mountains which stretch across the continent from Spain to northern India, and in an east and west direction from the Hebrides to the Steppe of Kirghiz. During the Glacial epoch it is surmised that the genus was well-nigh exterminated, and was preserved only in the two isolated regions in which it still survives. The fossil remains consist chiefly of cones which are sometimes attached to their branches, and of foliation which connects the fossil forms quite naturally with the existing species.

The genus commemorates Sequoyah, a Cherokee Indian of mixed blood, better known by his English name of George Guess, who is supposed to have been born about the year 1770. He first became known as a small farmer in the Cherokee country of Georgia, and as a skilful silversmith, and afterwards by his invention of an alphabet and a written language for his tribe, which was published in 1826. This alphabet consists of eighty-five characters, each representing a single sound, and was used in printing the "Cherokee Phœnix," a journal devoted to the interests of the Cherokee nation, and also of a part of the New Testament. Compelled to move with his tribe into the Indian territory beyond the Mississippi, he died at San Fernando, in northern Mexico, in 1843. His remarkable alphabet is destined to pass away with his nation, but his name will be for ages kept in memory by the most stupendous productions of the Vegetable Kingdom.

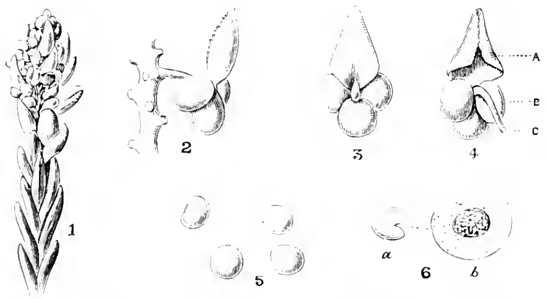


Fig. 82. *Sequoia Wellingtonia.* 1, Staminate flower somewhat advanced. 2, Stamen attached to axis. 3, The same, dorsal—4, ventral view; A, connective; B, three anther cells; C, filament. 5, Pollen grains. 6, A pollen grain as seen when placed in water; *a*, the empty extine of the bursted pollen grain; *b*, the swollen contents of the same. 1, Nat. size; 2, 3 and 4 magnified five diameters; 5 and 6, 240 diameters.

Sequoia sempervirens.

A gigantic tree with a trunk towering to a height that varies from 180 to 250 or more feet in the individual trees, and with a diameter near the base of from 12 to 18 or more feet, often free of branches for 75 to 100 or more feet of its height.* Bark fibrous, spongy in texture and of a reddish brown colour, 6—12 inches thick, divided into rounded ridges 2—3 feet wide.† Primary branches close set, the lowermost (as seen in the oldest trees in Great Britain) decumbent, those above horizontal, the uppermost slightly ascending; branchlets distichous, alternate or opposite. Buds small, globose-cylindric, covered with green leaf-like scales that are for the most part persistent at the base of the developed shoot, and change to orange-brown with age. Leaves Yew-like, persistent three—four years, sub-distichous and alternate, usually longer in the middle of the shoot than at the

* Individual trees have been measured whose heights exceeded 300 feet, and whose diameter at five feet from the ground was found to be from 18 to 20 feet. One on Eel River measured in 1896 was 340 feet high.—Garden and Forest, X. 292.

† The bark of the Redwood contains no resin, whence the fires that frequently burn up the undergrowth of the Sequoia forests have no effect on the standing trunks.

extremities; linear-lanceolate, mucronate, sometimes falcately curved, 0·25—0·75 inch long, inclined forwards at an angle of about 45° to the axis, dark green with an almost obsolete median line above, with two pale stomatiferous bands beneath. Staminate flowers on short footstalks clothed with acicular, imbricated, leafy bracts spirally arranged around them, globose or globose-cylindric, consisting of eight—ten stamens with ovate connectives, each bearing three anther cells. Strobiles on short footstalks, clothed with minute imbricated scales, terminal on short branchlets of the preceding year, 0·75—1 inch long, composed of fifteen—twenty rhomboidal, peltate scales each bearing five—seven seeds.

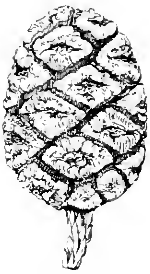


Fig. 83.
Strobile of
Sequoia sempervirens.

Sequoia sempervirens, Endlicher, Synops. Conif. 198. (1847). Murray in Gard. Chron. (1866), p. 971. Carrière, Traité Conif. ed. II. 210. Parlatore, D. C. Prodr. XVI. 436. Hoopes, Evergreens. 244. Gordon, Pinet. ed. II. 379. Brewer and Watson, Bot. Califor. II. 116. Sargent, Forest Trees N. Amer. 10th Census. U.S.A. IX. 181; and Silva N. Amer. X. 141, t. 535. Beissner, Nadelholzk. 157. with figs. Masters in Gard. Chron. VIII. ser. 3 (1890), p. 303 with fig; and Journ. R. Hort. Soc. XIV. 247.

S. gigantea, Endlicher, Synops. Conif. 198 (in part, not Decaisne).

Taxodium sempervirens, Lambert, Genus Pinus, II. t. 7 (1824). London, Arb. et Frut. Brit. IV. 2487, with figs. Hooker, W. Flor. Bor. Amer. II. 164.

Eng. and Amer. Californian Redwood. Germ. Immergrün, Sequoie, Eiben Cypresse. Ital. Il Legno rosso di California.

var.—adpressa (syn. *alba spica*).

A smaller tree with shorter and more rigid branches. Leaves shorter, broader, and inclined to their axis at a much more acute angle than in the type; the younger leaves and tips of the branchlets cream-white, the older leaves glaucescent.

S. sempervirens adpressa, Carrière, Traité Conif. ed. II. 211. Beissner, Nadelholzk. 159. S. sempervirens alba spica of British gardens.

The Redwood inhabits a narrow strip of territory along the Pacific littoral extending for about five hundred miles from the southern boundary of Oregon to a little beyond Monterey in South California, and rarely ranging more than from twenty to thirty miles inland. Within this restricted habitat it presented, when first discovered, one of the most remarkable phenomena of vegetation to be seen throughout the world, whether as regards the gigantic size of individual trees or the enormous amount of vegetable tissue that had been built up within so limited a space. Large stretches of Redwood forest unmixed with other trees covered the country in Mendocino county, along the Russian river north of San Francisco, and in Santa Cruz county south of that city, the trees in places standing so close together as scarcely to leave room for a lumber truck to pass between them. And generally, the lower mountains near the coast were almost exclusively covered with Redwood, which in places spread inland into the cañons, presenting to the view masses of timber greater than could be found on an equal area in the densest tropical forest. Along the eastern fringe of the belt, the trees that remain are smaller and are mixed with the Douglas Fir *(Abietia Douglasii)*, the Bark Oak *(Quercus densiflora)* and other trees; they are also smaller at the southern limit of the belt where the annual rainfall is lighter. In seeking for an explanation of this exuberant arborescent growth, there can be no doubt that the climate of the region has been the most important factor, not only in the formation of the Redwood forests, but in building up the other gigantic coniferous trees of California.

The climate of the coast region of California is marked by a comparatively equable temperature throughout the year, the summer average at San Francisco being about 15° C. (60° F.), and the winter 10° C. (50° F.). Two causes co-ordinate to bring about this narrow fluctuation. One is the cold arctic current from Behring Strait which strikes the Californian coast in about latitude 42° N. and continues its course southwards; by this stream of arctic water the temperature of the ocean from May to October is reduced much below the average in the same latitude elsewhere; concurrently with the arctic stream, a cool wind blows uninterruptedly in the same direction during the same period and in which no rain falls. The other is a warm wind which blows during the remainder of the year from the south-west over the equatorial region of the Pacific Ocean charged with the evaporation that is raised in prodigious quantities under a vertical sun: most of this vapour is precipitated on the country from the coast to the summit of the Sierra Nevada, the precipitation gradually diminishing in quantity in a southern direction to the lower Californian peninsula where it ceases altogether and the country is a desert. This alternation of seasons is regular from year to year; all through the summer season fogs rise from the Pacific Ocean and flow inland like a great level sea of vapour: the lower mountains near the coast are enveloped, and further inland it fills the cañons, leaving the higher mountains to rise like islands out of it. It is these ocean fogs that exercise so powerful an influence on the distribution and growth of the Redwood; outside their range it does not spread spontaneously. The tree is not only a lover of moisture, but to an extent hardly to be believed unless seen, a condenser and consumer of moisture; the tops of the trees reach high into the sea of vapour and constant precipitation from them like rain, takes place during the prevalence of the fogs.*

Sequoia sempervirens ranks second in size amongst the gigantic coniferous trees of western North America. In its scientific aspect and associations, it is one of the most interesting of trees, whether we regard it as a surviving representative of the vegetation of a former epoch that has well nigh disappeared, or look upon it simply in its relationship to existing Coniferae. In the geological age termed the Miocene, *S. sempervirens* or a species closely allied to it was widely distributed over the eastern continent in high latitudes,

* Garden and Forest, III. 235.

extending to Spitzbergen and also to Greenland; and even earlier in central Europe. But from the time of its greatest development in Miocene times the Redwood gradually disappeared from the vast area over which it was once spread till it finally receded to the strip of territory along the Pacific coast of North America, a most significant fact in its history which of itself portends its ultimate extinction.

But a process of destruction far more rapid than that provided by Nature has been in operation ever since the occupation of the country by the white settlers. The Redwood is the most valuable of all the Californian timber trees; it is the most common building material of the State, and it is used for every description of out-of-door carpentry. The wood is close-grained and splits with peculiar facility by means of wedges, so that planks can be made from it without the use of the saw; it is durable in contact with the soil and it is therefore extensively used for fencing and railway ties; it is of a beautiful red colour and susceptible of a high polish, qualities which render it peculiarly adapted for all kinds of domestic furniture, and so highly valued is Redwood timber beyond the range of its native forests, that it is exported to Australia, the Pacific Islands, to China, and even occasionally to Europe.* To supply the enormous and ever-increasing demand and owing, too, to the accessibility of the Redwood forests, due to their proximity to the coast and to their being traversed by numerous streams, the consumption of Redwood timber is proceeding at a rate that would almost exceed belief were it not attested by reliable statistics, and by the testimony of those who have witnessed its destruction. "The felling of the monster trees and the manufacture of their trunks into lumber by the use of modern machinery and appliances, afford examples of the most stupendous lumber operations ever witnessed, but, alas, the end is near. At the present rate of destruction, not an unprotected Sequoia of timber-producing size will be left standing twenty years hence."† The best forests will soon be but dim memories only, and the generation next succeeding that which witnessed their discovery will see their places occupied by human habitations surrounded with other vegetation. The Redwood is, however, exceedingly tenacious of life: when cut down a whole copse of vigorous shoots spring up from the base of the monster trunk and soon hide it; it is only by repeated cuttings that the tendency of the tree to reproduce itself in this manner can be repressed; when these shoots are left to themselves, they will grow in time into a circle of tall trees.

The most salient points in the botanical history of the Redwood are but few. It was discovered by Archibald Menzies in 1795, from whose herbarium specimens it was figured and described by Lambert in "The Genus Pinus" under the name of *Taxodium sempervirens*. It was re-discovered by David Douglas in 1831 and shortly afterwards by Dr. Coulter near its southern limit in the neighbourhood of Monterey. In 1847 it was separated from Taxodium by Endlicher who founded the genus Sequoia for its reception. About the same

* Silva of North America, X. 142.
† Lemmon, Handbook of North-west American Cone-bearers, 1895.

time it was introduced into British gardens by the Horticultural Society of London through their collector Hartweg.

Although a native of a somewhat warmer climate than that of Great Britain, the Redwood in this country is a fast-growing tree of pyramidal outline and dark Yew-like aspect. It has a tendency to commence the season's growth early in spring, and to continue growing till late in the autumn which renders it liable to injury by winter and spring frosts, by which the youngest part of the leader and terminal shoots of the branches are sometimes destroyed; the foliage is also frequently discoloured or "browned" by the same agency, so that the Redwood has not been regarded with so much favour as might be expected from so remarkable a tree. It should, however, be included in every collection of ornamental Conifers and planted in every park where it can be sheltered from cold piercing winds, and where a space with a minimum radius of 30 to 40 feet can be allowed for it to develop its fine proportions. A moist and well-drained soil is the best for it, and as might be expected, it thrives well in the neighbourhood of the sea coast in the south and south-west of England, in Wales and in Ireland.*

Sequoia Wellingtonia.

The largest of all coniferous trees† with a massive tapering trunk rising to a height of 300 or more feet and with a diameter of 20 to 30 feet near the ground. The average height of the oldest trees now standing is about 275 feet and the diameter near the ground about 20 feet,‡ the trunk enlarged at the base into broad rounded buttresses and usually free of branches for one-half or more of the height, the remainder somewhat scantily furnished with branches that are small in proportion to the gigantic trunk from which they spring, and clothed with foliage on their terminal branchlets only. Bark 20 — 30 inches thick,§ of spongy texture and cinnamon-brown colour, the exposed part separating into loose fibrous scales. In Great Britain the Wellingtonia

* Among the many fine specimens of the Redwood scattered over Great Britain are those at Dropmore, Linton Park, Tortworth Court, Eastnor Castle; Bayfordbury and Essendon, Herts; Bowood, Wilts; Orton Hall; Penrhyn Castle; Castle Menzies, Ochtertyre, Scone Palace, Abercairney and Cultoquhey in Perthshire; Fota Island, Cork; Hamwood, Co. Meath; Charleville, Co. Wicklow; Woodstock, Co. Kilkenny, etc.

† The Wellingtonia is not only the largest coniferous tree, but it is also not surpassed in size by trees belonging to any other Natural Order. Some of the Australian Eucalypti have attained a greater height than any Wellingtonia at present standing, but the diameter of their trunks is considerably less. Trunks of the Adansonia or African Baobab tree have been observed with a greater diameter, but their height is not nearly proportionate compared with the Wellingtonia.

‡ Silva of North America, X. 145. The tallest living tree that has been measured was found to be 325 feet high; it is one of the "Three Sisters" standing in the Calaveras Grove; the other two also exceed 300 feet in height. The height of the tallest measured Wellingtonia is therefore surpassed by that of the Redwood on Eel River, *see* page 270. Nevertheless the average height of the Wellingtonia is recognised by the best authorities to exceed the average height of the Redwood. Exceptional heights attained by Wellingtonias that have been felled, or overthrown by storms in their extreme old age have been estimated at 425, 363, 350, 325, 300 feet, etc.

§ Very little difference can be detected between the barks of the oldest Wellingtonias and Redwoods growing in Great Britain; that of the Redwood is perhaps somewhat more fibrous than the other.

is characterised by extreme formality of habit which is that of a spire or elongated cone, its outline scarcely broken by a projecting branch. Trunk strictly erect, covered with fibrous cinnamon-brown bark which breaks off in irregular thickish plates. Primary branches slender, close-set and gradually contracted in length upwards, the lowermost decumbent, those above spreading horizontally or slightly ascending. Branchlets stoutish and much ramified, the ramifications crowded and often forming dense tufts. Leaves persistent three four years, on the stouter growths ovate, acuminate, passing upwards into lanceolate, acuminate, 0·25—0·5 inch long, about three completing the circuit of their axis, appressed and decurrent at the base, free beyond the middle: on the lateral shoots shorter and smaller, at first bluish green, changing with age to dull grass-green. Staminate flowers about 0·25 inch long; stamens spirally arranged, with a short filament and ovate, acute connective bearing three anther cells. Ovuliferous flowers somewhat larger, consisting of pale yellow scales narrowed into a long slender point, each bearing five—nine ovules in two series. Strobiles ovoid-cylindric, obtuse, 2—2·5 inches long and 1·5—2 inches in diameter, composed of 25—30 ligneous scales arranged around a spindle-shaped axis, the exposed dilated end approaching rhomboidal shape with a central depression and transverse ridge on each side of it, each scale bearing five—nine seeds, but usually fewer from non-fertilisation of ovules.

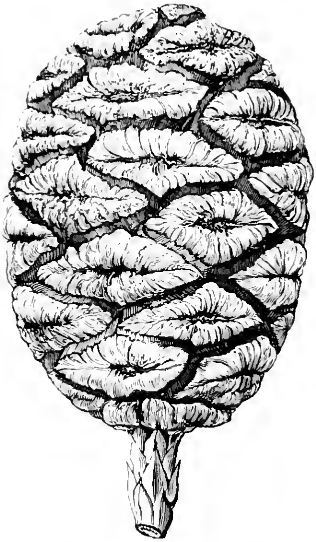


Fig. 84. Cone of *Sequoia Wellingtonia* from the Calaveras Grove.

Sequoia Wellingtonia, Seeman, Bonplandia, III. 27 Feb. 1855. Lawson, Pinet. Brit. III. 299, tt. 37, 51, 53. Sargent, Silva N. Amer. X. 145, t. 536.

S. gigantea, Decaisne in Bull. Soc. Bot. de France, I 72 (1854), not Endlicher. Torrey, Report U. S. Pacific Rail. IV. 140 (1857). Parlatore, D. C. Prodr. XVI. 437. Hoopes, Evergreens, 239, with fig. The Garden, I. 54, 75, with figs. Brewer and Watson, Bot. Califor. II. 117. Garden and Forest, V. 541, 546, with figs. Beissner, Nadelholzk. 160, with figs. Masters in Journ. R. Hort. Soc. XIV. 71.

Wellingtonia gigantea, Lindley in Gard. Chron. 1853, p. 823. Hooker, W. Bot. Mag. tt. 4777, 4778. Carrière, Traité Conif. ed. II. 217. Gordon, Pinet. ed. II. 414.

Eng. Wellingtonia, Mammoth Tree. Amer. Big Tree. Fr. Sequoia gigantesque. Germ. Riesen Sequoia. Ital. Gigante della California.

var.—pendula.

Primary branches quite pendulous, sometimes hanging down so close to the trunk that the space occupied by the tree with its appendages scarcely exceeds two yards in diameter. This is the most marked deviation from the common form yet observed.

Other varieties are distinguished by horticulturists by names sufficiently indicative of their character as *argentea*, *glauca pyramidalis*, *pygmaea*, *variegata*, etc.

The Wellingtonia inhabits the western slopes of the Sierra Nevada of California on which it has a vertical range of from 5,000 to 8,000 feet above sea level. Its northern limit is near the 39th parallel of north latitude whence it spreads meridionally in a narrow belt for a distance of 260 miles to Deer Creek, just beyond the 36th parallel. In the northern part of this belt it occurs in isolated groves varying in extent from a few acres to three or four square miles, and standing from forty to sixty miles apart;* south of King's River for a distance of about fifty miles the Wellingtonia forms an almost continuous forest in places nearly five miles wide, intercepted only by the steep-walled, deep cañons that intersect the mountains.† On the Sierra Nevada at this elevation is precipitated for nearly six months of the year (November — April) a large proportion of the enormous evaporation raised in the equatorial region of the Pacific Ocean, and wafted

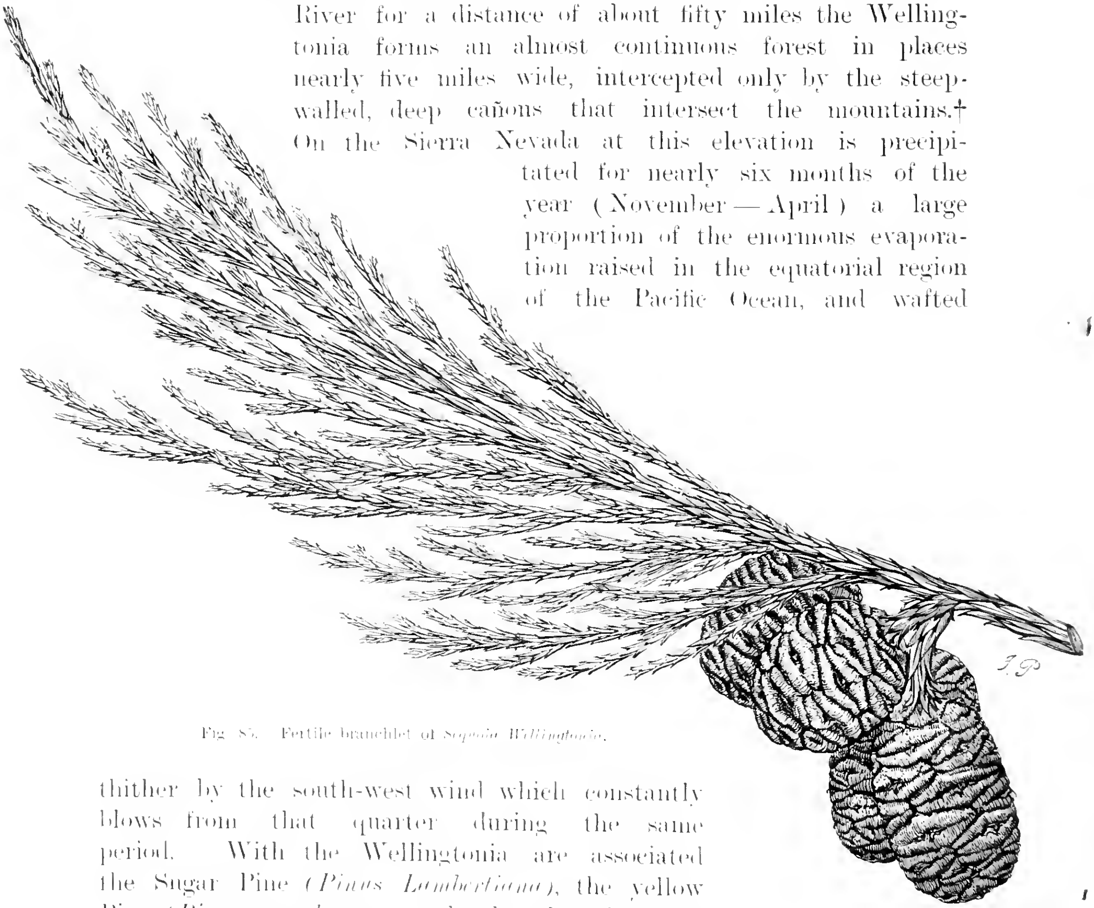


Fig. 85. Fertile branchlet of *Sequoia Wellingtonia*.

thither by the south-west wind which constantly blows from that quarter during the same period. With the Wellingtonia are associated the Sugar Pine (*Pinus Lambertiana*), the yellow Pine (*Pinus ponderosa*), and the Douglas Fir (*Abietia Douglasii*), which under the like climatic conditions attain stupendous dimensions.

* These groves are distinguished by names some of which are familiar to British readers, as the Calaveras Grove, the smallest and northernmost of them, which contains at the present time about ninety large trees. South of this are the Mariposa Grove, the Merced Grove, etc.

† Silva of North America, *loc. cit. supra*. An excellent detailed account of the distribution of the Wellingtonia on the Sierra Nevada, by Frank J. Walker, accompanied by a sketch map, is given in the Garden and Forest, III. 571, which, although of great local interest, is too elaborate to be reproduced here.

The first white man who saw the "Big Trees" was probably John Bidwill, who crossed the Sierra Nevada, in 1841, from the east into California, when he passed in haste through the Calaveras Grove, at that time Indian country and exceedingly dangerous to traverse, but he made no mention of his discovery till after the trees had been seen by the hunter, Dowd, eleven years later. In 1852, Dowd, while following a wounded bear, passed through the forests of *Pinus Lambertiana* and *P. ponderosa*, and entered the Calaveras Grove where he saw the gigantic trees for the first time and communicated his discovery to his comrades. Shortly afterwards Dr. Kellogg forwarded specimens to Doctors John Torrey and Asa Gray, and he also informed William Lobb of the discovery.* Lobb, who had been sent on a collecting mission to California by the late Mr. James Veitch, was at that time staying at Monterey, but he lost no time in making his way to the Calaveras Grove where he collected a large quantity of cones and seeds which, with two living plants and herbarium specimens, he brought to England late in the autumn of 1853, and from him was obtained the first authentic account of the "Big Trees." The specimens brought home by Lobb were placed in the hands of Dr. Lindley for determination, and he, believing the tree to be generically distinct from the Redwood, created for its reception a new genus which he named Wellingtonia† in these terms: "The most appropriate name for the most gigantic tree that has been revealed to us by modern discovery is that of the greatest of modern heroes; let it then bear henceforward the name of *Wellingtonia gigantea*. Lindley's generic name was, however, soon after challenged by both European and American botanists, and when staminate flowers which Lindley had not seen were procurable and were found to be identical in structure with those of the Redwood *Sequoia sempervirens*, the conclusion was inevitable, a conclusion strengthened by the identity in structure also of the ovuliferous flowers and cones, and by the similarity of the two trees in stature, bark, ramification and even in certain states of the foliage.

The controversy that arose respecting the generic name of the "Big Trees" is now a thing of the past, but the change in the specific name here adopted may seem to non-botanical readers to require explanation. One of the first botanists who called into question Lindley's genus Wellingtonia was Dr. Seemann, editor of a scientific periodical named "Bonplandia." In the issue of this publication for February, 1855, Dr. Seemann distinctly recognised the Wellingtonia of Lindley to be a second species of Sequoia and accordingly named it *Sequoia Wellingtonia*,‡ Lindley's specific name *gigantea* having been previously taken up by Endlicher for an undescribed form of the Redwood.§ The late

* C. H. Shinn in Garden and Forest, II, 614.

† The public funeral of the Duke of Wellington in St. Paul's Cathedral had taken place but little more than a year previously.

‡ Ich erkenne *Wellingtonia gigantea* als eine wahre Sequoia und erlaube mir sie *Sequoia Wellingtonia* zu nennen. Der alte species—Name konnte deshalb nicht beibehalten werden, weil derselben bereits von Endlicher einem Nondescript verliehen worden ist.—Seemann in Bonplandia *loc. cit.*

§ SEQUOIA GIGANTEA, Endl.—Sequoia foliis linearibus. $1\frac{1}{2}$—2" acutis subtus glauco pulverulentis. Habitat in California (Dougl.). Arbor trecentorum pedum altitudinem attingens, trunci ambitu triginta pedali.—Synopsis Coniferarum. p. 198. This was published in 1847 or five years prior to Dowd's discovery of the "Big Trees" of the Calaveras Grove.

Andrew Murray, recognising the import of Seemann's announcement adopted his name for the "Big Tree" in Lawson's "Pinetum Britannicum"; it is also adopted by Professor Sargent in his monumental work "The Silva of North America."

The observation in page 272 on the restricted habitat of *Sequoia sempervirens* and its significance in respect of the stability of the species is applicable to *S. Wellingtonia* with still greater force so far as natural agencies are concerned. The Wellingtonia covers a much smaller area than the Redwood, and in numbers is still infinitely behind it; but although seedlings are well nigh absent from the northern groves, they are numerous in the southern forest, and thus far the perpetuation of the species is assured. And whilst the Redwoods are being decimated by lumber operations at an almost incredible pace, the destruction of the Wellingtonias by this agency is proceeding at a much slower rate, and will probably cease altogether in consequence of the greater part of the land on which the trees stand having been taken over by the United States Government which has stretched forth a protecting hand over the trees, and these therefore will be preserved so long as the law affecting them remains in force. The timber of the Wellingtonia is inferior to that of the Redwood; it is light, soft and coarse-grained, not strong, but very durable in contact with the soil; it is used locally for fencing and other out-of-door carpentry.*

The immense size of the Wellingtonias naturally led to conjectures as to the ages of some of the "full-grown giants," but which in the first instances were enormously in excess of the reality. The earliest approximation to the truth was obtained by Professor Whitney, the State Geologist of California, by counting the rings of a felled tree in the Calaveras Grove. This tree was 24 feet in diameter exclusive of the bark, and contained 1,255 annual rings at a section of the trunk made 30 feet from the base. "There was a small cavity in the centre of the tree which prevented an accurate fixing of the age; but making due allowance for that and for the time it required to grow to the height at which the count was made, it will be safe to say that this particular tree which was as large as any standing in the grove was, in round numbers, thirteen hundred years old." The annual rings of other trees counted by different persons gave much higher results, but these were probably exceptional instances. Quite recently a full-sized tree was felled in Tresno County, California, and a section of its trunk set up in the Jesup collection of American woods in the Museum of Natural History at New York, and another section from the same tree, next above the Jesup section, was secured for the British Museum of Natural History at South Kensington, and is set up in the Central Hall; the annual rings of this section have been carefully counted and found to number 1,335. This particular tree was 62 feet in girth at eight feet from the ground, 300 feet high and without branches for 200 feet of its height. From these and other authentic data, it is not unsafe to infer that none of the existing Wellingtonias ante-date the Christian era, or that with very few exceptions, the oldest of them reach within five hundred years of that epoch, and whose ages therefore do not much exceed that of the oldest Yews in Great Britain.

* Silva of North America. X. 147.

The Wellingtonia has proved hardy in Great Britain and Ireland; it grows in all ordinary soils in which water does not stagnate, but prefers a retentive loam with a porous subsoil, in open airy places but not exposed to piercing winds; in dry and shallow soils its progress is much slower and it soon loses its ornamental qualities. The average annual rate of increase in height of the "leader shoot" varies with the locality and its environment from 15 to 25 inches and even more in young vigorous trees planted in good soil. But the older trees growing under the most favourable circumstances are beginning to show a slow but steady diminution of the annual increase in height of the trunk, so that there is no probability of the Wellingtonia ever attaining in Great Britain more than one-half the size and age of its gigantic Californian progenitors. The trunk increases in thickness in proportion to its height faster than in most other large coniferous trees, the circumference near the base being often as much as one-fifth or one-sixth of the height; in *Abietia Douglasii* the circumference of the trunk at the base is generally not more than one-eighth or one-tenth of the height, and this proportion is not much exceeded in other tall Conifers as *Abies grandis*, *A. nobilis*, *Cedrus Deodara*, *Pinus Lambertiana*, etc.

The formality of the Wellingtonia as a landscape tree is well known; as such it offers a strong contrast to the irregular contour of many deciduous trees, and is of itself a striking object when standing alone and feathered with branches from the base to the summit. One of the most remarkable arboricultural effects produced by it is the Wellingtonia Avenue at Orton Hall, near Peterborough; this avenue extends 700 yards in an east—west direction and is composed of two rows of trees standing 30 feet apart with an interval of 36 feet between the rows; the trees are fairly uniform and range from 60 to 70 feet in height.* Viewed from the west end, the avenue appears like two enormous walls of green foliage; the impression caused by the vista is not easily forgotten. There is also a fine avenue of Wellingtonias at Linton Park, near Maidstone, planted in 1866; the trees have now attained an average height of over 60 feet with three exceptions which are about 20 feet less; the length of the avenue is about 400 yards and the breadth 20 yards; the trees stand 30 feet apart in the rows, the lowermost branches of each tree on each side of it in the direction of the avenue in most cases meeting those of the trees standing next to it.† One of the three shorter trees differs in habit and foliage from all the others; the trunk is thicker in proportion to the height, the branchlets more elongated and quite pendulous and the leaves longer and of a deeper green.‡

* Communicated by Mr. Harding, the Gardener.

† Communicated by Mr. Mackenzie, the Gardener.

‡ Space admits of the enumeration of only a few of the finest Wellingtonias in Great Britain. In England: The Royal Domain, Windsor; Poltimore, and Powderham Castle near Exeter; Penrhyn Castle, Bangor; Pampesford, Cambridge; Eastnor Castle, Ledbury; Tortworth Court and Highnam Court, Gloucestershire; Kenfield Hall, Canterbury; Bicton, Devonshire; Fonthill Abbey and Bowood Park, Wilts; Revesby Abbey, Lincolnshire; Studley Royal, Yorkshire; Chetwynd Park, Shropshire; Ruxley Lodge, Esher; Thoresby Park, Notts. In Scotland: Murthly Castle, Castle Menzies and Scone Palace, in Perthshire; Whittinghame, East Lothian; Castle Leod, Ross-shire, remarkable for so high a latitude. In Ireland: Castlewellan, Co. Down; Woodstock, Kilkenny; Fota Island, Cork; Powerscourt and Coollattin, Wicklow; Carton, Kildare. Upwards of ninety Wellingtonias are included in Dunn's Census in the Conifer Conference Report, scattered over the country from Sutherlandshire southwards, most of them described as "fine specimens."

TAXODIUM.

L. C. Richard in Annales du Musée de Paris, XVI. 298 (1810). Endlicher, Synops. Conif. 66 (1847). Parlatore, D. C. Prodr. XVI. 439 (1868). Bentham and Hooker, Gen. Plant. III. 429 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 90 (1887). Masters in Journ. Linn. Soc. XXX. 24 (1893).

Two species are here included in Taxodium, of which *T. distichum* (the type) was referred by Linnæus and the older botanists to Cupressus whence probably arose its popular name, the deciduous Cypress. It was separated from Cupressus by the elder Richard* who founded upon it the genus Taxodium now firmly established notwithstanding the attempts of Mirbel and Spach to replace it by Schubertia of the first named author. With the American type Brongniart joined the Chinese Water Pine, in which he is followed by Bentham and Hooker in the "Genera Plantarum." Endlicher, however, proposed for the Chinese species a new genus which he called Glyptostrobus; but the structure of the fruit on which he chiefly relied for separating it from Taxodium does not seem to afford characters sufficiently distinct to justify the separation,† and the staminate flowers which were unknown to him differ only in arrangement and position from those of *T. distichum.* Nevertheless further investigation of fresh specimens of the Chinese species is required to determine satisfactorily the relationship between them; as an opportunity of doing this is not likely to be afforded in this country for an indefinite period, it seems better to unite provisionally the American and Chinese species under one genus.

By some authors the Mexican Taxodium is described as a species distinct from the northern type, but the characters adduced in support of this course seem to be so small in value that it may be more properly regarded as a geographical form that has slightly diverged from the type under the influence of climate, altitude and environment.

Like other prominent members of the Taxodineæ, the deciduous Cypress has a record reaching far back into geological ages, and at one period it had a distribution as extensive as any of them. In Tertiary times, and perhaps earlier, it was not only spread over Europe from the Mediterranean to the Baltic, but also over North America and Greenland; that it was also once a denizen of Great Britain is proved by the fossil remains of it found near Bournemouth and other places; it seems to have disappeared in the Pleiocene Age. It is still spread over a considerable area of North America which may be roughly stated as lying between the 39th parallel of north latitude and the Gulf of Mexico, and extending from the Atlantic Ocean westwards to about the 98th meridian; it also spreads southwards into Mexico as far as Oaxaca, attaining in that country enormous dimensions.

The name Taxodium is derived from τάξος (the Yew), and εἶδος (external appearance), from the resemblance of the foliage, as regards its arrangement, to that of the Yew.

* Louis Claude Richard and Achille Richard, father and son, were eminent French botanists of the early part of the nineteenth century.

† See Gardeners' Chronicle, XXVI. ser. 3 (1899), p. 489, where the seeds are said to be pendulous, not erect as in *Taxodium distichum.*

Taxodium distichum.

A lofty deciduous tree attaining its greatest development in Mexico, where it towers to a height of 175 or more feet with a massive trunk 10—15 feet in diameter, and individual trees are known greatly exceeding these dimensions.* Even near its northern limit in Indiana and Delaware it attains in places a height of 150 feet with the diameter of the trunk 6—8 feet above the swollen buttresses at the base. In general, "the trunk with furrowed dark red bark, ascends perfectly straight from its enlarged base, forming a tapering column 80—90 feet high when it divides into a number of long, stout horizontal branches which form a wide, flat, Cedar-like top." In Great Britain, *Taxodium distichum* is variable in size and aspect, according to situation; when standing near water it is often 80—100 feet high: the trunk cylindric or very gradually tapering, rarely lobed as in America, but projecting at the base into rounded buttresses. Bark peeling off into longitudinal shreds exposing a reddish brown fibrous inner cortex. Branches usually short in proportion to height of trunk, spreading horizontally, and much ramified at the distal end; branchlets slender with light reddish brown bark striated longitudinally. Buds minute, ovate, acute, mostly axillary. Leaves from fifty to one hundred on each branchlet, inserted on epidermal outgrowths and spirally arranged, but owing to a slight twist at the base, pseudo-distichous, linear-lanceolate, apiculate or sub-acute, 0·25—0·75 inch long, soft light green with a shallow sunk line along the midrib above, keeled and stomatiferous beneath, changing to orange-brown in autumn, and falling off with the slender shoots on which they are inserted. Flowers monœcious. Staminate flowers in panicles 3—5 inches long on short pedicels surrounded at the base with closely imbricated, triangular, scale-like bracts; stamens six—eight in decussate pairs. Ovuliferous flowers solitary, terminal or pseudo-terminal on branchlets of the previous year, sub-globose, composed of numerous imbricated scales, bearing at the base on the ventral face two erect ovules. Strobiles ripening in one season, somewhat smaller than a walnut, ovoid-globose, consisting of about nine spirally arranged, imbricated, fertile scales, and several smaller sterile ones. Seeds three-angled, the testa produced into three unequal lateral wings.

Taxodium distichum, L. C. Richard in Annales du Musée de Paris, *loc. cit. supra* (1810); and Mém. sur les Conif. 52 (1826). Brongniart, Ann. Sc. Nat. XXX. 182. Lambert, Genus Pinus. II. t. 26. Loudon, Arb. et Frut. Brit. IV. 2481, with figs. Forbes, Pinet. Woburn. 177, t. 60. Endlicher, Synops. Conif. 68. Carrière, Traité Conif. ed. II. 180. Parlatore, D. C. Prodr. XVI. 440. Hoopes, Evergreens. 364, with fig. Gordon, Pinet. ed. II. 180. Lawson, Pinet. Brit. II. 205, with figs. and t. 36. T. Montezumae (. Beissner, Nadelholzk. 148, with figs. Masters in Gard. Chron. VII. ser. 3 (1890), p. 324, with fig.; and Journ. R. Hort. Soc.

* There is a gigantic specimen at Santa Maria del Tule whose trunk, following the sinuosities, has a circumference of 146 feet, or about 104 feet girth. Another tree of historic interest stands in the garden of Chapultepec, near the city of Mexico; it is called the Cypress of Montezuma by Humboldt and it is the tree under which Cortes, the Spanish conqueror of Mexico, passed the night (La noche triste) after the defeat and expulsion of the Spaniards from the city. It is 170 feet high, and the trunk is from 40 to 50 feet in circumference. Both trees are figured in the Garden and Forest, the first in Vol. X p. 125, and the second in Vol. III. p. 155.

XIV. 248. Sargent. Forest Trees N. Amer. 10th Census, U.S.A. IX. 183; and Silva N. Amer. X. 151, t. 537. And many others.
Cupressus disticha. Linnaeus. Sp. Plant. II. 1003 (1753). Miller, Dict. ed. VIII. No. 4 (1768).
Schubertia disticha. Mirbel in Mém. Musée d'Hist. Nat. XIII. 75 (1825). Spach. Hist. Veg. Phanér. XI. 349.
Eng. Deciduous Cypress. Amer. Bald Cypress. Swamp Cypress. Fr. Cyprès chauve. Germ. Sumpfcypresse. Ital. Cipresso di Virginia.

var.—pendulum.

In Great Britain, a smaller and more slender tree than the common form and smaller in all its parts. Leaves spirally inserted on the deciduous branchlets which are mostly pendulous but sometimes erect or taking an intermediate position according to soil and locality, linear-acicular acuminate, 0·5 to 0·75 inch long, more or less appressed at the base and free at the apex, and of a soft light green.*

T. distichum pendulum. Carrière. Traité Conif. ed. II. 182 (1867). Beissner. Nadelholzk. 152. Masters in Gard. Chron. XXVI. ser. 3 (1899), p. 489, with fig. T. microphyllum. Brongniart. Annales de Sc. Nat. XXX. 182. T. sinense, Gordon. Pinet. ed. II. 385. Glyptostrobus pendulus, Endlicher, Synops. 71. Hooker fil. Bot. Mag. t. 5603. Cupressus disticha imbricaria,† Nuttall, Gen. III. 224 (1818).

Taxodium distichum is a semi-aquatic tree always found growing in or near water or on low flat lands adjacent to rivers and lakes that are subject to periodical inundation. In these situations, especially in the warm climate of the southern States, the trunks often attain an enormous diameter in comparison with their height, the proportion between the two dimensions being often greater than in the gigantic Sequoias of California.

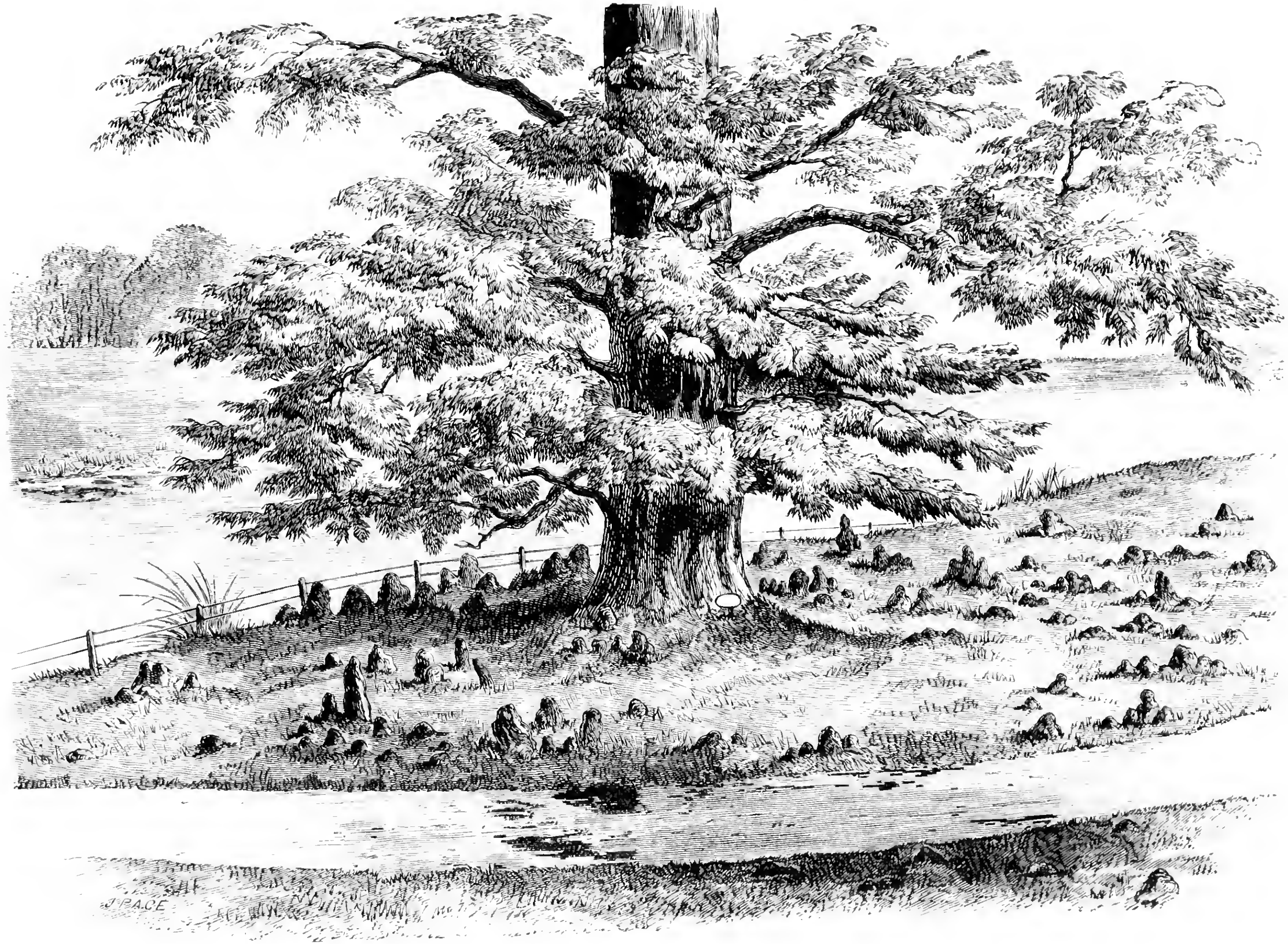
"That part of the trunk which is covered with water or liable to be by inundations, is greatly enlarged by huge, often hollow buttresses which project in all directions. Each of these buttresses terminates in a long branching root which extends out to a great distance, sending our stout anchor roots deep into the ground, and many lateral roots from which spring the 'knees' peculiar to this tree. The 'knees' first appear often close together as small tubercles on the upper side of the roots; they grow rapidly until they attain a height of from two to ten feet, or have pushed well above the water, when they cease growing upwards but increase in diameter. They are composed of exceedingly light soft spongy wood and are frequently hollow in old age."‡

Much discussion has taken place among American naturalists respecting the physiological significance of these "knees," it being contended on the one hand that "their function is to stiffen and strengthen the roots in order that a great tree may anchor itself safely in a yielding material," and on the other that "the service which these peculiar growths perform is to bring air to the roots otherwise cut off by the water which covers them during a considerable portion of the year." Probably there is much in both assertions that is true, the advocates of both relying on the circumstance that trees growing on

* This form of leaves also occurs on erect branches and branchlets of the common form, and both this form and the usual distichous leaves have been observed on branches of the same tree.

† This is the oldest of the varietal names, but as it has not been taken up by any European botanist and is quite unknown in British gardens, it is inexpedient to revive it.

‡ Garden and Forest, Vol. III. p. 2.



Taxodium distichum with "knees" at Syon House.
The "knees" extend 60 feet from the bole.

dry ground fail to develop "knees"; in addition to which those who contend that the supply of air to the roots is the main function, note that "the development of the 'knees' is always *above* the permanent water-level and to a height varying with that level, and conversely, whenever the level of permanent water rises above the top of the 'knees,' the destruction of the trees ensues."*

Taxodium distichum was first described by Parkinson in his Herbal or Theatre of Plants published in 1640, but mention of it had been made much earlier by William Strachy who visited the English colony on James River in 1610. According to Parkinson, seeds were brought from Virginia by the younger Tradescant, which he himself saw "springing up very bravely"; the deciduous Cypress was thence one of the first American trees introduced into Great Britain. Since Parkinson's time, mention of the tree is frequent in works devoted to horticulture, and many beautiful specimens may be seen throughout the country;† but it cannot be said to thrive satisfactorily except in proximity to water or where the soil is permanently moist, and even then its progress may be called slow, its average yearly growth rarely exceeding twelve inches. Nevertheless in such situations it is one of the most beautiful of trees; its elegant and light feathery foliage of the softest green imparts to it an individuality that seldom fails to elicit the admiration of the beholder.

If such is the impression made by the deciduous Cypress when seen in its best aspects in Great Britain, very different are the feelings of those who have penetrated the Cypress swamps in the southern States of North America especially where this tree forms the sole ingredient of the forest. A typical feature of a Cypress swamp is thus described by Mr. Montefiore in "Murray's Magazine," which is here transcribed from the "Gardeners' Chronicle," Vol. VII. ser. (1890), p. 324.

"It forms one of the most desolate scenes I have ever beheld. I have gazed on the black rock of St. Paul's standing almost alone in the Indian Ocean; upon the repellent rufous hills of St. Helena; the salt marshes of the delta of the Godavery; the cruel solitude of Cape Agulhas, but I do not think I have ever seen anything so dismal and so desolate as the Cypress swamps of Florida. You enter them almost without warning; you hold your breath, as it were, while going through them; and the feeling of relief on leaving them is not less strong than the strangely morbid attraction they have for you, and which makes you visit them again and again. The Cypresses stand overhead reaching to a great height and spread their limbs widely around, and yet there is not a single green leaf to be seen. From bough and branch and twig there hang long tails and festoons of Spanish moss *(Tillandsia usneoides)*, grey in colour and looking for all the world like the dishevelled tresses of an aged woman. Every way you look these

* Other coniferous trees growing near water have been observed to develop "knees," as the Pond Pine *(Pinus rigida* var. *serotina)*, and the Redwood *(Sequoia sempervirens)*.

† Notably at Syon House, Middlesex.

sad grey hairs are either hanging listlessly or swinging mournfully in the breeze. The water, which is often four to five feet deep,* even in the paths, if paths they may be called, which are selected by your guide, is coloured a dark reddish brown by the quantity of tannin exhaled by the spongy mass of vegetation which everywhere underlies it. This dark muddy water, silent and motionless save where your party is churning it into something like frothy beer, is made even more dismal by its perfect reflection of the ghostly desolation overhead. It reproduces with startling vividness the long white trunks of the Cypress trees and the tangled grey hairs of the Spanish moss. Now and again the harsh piping cry of some lonely water-bird accentuates the stillness; here and there the deadly moccassin coils about the spreading roots, black and grimy with the stagnant water, and adds by its very movement to the uncanny, desperate desolation of it all."

The wood of *Taxodium distichum* is light, soft, straight-grained, easily worked and very durable in contact with the soil. It is largely manufactured into lumber and used for construction, railway-ties, posts, fencing, etc.† The manufacture of Cypress shingle has been greatly on the increase for some years past, especially since the supply of timber afforded by the useful Pines has been on the decrease owing to the gradual exhaustion of the forests. The excess of moisture in which it flourishes and its comparatively difficult accessibility have hitherto preserved the deciduous Cypress both from fire and the axe, but the saw-mill is now being established in many districts and the work of destruction is proceeding apace.

Under cultivation *Taxodium distichum* has a tendency to sport in the seed beds, and many varieties have thence at different times been selected and named by horticulturists chiefly in reference to the habit of the plants.‡ But it is now well known that although the deciduous Cypress in its maturity presents considerable diversity as regards habit, the striking differences observed in young plants gradually diminish with age, and that the trees as they grow older approach more and more nearly to a general type in which individual differences are too insignificant to call for a separate designation. By far the most distinct of the varieties of *Taxodium distichum* is that described above as *pendulum*. It is a "juvenile" (Jugendform) of American origin which must have been introduced into this country at an early date, as a small tree long since dead was in the Royal Gardens at Kew in the time of the elder Aiton, but of whose origin nothing was known. It appears to have been first noticed as a native American plant by Nuttall in the early part of the nineteenth century; it is not uncommon in South Carolina and Florida where it is a smaller tree than the common form. Although a damp soil is the most suitable for it, it thrives in drier ground better than the common form.

* The depth of water in the southern swamps prevents natural reproduction of the deciduous Cypress; the seed cannot germinate and there are no young trees, and comparatively few small ones to replace the old ones.—Silva of North America, X. 153.

† Sargent, Woods of the United States, p. 112.

‡ Loudon, Arboretum et Fruticetum Britannicum, IV. 2481, gives the names and description of five of these forms; Carrière, Traité Général des Conifères, ed. II. 181—185, describes fifteen varieties; and Beissner, Nadelholzkunde, 152—154, has transcribed most of them.

Taxodium heterophyllum.

A low tree or shrub inhabiting marshy places in various parts of China. In Great Britain a low, much-branched shrub of irregular outline. Bark of branchlets chestnut-brown, peeling off in thin scales exposing a light orange-brown inner cortex; leaf-bearing branchlets deciduous, pseudo-distichous, opposite or alternate, 2—4 inches long.* Leaves dimorphic, of the sterile branches pseudo-distichous, close-set, twenty—forty or more on each branchlet, linear-lanceolate, sub-acute, 0·25—0·5 inch long, the longer leaves at the middle, gradually shorter towards the base and apex, soft light green with an obscure median line above, paler, scarcely glaucescent beneath; of the fertile branches † small, subulate, adnate at the base, free at the apex. Staminate flowers solitary and terminal on lateral branchlets, sub-globose and consisting (apparently) of four—six anthers in decussate pairs. Strobiles terminal on short lateral branchlets, ellipsoid-globose, inclining to obovoid or clavate, about 0·75 inch long, composed of several imbricated, spirally arranged scales of obovate-cuneate shape and unequal size, thickened upwards and minutely tuberculated at the apical margin with a blunt mucro below. Seeds obscurely winged.

Taxodium heterophyllum, Brongniart in Ann. des Sc. Nat. ser. I. Vol. XXX. 184 (1833). Bentham in Gen. Plant. III. 429. Beissner, Nadelholzk. 154.

Glyptostrobus heterophyllus, Endlicher, Synops. Conif. 69 (1847). Carrière, Traité Conif. ed. II. 189. Parlatore, D. C. Prodr. XVI. 438. Gordon, Pinet. ed. II. 126. Masters in Journ. R. Hort. Soc. XIV. 210.

Eng. Chinese Water Pine. Fr. Taxodier nucifere. Germ. Chinesische Sumpf-Cypresse.

Not much is known respecting the geographical distribution of *Taxodium heterophyllum* beyond the simple fact that it is a native of China; the localities given with herbarium specimens are few and confined to two or three of the eastern provinces. It first became known to science through Lord Macartney's mission to China (1792—1795), and is supposed to have been introduced to the Royal Gardens at Kew in 1804 by William Kerr. The few plants at present existing in Great Britain were probably introduced by Robert Fortune who met with it either wild or in cultivation in Foo-chow.

SCIADOPITYS.

Siebold and Zuccarini, Fl. Jap. II. 1, tt. 101. 102 (1842). Endlicher, Synops. Conif. 198 (1847). Parlatore, D. C. Prodr. XVI. 435 (1868). Bentham and Hooker, Gen. Plant. III. 437 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 84 (1887). Masters in Journ. Linn. Soc. XXX. 21 (1893).

A singular monotypic genus of much interest in its scientific import, of which the existing species is endemic only in Japan, where it is confined, so far as at present known, to one district. The remoteness of its affinity, comparatively speaking, to any other genus, its peculiar foliation imparting to it an aspect unlike that of any other tree, and its restricted habitat, are all significant facts in the present condition of Sciadopitys that seem to point to an ancestry far more remote than

* Branch and branchlets with foliage communicated from Castlewellan, Co. Down, by the Earl of Annesley.

† As seen in herbarium specimens.

that of most other Conifers, but of which no trace whatever has been discovered. Like the Gingko it stands alone amidst the existing vegetation, so that if the hypothesis of its great antiquity has any real foundation, a whole series of forms which once connected it with other types, must have been swept away, leaving the Sciadopitys as the sole survivor of a phase of vegetation long since extinct.

The generic characters will be understood from the description of the species that follows. The Sciadopitys has obtained in Japan a popular name signifying the Umbrella Pine,* from the circumstance of the phylloid shoots which function as leaves, spreading out like the ribs of an umbrella. The scientific name is a literal translation of it, and is formed from σκιὰς, σκιάδος (a parasol), and πίτυς (the pine tree).

Sciadopitys verticillata.

A tree of variable height, at its greatest development upwards of 100 feet high, with a trunk 2–3 feet in diameter near the ground, and with a narrow, compact, pyramidal crown. Bark greyish brown, fissured and peeling off in irregular flakes, exposing a reddish brown inner cortex. Branches numerous, sub-verticillate or scattered, spreading horizontally. Branchlets short, sub-verticillate or alternate; the bark pale brown, fissured into

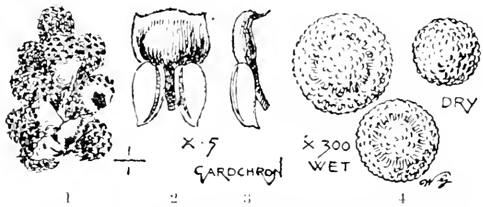


Fig. 86. 1, Staminate flowers of *Sciadopitys verticillata*, nat. size. 2, Anther, front view. 3, Side view. 4, Pollen grains, enlarged.

narrow longitudinal plates that terminate in a small conical outgrowth. Buds sometimes in pairs on the fertile branchlets, from one of which is developed either the ♂ or ♀ flower, dome-shaped, pale yellowish brown, the perulæ ovate or ovate-elliptic, closely imbricated. Leaves scale-like, of deltoid shape and soon falling off; from the axils of these arise the phylloid shoots or cladodes which perform the functions of true leaves; they are produced in whorls of twenty—thirty each, and vary much in length and size according to the age and condition of the tree, usually from 2 to 4 inches long, emarginate, with a median furrow on both sides, that on the under side broader and deeper than that above, very coriaceous in texture, dark glossy green above, paler beneath. Staminate flowers in dense heads at the apex of short branchlets, and surrounded at the base by a few short involucral bracts, each flower globose, about 0·25 inch in diameter, the anthers on short filaments inserted on a fleshy axis, two-lobed with vertical dehiscence. Ovuliferous flowers terminal and solitary, sub-cylindric, about an inch long, composed of rhomboidal-cuneate, imbricated scales, scarcely thickened beyond the middle, reflexed at the apex and spirally arranged around the axis, each scale bearing a partially concrescent bract and seven–nine anatropous ovules placed in a transverse series

* Kôya-maki, the name quoted *infra*, means the Pine from Mount Koya.

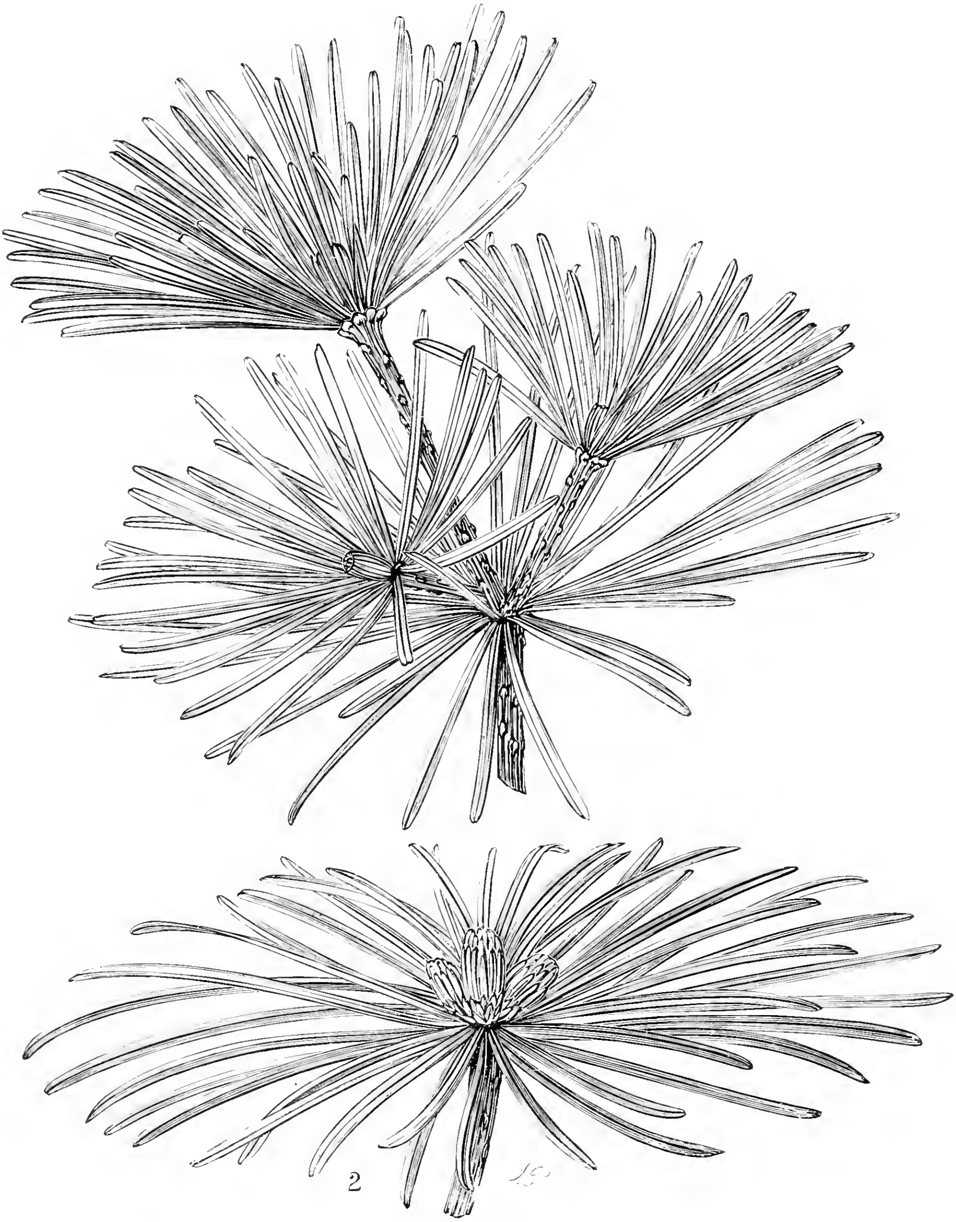


Fig. 87. Branchlets with foliage (phyllodes) of *Sciadopitys verticillata*.
1, reduced. 2, nat. size.

along the inner face. Strobiles cylindric, obtuse, 2—4 inches long and 1·25—2·5 inches in diameter, the scales large in proportion to the size of the cone. Seeds compressed with a small membraneous wing.

Sciadopitys verticillata, Siebold and Zuccarini, *loc. cit. supra*. Lindley in Gard. Chron. 1862, pp. 22, 360, with fig. Murray, Pines and Firs of Japan, 109, with figs. Van Houtte, Flore des Serres, XIV, t. 1483. Carrière, Traité Conif. ed. II. 232. Parlatore, D. C. Prodr. XVI. 435. Gordon, Pinet. ed. II. 376. Masters in Journ. Bot. XXII. (1881), p. 97; Journ. Linn. Soc. XVIII. 502; and Journ. R. Hort. Soc. XIV. 70. Beissner, Nadelholzk. 203, with fig.

Taxus verticillata, Thunberg, Fl. Jap. 276 (1784).

Eng. Umbrella Pine. Fr. Sapin à Parasol. Germ. Japanische Schirmtanne. Ital. Il pino parasole. Jap. Kôya-maki.

This remarkable tree first became known to Europeans through the Swedish botanist, Thunberg, who saw it in cultivation during his mission to Japan, 1775—1776. Although possessed of considerable botanical knowledge for that period, Thunberg, curiously enough, believed it to be a species of Yew, and he accordingly referred it to the genus Taxus in his "Flora japonica" published a few years after his return to Europe, a circumstance that caused it to be generally overlooked by botanists till Siebold, half a century later, with better opportunities of observing it, determined its true characters and founded upon it the genus Sciadopitys. The publication of Siebold's description with excellent figures in 1842, attracted much attention, and a general desire was felt among botanists that so remarkable a tree should be introduced into European gardens, a wish that was not destined to be satisfied so long as Japan remained closed against foreigners. Nevertheless, through the footing the Dutch had gained in the country, many Japanese plants found their way into the Botanic garden established by them at Buitenzorg in Java, and among these was the Sciadopitys, whence Thomas Lobb while collecting for the Veitchian firm obtained the first plant that reached England alive; it arrived at the Exeter nursery in 1853 in very feeble health, and all attempts to restore it proved fruitless. A few years later the great political changes in Japan began, and in 1861 Mr. John Gould Veitch brought home cones and seeds of the Sciadopitys gathered in its native country, and from these most of the oldest specimens growing in Europe were raised. About the same time or shortly afterwards, Mr. Robert Fortune sent seeds to Mr. Standish at Ascot.

The Sciadopitys has now been in our midst more than forty years, but large specimens are still comparatively rare. Complaints have arisen in many places that it will not grow, whence it is evident that its requirements have not been met, and yet these may be thus briefly formulated—"Where the Rhododendron thrives, the Sciadopitys will grow." This means that the soil in which the Sciadopitys is planted must be sufficiently retentive to afford a constant supply of moisture to the roots during the growing season; where this supply is intermittent, that is to say—when the Sciadopitys is planted in a soil that is sometimes dry and sometimes wet according to the changes of weather, it does not thrive.

The following sketch of its present condition in its native country is from the pen of one of the most eminent living authorities on Forestry and Arboriculture:—

"The Sciadopitys was for a long time known only from a few individuals cultivated in temple gardens and from the grove on the hill in Kiushiu where the ancient monastery town of Kôya stands, to which the Sciadopitys owes one of its Japanese names, Kôya-maki. There is said to be a remarkable grove of these trees here which was once supposed to be the original home of the species, but the best authorities now agree that they were originally planted by the monks. In the province of Mino on the Nakasendo below Nakatsu-gawa, we saw young plants of Sciadopitys in all the roadside gardens, a pretty sure indication in this remote region that the tree was growing in the woods not very far off, and here for the next two or three days we saw it sending up its narrow pyramidal heads above the Pines and other trees of the forest, growing, as we thought, quite naturally, and leading us to believe that we had found the true home of this tree, although in a country like Japan which has been densely populated for centuries and in which transplanting has been a recognised industry for more than a thousand years, it is not easy to determine whether a forest has been planted by man or not. But whether these trees had been planted or whether they were the offspring of trees brought from some other region or the indigenous inhabitants of the forest, the Sciadopitys grows on the mountains of Mino in countless thousands, often rising with a tall straight trunk to the height of nearly 100 feet, and remarkable in its narrow compact pyramidal head of dark and lustrous foliage. The wood, which is nearly white, strong and straight-grained, is a regular article of commerce in this part of Japan, and from Nakatsu-gawa is floated in rafts down the Kisiogaiva to Osaka where it is said to be chiefly consumed. Except in the neighbourhood of Nakatsu-gawa the Sciadopitys is not very much cultivated as a garden plant in Japan; and it is not often found in old gardens except in the immediate neighbourhood of temples where picturesque old specimens may occasionally be seen occupying a place of honour within the fence which encloses the principal building, and carefully protected by low stone railings. There is a remarkable specimen with pendulous branches standing before one of the mortuary temples in the Shiba Park in Tokio."*

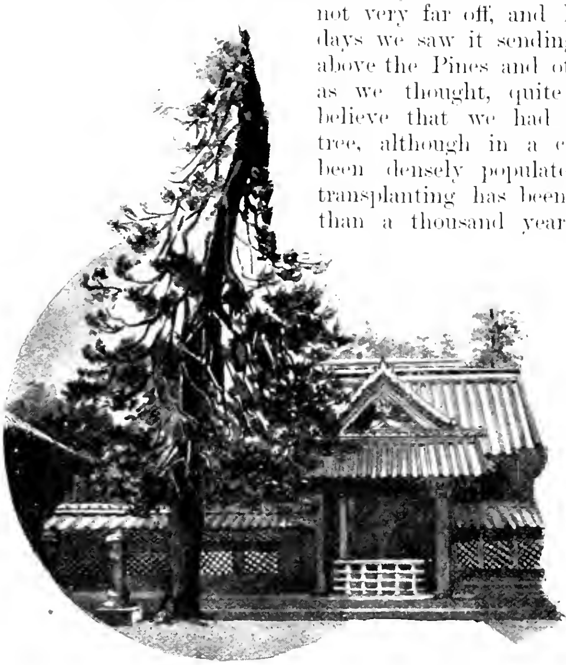


Fig. 88. *Sciadopitys verticillata* in the Shiba Park, Tokio.

* C. S. Sargent, Forest Flora of Japan, p. 77.

TRIBE—ARAUCARINEÆ.

Flowers monœcious or diœcious. Staminate flowers umbellate or solitary, terminal or axillary. Stamens mostly pendulous and free, with 3—12 or more longitudinally dehiscent anther cells. Cones with the scales spirally arranged, in the two-fold structure of which the bract greatly predominates; the ovuliferous scale confluent and reduced to an inconspicuous cellular projection. Seeds pendulous, free or concrescent with the scale.

Flowers monœcious.
  Staminate flowers umbellate and terminal.
    Seeds 3, pendulous and free - - - 11.—Cunninghamia.
  Staminate flowers solitary and axillary.
    Seeds solitary, free - - - - - 12.—Agathis.
Flowers diœcious, rarely monœcious.
  Staminate flowers solitary or clustered.
    Seeds solitary, concrescent with the scale - 13.—Araucaria.

CUNNINGHAMIA.

Robert Brown ex L. C. Richard, Mém. sur les Conif. 80. t. 18 (1826). Endlicher, Synops. Conif. 193 (1847). Parlatore, D. C. Prodr. XVI. 432 (1868). Bentham and Hooker, Gen. Plant. III. 435. Eichler in Engler and Prantl. Nat. Pfl. Fam. 85 (1887). Masters in Journ. Linn. Soc. XXX. 25 (1893).

A monotypic genus founded by Dr. Robert Brown in 1826 upon an herbarium specimen brought from China by Sir George Staunton in 1795, which Lambert had figured and described under the name of *Pinus lanceolata*, a genus so evidently unsuited for its reception that R. A. Salisbury, so early as 1807, proposed a new genus for it which he named Belis. This, however, was not taken up on account of its close resemblance to Bellis used for the Daisies, and Brown's name, given in compliment to James Cunningham, the original discoverer of this remarkable tree, has been universally adopted.

The botanical affinity of the Cunninghamia remained a long time doubtful. Endlicher placed it in the Abietineæ with Athrotaxis and Sequoia; Parlatore removed it to the Taxodineæ in which he is followed by Eichler; Bentham and Hooker, however, joined it with Araucaria and Agathis in which it agrees in the bracts of the ovuliferous flowers being in continuous series with the leaves, and its cones in like manner being chiefly composed of bracts. Moreover, in the subordinate characters of foliage, branching and general habit, the Cunninghamia approaches more closely the Araucarias (section Colymbea) than any other genus.

The Cunninghamia is of geological antiquity. Remains of cones and foliage closely resembling those of the living species have been found in the lower Tertiary strata.

Cunninghamia sinensis.

A medium-sized tree, said to attain a height of 40—50 feet in its native country, but in the south of Europe seldom exceeding 30—35 feet. Branches at first pseudo-verticillate, subsequently becoming very irregular in old trees; ramification distichous and opposite, bark of branchlets green like the leaves. Leaves persistent five—seven years, spirally arranged, but twisted obliquely at the base so as to spread laterally in two opposite directions, narrowly lanceolate, acuminate, 1—2 inches long with thickened midrib and margins, pale lustrous green above, glaucous beneath. Flowers monœcious on different branches, terminal or pseudo-terminal. Staminate flowers densely umbellate, surrounded at the base by numerous triangular, serrulated and closely imbricated involucral bracts; stamens spirally crowded, with a short filament and suborbicular connective from which depend three longitudinally dehiscent anther cells. Cones erect, solitary or clustered at or near the end of branchlets of the preceding year, ovoid-globose, 1—1·5 inch in diameter, persistent after the fall of the seeds, composed chiefly of spirally arranged bracts "wholly confluent with the seed scale which is reduced to a mere cellular projection with a vascular connective between the central bundle of the bract; from this placental process hang three compressed seeds, each with a membranous wing."*

Cunninghamia sinensis, Robert Brown ex L. C. Richard, *loc. cit. supra.* London, Arb. et Frut. Brit. IV. 2415, with figs. Siebold and Zuccarini, Fl. Jap. II. 7, tt. 103, 104. Murray, Pines and Firs of Japan, 116, with figs. Carrière, Traité Conif. ed. II. 228. Gordon, Pinet. ed. II. 76. Beissner, Nadelholzk. 196, with fig. Masters in Journ. R. Hort. Soc. XIV. 203.
C. lanceolata, Hooker, W. Bot. Mag. t. 2743 (1827).
Pinus lanceolata, Lambert, Genus Pinus, I. t. 34 (1803).
Belis jaculifolia, Salisbury in Trans. Linn. Soc. VIII. 315 (1807).

Cunninghamia sinensis is a native of southern China where it has been seen in several localities by botanical travellers, and quite recently by Dr. Henry in the province of Yun-nan,† but the extent of its distribution is very imperfectly known. It was originally discovered by James Cunningham in the early part of the eighteenth century, but scarcely anything was known of it till herbarium specimens were brought from China by Sir George Staunton in 1795. It was introduced in 1804 by William Kerr.‡

The Cunninghamia was for some years after its introduction treated as a greenhouse plant, and in one of the houses in the Botanic Garden at Glasgow its staminate flowers were produced for the first time in 1826. In 1816 a plant was turned out into a sheltered part of the grounds at Claremont, where it continued to live without protection during the winter; this course was followed in other places, so that some old trees are still to be found scattered over the southern counties. At its best the Cunninghamia is a very distinct tree of Araucaria-like aspect, but the foliage of more than one year's standing is invariably more or less discoloured, probably from a combination of causes, which has proved a drawback to its use as an ornamental tree in this country.

* Masters in Journal of the Linnean Society, *loc. cit. supra.*
† Kew Bulletin (1897), p. 409. ‡ *See* page 170.

AGATHIS.

Salisbury in Trans. Linn. Soc. VIII. 311. t. 15 (1807). Bentham and Hooker. Gen. Plant. III. 436 (1881). Eichler in Engler and Prantl. Nat. Pfl. Fam. 66 (1887). Masters in Journ. Linn. Soc. XXX. 25 (1893). Dammara. Lambert. Genus Pinus. II. t. 6. Endlicher. Synops. Conif. 188.

A genus of evergreen trees closely allied to Araucaria, and including about ten species that are distributed through the Malay Archipelago, the islands of the south Pacific Ocean, eastern tropical Australia and New Zealand. Inhabiting only tropical and sub-tropical regions, the species can have no place in the British Pinetum, nor would notice of the genus be taken in this place but for the great importance, in an economic sense, of *Agathis australis*, the species indigenous to New Zealand, which is one of the best timber and resin-producing trees known. The following description of it and the subjoined particulars are derived wholly from Kirk's "Forest Flora of New Zealand."

Agathis australis.

A lofty tree with a straight trunk 80—100 or more feet high, and 4—8 feet in diameter, free of branches for the greater part of the height, and when standing alone with a broad spreading head. Bark of trunk thick and very resinous, cinereous-brown, fissured into large flat plates. Branches spreading, somewhat distant, much ramified at the distal end. Leaves persistent several years; on young trees narrowly lanceolate, acute, 1—3 inches long, spreading, distant, very thick and coriaceous; on adult trees oblong or obovate-oblong, close-set, bright lustrous green. Staminate flowers axillary, cylindric, obtuse, 1—1·5 inch long; stamens spirally crowded, with a peltate connective bearing ten—twelve pendulous anther cells. Ovuliferous flowers terminal on short lateral branchlets, composed of numerous broadly obovate, imbricated scales each bearing a solitary inverted ovule at the base on the ventral side. Cones globose, about 2 inches in diameter; scales ligneous; seeds with a small membranous wing.

Agathis australis, Salisbury in Trans. Linn. Soc. *loc. cit. supra*. Kirk, Forest Fl. N. Zeal. 143. tt. 79—81.

Dammara australis, Lambert, Genus Pinus, II. t. 6 (1828). Loudon, Arb. et Frut. Brit. IV. 2488. with fig. Hooker fil. Handb. N. Zeal. Fl. 252. Carrière. in Van Houtte's Flore des Serres. XI. 75. with fig. Parlatore. D. C. Prodr. XVI. 376. Gordon, Pinet. ed. II. 108.

Podocarpus zamiæfolia, A. Richard. Fl. N. Zeal. 231.

N. Zeal. vernacular, Kauri Pine.

Agathis australis at the present time has but a limited range in New Zealand: with the exception of a few isolated trees on the west coast, it is confined to the area in the North Island lying between the North Cape and the 38th parallel of south latitude. It usually forms large groves mixed with other trees: pure forests are rare and of small extent. The superb Kauri forests are, however, fast disappearing; those that formerly existed on the banks of the Manukon river have already been exhausted of all the available timber, and a similar fate awaits those that remain. The process of destruction is often hastened by frequent forest fires by which thousands of the trees perish annually.

The Kauri Pine is the monarch of the New Zealand forest; no other timber tree in the colony is applied to so many and varied uses, and its resinous products are scarcely surpassed in value by those of any other coniferous tree. Kauri timber varies in colour from yellowish white to brown; it is firm, straight in grain and of great strength, durability and elasticity; it is used for every purpose for which timber is in request; for building, heavy framework, weather-boarding, bridges, railway-ties, telegraph-posts, every description of joinery and decorative fittings both for public buildings and for private dwellings. The sapwood is excessively charged with resin and possesses great heating power. Kauri Gum, its most valued resinous product, has been already adverted to in page 96.

ARAUCARIA.

Jussieu, Gen. Plant. 413 (1789). Endlicher, Synops. Conif. 184 (1847). Parlatore, D. C. Prodr. XVI. 369 (1868). Bentham and Hooker, Gen. Plant. III. 437 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 67 (1887). Masters in Journ. Linn. Soc. XXX. 26 (1893).

The Araucarias are massive evergreen trees with lofty trunks from which the branches are produced in whorls of four to eight, five being the predominant number. During the earlier period of growth the branches of most of the species with subulate (awl-shaped) leaves are strictly horizontal and very regularly ramified, the lateral branchlets being evenly placed, gradually shorter from the base to the apex and more or less decurved, rarely rigid and on one plane. This formal but elegant habit renders them useful subjects for the decoration of large conservatories, public halls, etc. In their old age the Araucarias become denuded of the lower branches and have usually flattened or rounded tops of which the branches are irregularly developed and sparsely furnished with branchlets and foliage; in this state the aspect of the trees is described as singular and even grotesque, an effect which is greatly intensified in *A. imbricata* by its large hedgehog-like cones with which the fertile old trees are often loaded.

The most obvious generic characters are—

Flowers diœcious, rarely monœcious, lateral or terminal. Staminate flowers in a cone-like or cylindric mass and consisting of numerous spirally crowded and imbricated stamens, each with six — twenty anther-cells in two series, the dehiscence of which is longitudinal.

Ovuliferous flowers clavate or sub-globose, composed of many spirally arranged scales in continuous series with the foliage leaves, each bearing a single pendulous ovule that ultimately becomes confluent with the scale.

Cones large, globose, the scales closely imbricated, the margins of which are usually attenuated into wings at the base, thickened and woody at the apex and enclosing a single flattened wingless seed adnate to the scale at the base.

The Araucarias are not absolutely diœcious, probably far from it. There is a tree of *A. imbricata* at Bicton in Devonshire that has frequently borne both staminate and ovuliferous flowers; another tree at South Lytchett in Dorsetshire showed the same peculiarity until it was unfortunately uprooted by the great gale of March 3rd, 1897, and other instances have also been recorded. The difference in the sex of the trees was generally believed to be the cause of the difference in aspect and habit which occurs so frequently in *A. imbricata* and to some extent in other species as *A. Rulei* and *A. excelsa*; but the Araucarias are now known to be polymorphous irrespective of sex.

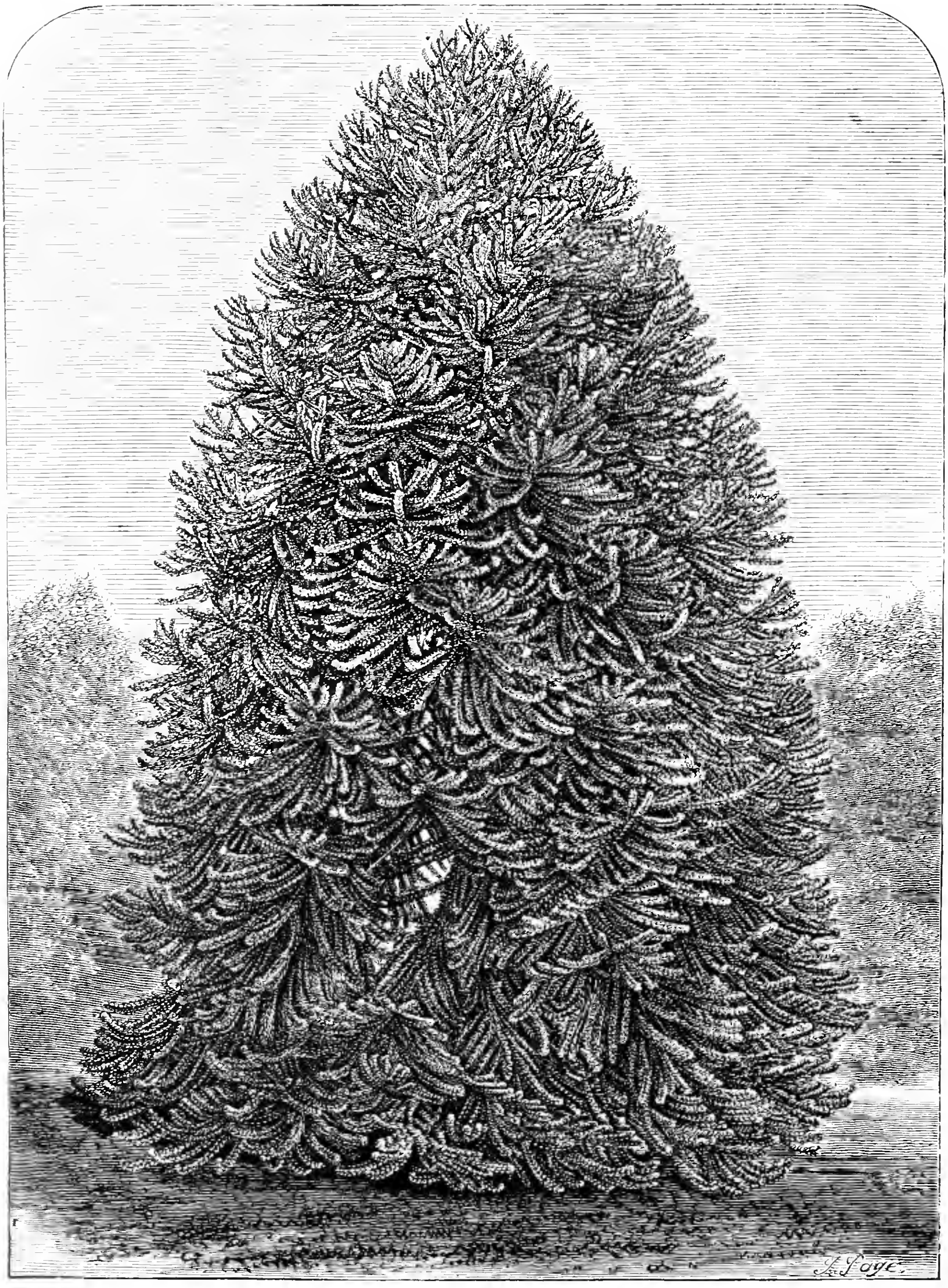
The genus is restricted to a comparatively limited area in the southern hemisphere, viz., temperate South America, eastern Australia, and a few of the islands in the south Pacific Ocean. The South American species form in places pure forests of considerable extent; the Australian species, from climatic causes, are confined to districts in the neighbourhood of the coast; and the insular species are restricted for the most part to a single island or small group of islands, and exist in numbers so few that they appear to be the last relics of a race that is passing away. Of the ten or twelve species known to science, the two endemic in South America and one in Australia are distinguished from the others by a difference in their foliage, cones and in some other characteristics; the Araucarias therefore admit of a division into two sections thus:—

Colymbea. Leaves relatively large, flattened, broad at the base and more or less embracing the stem, acuminate and pungent. Cones among the largest in the Order, the scales of which are scarcely winged and the seeds almost destitute of a basilar appendage.

Eutassa. Leaves linear-subulate, obscurely four-angled, compressed, spirally arranged and spreading or falcately curved from all sides of their axis. Cones relatively small, the scales broadly winged and the seeds with a distinct basilar appendage.*

The economic value of the Araucarias has not yet been much developed. The timber of *A. imbricata* where accessible, is used in southern Chile for building and other purposes; the wood is yellowish, beautifully veined and admits of a fine polish; the wood of *A. Bidwilli* is close-grained and durable, and much used in Queensland for building.

* A further distinction between the two sections has been referred to the mode of germination of the seeds which is said to be hypogeal or epigeal, according as the cotyledons are developed beneath or above the soil, the former being common to the broad-leaved (Colymbea) section, and the latter to the narrow-leaved (Eutassa) section. It is, however, doubtful whether the distinction so set up has the full significance that has been attached to it; instances have been observed in which the process of germination of the seeds of species included in one section differ *inter se* almost as much as that by which the two sections are distinguished. But further observation extended to all the species is still wanting.



Araucaria imbricata at Dropmore.

The secretions are copious and are applied to various uses in the region in which the trees are native: the fragrant resin that exudes from the trunk of *A. brasiliensis* is mixed with wax for making candles: the whitish resin of *A. imbricata* is used by the Chilians much in the manner of mediaeval pharmacy, as a remedy for bruises, wounds, etc., and when dry as a mitigant of pain.* The seeds or "nuts" of all the large-coned species are edible and are consumed in great quantities by the poorer inhabitants of the districts in which these trees abound. Only one species is sufficiently hardy for the climate of Great Britain, but most of the others are cultivated in a young state in glass structures.

The remains of ancestral forms of Araucaria have been discovered in Jurassic strata; an enormous antiquity must thence be assigned to the race. The remains consist of entire cones, cone-scales and portions of leafy cone-bearing branches. Remains have also been found in the Oolite of Yorkshire and in the Eocene formations both of England and France; † the Araucarias therefore must have been widely distributed over the globe before they receded to their present narrow limits.

The name Araucaria is derived from Arauco, a province of southern Chile, the habitat of the type or earliest discovered species.

Araucaria imbricata.

A lofty tree, 70—100 or more feet high, with a trunk 5—7 feet in diameter near the ground, and usually with a dome-shaped head of spreading branches; the bark of the trunk fissured in a peculiar manner which has been described as "a child's puzzle of knobby slabs of different sizes with five or six decided sides to each, and fitted together with the neatness of a honey-comb." ‡ In Great Britain a massive tree of singularly distinct aspect, with a sub-cylindric or scarcely tapering trunk covered with roughish reddish brown bark with transverse narrow ridges marking the position of the fallen leaves. Primary branches in pseudo-whorls of four—six and ramified distichously, the lowermost more or less procumbent, and the uppermost gently curved upwards. Leaves persistent twelve—fifteen or more years, spirally crowded and imbricated, ovate-lanceolate, 1—1·5 inch long, rigid and pungent, slightly concave on the ventral side, smooth, bright lustrous green and stomatiferous on both sides. Staminate flowers solitary or in clusters of two—five, sub-cylindric, 3—5 inches long, the stamens with a narrowly lanceolate, acuminate, recurved connective bearing six—nine or more anther-cells. Cones solitary, sub-spherical, broader at the base than at the apex, 4—6 or more inches in diameter, the concrescent bract and scale wedge-shaped, prolonged at the apex

* Los campesinos administran la resina en parches contra las contusiones y ulceras putridas; cicatriza las heridas recientes; mitiga los dolores de cabeza producidos de fluxiones y jaqueca, etc.—Claudio Gay, Historia de Chile, V. 416.

† It is an interesting fact that an Araucaria closely resembling the beautiful *A. excelsa* of Norfolk Island, once inhabited this country; fossil remains of it have been found in Dorsetshire and Somersetshire.

‡ The late Miss Marianne North ex W. B. Hemsley in Gard. Chron. XXIV. (1885), p. 276.

into a lanceolate, acuminate, tail-like appendage nearly an inch long, and bearing one seed that is adnate to the scale. Seeds large, wingless, obscurely four-angled, about an inch long with a thick chestnut-brown testa.

Araucaria imbricata, Pavon in Mém. Acad. Madr. I. 197 (1795). Lambert, Genus Pinus, II. 9, t. 4 (1824). Loudon, Arb. et Frut. Brit. IV. 2432, with figs. Endlicher, Synops. Conif. 186. Gay, Fl. Chil. V. 415. Forbes, Pinet. Woburn, 103, tt. 55, 56. Gordon, Pinet. ed. II. 39. Lawson, Pinet. Brit. I. 99, tt. 55, 56. Beissner, Nadelholzk. 199, with figs. Masters in Gard. Chron. VII. ser. 3 (1890), p. 587, with figs.; and Journ. R. Hort. Soc. XIV. 198.
Dombeya chilensis, Lamarck, Dict. II. 301 (1786).*
Colymbea imbricata, Carrière, Traité Conif. ed. II. 598.
Eng. Chile Pine, Monkey Puzzle. Germ. Chilenische Araukarie, Schmucktanne.

Fig. 89. Staminate flower of *Araucaria imbricata*.
Nat. size.

The native home of *Araucaria imbricata* is in southern Chile; the precise limits of its distribution are not accurately known, but may be stated approximately to be between the 38th and 45th parallels of south latitude. In the northern portion of its range, it is confined to the higher western slopes of the Andes, always in proximity to the snow-line, forming a belt of forest immediately below it. Further south it descends lower down, and the area over which it is spread gradually widens till its southern limit is reached where it approaches the Pacific coast.

* Lamarck's generic name, Dombeya, had been previously taken up for a group of Sterculiaceous shrubs chiefly African.

Araucaria imbricata was discovered in 1780 by Don Francisco Dendariarena, a Spaniard who was at that time officially employed to ascertain if any timber suitable for ship-building was procurable in southern Chile. It was also found very shortly afterwards by Drs. Ruiz and Pavon, two Spanish botanists who went out to Peru in 1777 to investigate the forests of that country, with the special object of collecting information respecting the Cinchona or Peruvian Bark, and who subsequently extended their explorations further south. They were accompanied by a French gentleman named Dombey, but he returned to Europe after a short stay, and before Ruiz and Pavon sailed for Chile. It was to him that Ruiz and Pavon sent the first dried specimens of the Araucaria received in Europe, and by him these were submitted to the eminent botanist, Lamarck, who named the tree *Dombeya chilensis*, and thus Dombey's name became associated with the synonymy of the tree. In 1795, Captain Vancouver reached the coast of Chile, when Mr. Archibald Menzies, who accompanied him in the capacity of botanist, procured some cones and seeds, and also some young plants, which he succeeded in bringing home alive. He presented these to Sir Joseph Banks, who planted one in his own garden, and sent the others to the Royal Gardens at Kew, where they were at first kept in a greenhouse. About the year 1808 one of them was planted out on what is now called Lawn L, where for many years it grew slowly, but was once a superb tree; eventually it lingered on as a mere botanical curiosity till the autumn of 1892, when it died.*

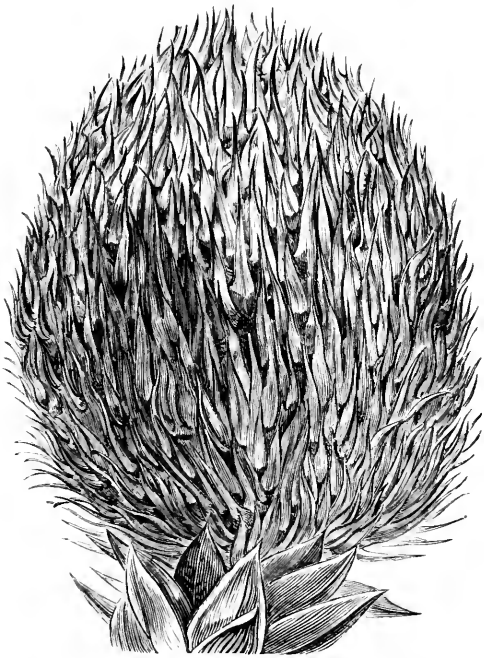


Fig. 90. Ovuliferous flower of *Araucaria imbricata*. Nat. size.

For many years after Menzies' introduction *Araucaria imbricata* continued to be very scarce in England; seeds could not be obtained, and the small quantity that reached this country from time to time, failed to germinate. It was not till 1844 that William Lobb, while collecting in South America for the Veitchian firm, succeeded in penetrating the Araucaria forests, and brought home the first large supply of seed received in England, and from which very many of the fine specimens now growing in various parts of the country originated. It is worthy of note that *Araucaria imbricata* is the only true coniferous tree inhabiting the southern hemisphere that has attained a

* Kew Bulletin, 1893, p. 24.

timber-like size in the open ground in Great Britain. Its power of endurance was severely tested in the memorable winter of 1860—1861, when many fine trees were killed, but the casualties occurred under such a variety of circumstances, that it is difficult, if not impossible, to deduce any special law affecting the hardiness of the tree. The following conditions are essential to securing fine free-growing specimens:—The soil must have a thorough drainage, either natural or artificial, to prevent the stagnation of water at the roots; the trees should be planted in full exposure to sun and air, and if in an elevated situation so much the better, a free open space being more conducive to their progress and well being than a confined and sheltered one. In very dry soils the Araucaria lives, but it loses its lower branches at an early age; the branches are slender and frequently become flaccid, and the plant has a thin starved appearance; it also loses its lower branches early when in a confined space or in contact with other trees or shrubs, or when its roots penetrate an ungenial sub-soil; it languishes if within the influence of the smoke of towns; and the foliage takes a yellowish sickly tint if the roots enter and remain in stagnant water or water-logged soil for a lengthened period. On the western slopes of the Chilian Andes, the native home of the Araucaria, the rainfall is far more copious than in England, and the trees are also within the influence of the southern region of prevalent westerly winds blowing across the Pacific Ocean. Hence it is that in Great Britain they thrive best where the rainfall is greatest, and the soil porous enough to carry off the water freely.

The aspect of *Araucaria imbricata* is dark and massive, and large healthy specimens furnished with tiers of branches from the ground to the summit are strangely impressive. Whether solitary or planted in avenues it is the most effective of all Conifers for contrast. The Araucaria avenue at Bicton belonging to the Hon. Mark Rolle presents one of the most striking and remarkable arboricultural effects that can be seen in this country. Isolated specimens, imposing as they are, convey but a faint conception of the vista produced by a double row of these strangely wonderful trees with their dark plexus of branches and rigid bristling foliage extending for a distance of 500 yards in straight unbroken lines. The trees are fifty in number, twenty-five on each side, those on the one side standing precisely opposite those on the other, the interval between every two trees being 63 feet in this direction, and 54 feet in the rows. The height of the trees varies a little, the tallest being (at the present time, 1900) about 55 feet, and the shortest not less than 30 feet. A few have cast off their lowest tiers of branches, and there are two or three whose trunks are free of branches to nearly one-third of their height; the uniformity is thus slightly but not materially impaired. The circumference of the trunks at three feet from the ground ranges from 5 to 7 feet; the length of the lower branches of the most spreading tree is about 20 feet.

A short avenue at Poltimore, near Exeter, is well marked by the evenness of growth and the healthy appearance of the trees composing it; and one of greater extent at Murthly in Perthshire forms a remarkable feature amidst its surroundings. The enumeration of even a fractional part of the number of fine Araucarias dispersed over Great Britain from Sutherland to Cornwall and over Ireland would occupy more space than

The Araucaria Avenue at Bicton.

can be spared; nevertheless, mention should be made of some of the larger trees of known repute, and of these the first place must be given to the superb specimen at Dropmore, the subject of the illustration and still the finest in the country. Closely approaching it in dimensions are trees at Tortworth Court, Gloucestershire; Trevarrick, Cornwall; Revesby Abbey, Lincolnshire; Howick Hall, Northumberland; Chaddlewood, south Devon; Piltdown, Sussex; Thornhill Park, Hants; Wansfell Holme, Cumberland; Drumlanrig, Dumfries-shire; Dunkeld, Perthshire; Cultoquhey, Dupplin Castle and Keir House in the same county; Gordon Castle, Morayshire; Castlewellan, Co. Down; Fota Island, Cork; Hamwood, Co. Meath; Curraghmore, Waterford; Woodstock, Kilkenny; and many more.

Araucaria Bidwilli.

A lofty tree attaining 100—150 feet in height with a stout trunk usually denuded of branches for half the height. Branches in whorls of ten—fifteen with distichous ramification. Leaves in crowded spires, lanceolate, acute, 0·75—1·5 inch long, sub-sessile, shortly decurrent and slightly twisted at the base which brings them into a pseudo-distichous position, coriaceous and rigid, dark lustrous green above, keeled beneath. Staminate flowers cylindric, 2—3 inches long, the imbricated connectives of the stamens triangular. Cones the largest in the genus, erect on the topmost branches, ovoid-globose, about 9 inches long and 7 inches in diameter, composed of spirally arranged, loosely imbricated scales of obovate-cuneate shape, about 3·5 inches long with a lenticular thickening at the apex and terminating in an acute edge.

Araucaria Bidwilli, Hooker. W. in Lond. Journ. Bot. II. 503, tt. 18, 19 (1843). Bentham, Fl. Austral. VI. 243 (Bunya-Bunya).

South Queensland, between the rivers Brisbane and Burnett; introduced about the year 1840. It commemorates Mr. J. T. Bidwill, one of the earlier botanical explorers of Australia and New Zealand.

Araucaria brasiliensis.

A tree 70—80 feet high, in old age with a large irregular head of spreading or sub-pendent branches with the branchlets and foliage more or less tufted at the distal end. Branches in whorls of five—seven and ramified distichously. Leaves persistent several years; on young trees narrowly lanceolate, often falcately curved, 1·5—2·5 inches long, prolonged into a pungent acuminate tip; shorter and broader on the fertile branches and on old trees, dark lustrous green with an obscure median keel above, paler and stomatiferous beneath. Staminate flowers solitary or two—three together, cylindric, obtuse, 4—5 inches long and 0·75 inch in diameter. Cones sub-globose or ovoid-globose, 5—6 inches in diameter; scales cuneate-oblong, of corky texture, with a rhomboidal thickening at the apex and terminating in a recurved spine.

Araucaria brasiliensis, A. Richard in Dict. d'Hist. Nat. I. 512 (brasiliana). Loudon, Arb. et Frut. Brit. IV. 2439, with figs. Parlatore, D. C. Prodr. XVI. 370. And others.

Mountains of southern Brazil in the provinces of Saõ Paolo and Minas Geraes up to 3,000 feet elevation, in places forming forests of considerable extent. Introduced into Europe in 1819. Much cultivated along the Mediterranean littoral of France and Italy.

Araucaria Cookii.

A lofty tree of singular habit and aspect, attaining a height of 150—200 feet, and which after shedding its primary branches for five-sixths or more of its height, replaces them by a smaller and more bushy growth, so that the tree has the appearance of a tall column crowned with a mass of branchlets and foliage of the first growth. On young trees cultivated in Great Britain the primary branches are spreading, and are produced in whorls of five—seven; the branchlets close-set, distichous and decurved at the distal end. Leaves spirally crowded, awl-shaped, laterally compressed, broad and slightly decurrent at the base, and terminating in a short point or mucro, bright green. Staminate flowers sub-cylindric, 1·5 inch long; stamens spirally crowded, with a cordate-ovate connective bearing ten—twelve anther cells. Cones shortly stalked, ovoid-globose, the longer diameter 4—5 inches, the shorter 3—5 inches; scales closely imbricated, ovate-cuneate, terminating in a long subulate mucro.

Araucaria Cookii. R. Brown ex Don in Trans. Linn. Soc. XVIII. 164 (1839). Parlatore, D. C. Prodr. XVI. 373. Gard. Chron. III. ser. 3 (1888), p. 774, with figs. A. columnaris, Hooker. W. Bot. Mag. t. 4635 (1852).

New Caledonia, Aneitum and one or two small islets in the New Hebrides group, but quite rare. Discovered in 1774 by Captain Cook, whose companions thought at first that they beheld in the distance a tall column of basalt or some other volcanic product standing aloft in solitary grandeur.* Several varieties of *Araucaria Cookii* are distinguished by name by Australian horticulturists.

Araucaria Cunninghami

A tall pyramidal tree, but usually with a flattened head in old age, in some localities attaining a height of 150—200 feet, but in others remaining much smaller. Branches in whorls of four—seven, spreading horizontally or more or less depressed; ramification distichous with many adventitious weaker shoots on the upper side of the branches of young trees growing under glass in Great Britain. Leaves in crowded spires, acicular, laterally compressed with the dorsal midrib decurrent, 0·25—0·5 inch long; those on the fertile branches shorter, triquetral and with a broad adnate base. Staminate flowers cylindric, 2—3 inches long; stamens densely crowded, with an ovate-rhomboid connective bearing eight—ten anther cells. Cones ovoid-globose, about 3 inches long and 2 inches broad, the scales with their marginal wings broadly cuneate and terminating in a lanceolate recurved mucro.

Araucaria Cunninghami, Lambert, Genus Pinus, II. t. 96 (1824). Loudon, Arb. et Frut. Brit. IV. 2443, with figs. Bentham, Fl. Austral. VI. 243. C. Moore, Fl. N. S. Wales, 376 (Moreton Bay Pine).

The most widely distributed of all the Australian Araucarias. From the north-east coast district of New South Wales it spreads northwards

* An amusing account of the discovery of this curious Araucaria is given by Captain Cook in the narrative of his second voyage to the south Pacific Ocean, much of which is reproduced by Sir William Hooker in the Botanical Magazine, *loc. cit.*

through the littoral region of Queensland to Cape York peninsula; it has also been found on Mounts Arfak and Obree, in New Guinea, up to 6,000 feet above the level of the sea; around Moreton Bay, where it is most abundant, it spreads eighty miles inwards. The species commemorates Allan Cunningham, one of the earliest and most energetic of Australian explorers.

Araucaria excelsa.

A stately tree 150—200 feet high with a trunk 5—7 feet in diameter, usually free of branches for more than one-half the height and crowned with a spreading top. In young trees cultivated in Great Britain, the branches are in whorls of four—seven, five being the predominant number, spreading horizontally and ramified distichously. Branchlets close-set and parallel, sometimes rigid and in one plane, but more frequently decurved at the distal end. Leaves persistent several years, spirally crowded, awl-shaped, straight or falcately curved, 0·25—0·75 inch long and of a uniform bright grass-green, broader at the base, keeled on the dorsal side and closely imbricated on fertile branches preserved as herbarium specimens. Cones spherical, 4—6 inches in diameter, broadest at the base; scales broadly cuneate, prolonged at the apex into a lanceolate, acuminate, incurved spine.

Araucaria excelsa, R. Brown in Aiton's Hort. Kew. ed. II. Vol. V. 412 (1813). Loudon. Arb. et Frut. Brit. IV. 2440. with figs. Parlatore, D. C. Prodr. XVI. 373. And others.

Norfolk Island in the south Pacific Ocean, discovered during Captain Cook's second voyage; and introduced to the Royal Gardens at Kew by Sir Joseph Banks about the year 1793. The trees in Norfolk Island, now greatly reduced in number by felling for the sake of their excellent timber, generally stand singly or in small groups; they are dotted over the island like the trees in an English park. *Araucaria excelsa* is more cultivated in this country than any of the Australian Araucarias, a preference which is owing to its formal but elegant habit, its bright verdant foliage and the facility with which it is propagated from cuttings; it is also much cultivated along the Mediterranean littoral of France and Italy, the sea air and other climatic conditions of the region being highly favourable to its growth. Among the varieties occasionally seen in cultivation are—*glauca* with foliage of a paler green and more or less glaucous; *alba spica* with the tips of the branchlets cream-white; *robusta* larger in all its parts with foliage of a deeper green, also known as *Goldieana*, *Sanderiana*, *Napoleon Baumann*, etc.

Araucaria Rulei.

A medium-sized tree 50—60 feet high with horizontal branches in whorls of five—seven, and distichous, sub-pendulous branchlets, but which in plants cultivated under glass in Great Britain are sometimes horizontal like their primaries or slightly ascending. Leaves persistent several years, spirally crowded, closely imbricated and incurved, narrowly oblong-lanceolate, obtuse or sub-acute, about 0·5 inch long; convex, obscurely keeled and dark green on the dorsal side, slightly convex and paler on the ventral side. Staminate flowers and cones not seen.*

Araucaria Rulei. Mueller ex Lindley in Gard. Chron. 1861, p. 861, with figs. Carrière, Traité Conif. ed. II. 605 (Eutacta). Parlatore, D. C. Prodr. XVI. 371. Gordon, Pinet. ed. II. 12.

Originally discovered about the year 1860 by William Duncan, a plant collector in the employ of Mr. John Rule, a horticulturist of Melbourne, Victoria, on an islet off the coast of New Caledonia, covering the summit of a lofty extinct volcano fully exposed to the severe storms which periodically sweep over that region; it is also said to be endemic in New Caledonia where it attains greater dimensions. It was introduced to British gardens by the Veitchian firm in 1863. In its young state *Araucaria Rulei* is polymorphous, and several varieties are distinguished by name in Australia where it is much cultivated as a decorative tree.

TRIBE—ABIETINEÆ.

Flowers monœcious. Staminate flowers terminal or axillary, solitary or spicate, often densely clustered, rarely umbellate. Stamens spirally crowded; anther cells 2, dehiscence longitudinal, rarely transverse. Scales of fruit-cones spirally arranged and consisting of two structures, the bract and seed-scale or sporophyll, the former more or less free or concrescent. Seeds 2, inverted.

SUB-TRIBE I.—PINEÆ.

Fruit-cones maturing in two, rarely in three years. Leaves dimorphic, the primordial scattered; the secondary fascicled, persistent - - - - - - - - - - 14.—Pinus.

SUB-TRIBE II.—LARICEÆ.

Branchlets dimorphic, the one elongated with the leaves scattered and inserted on cortical outgrowths (pulvini); the other arrested or "spur-like" with the leaves fascicled.

Fruit-cones maturing in one year. Leaves deciduous.

Staminate flowers solitary, seed scales persistent. 15.—Larix.

Staminate flowers umbellate, seed scales deciduous. 16.—Laricopsis.

Fruit-cones maturing in two years. Leaves persistent.

Staminate flowers solitary, seed scales persistent. 17.—Cedrus.

* Imperfect figures of both are given in the Gardeners' Chronicle, *loc. cit.*

SUB-TRIBE III.—SAPINEÆ.

Leaves persistent, for the most part homomorphic and inserted on cortical outgrowths or pulvini decurrent from their base. Fruit cones maturing in one year.

Leaves sessile or very shortly petiolate, angulate or flat with one—two lateral resin canals. Cones often large and pendulous; scales persistent - -	18.—Picea.
Leaves petiolate, flat, with a central resin canal. Cones small and pendulous; scales persistent -	19.—Tsuga.
Leaves flat with two lateral resin canals. Staminate flowers solitary or umbellate. Cones pendulous (or erect), scales persistent - - - - -	20.—Abietia.
Leaves flat, rarely angulate, with two lateral resin canals. Cones large and erect; scales deciduous -	21.—Abies.

PINUS.

Linnaeus, Sp. Plant. II. 1000, in part (1753). Lambert, Genus Pinus, I. in part (1803). Endlicher, Synops. Conif. 81, in part (1847). Parlatore, D. C. Prodr. XVI. 377, in part (1868). Bentham and Hooker, Gen. Plant. III. 438 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 70 (1887). Masters in Journ. Linn. Soc. XXX. 37 (1893).

The foliage of the Pines is so distinct from that of every other genus of trees that the circumscription of Pinus is one of the simplest; as Dr. Engelmann remarked long ago, "nobody fails to recognise the species belonging to it." This distinctness is owing to the peculiar mode of production of the foliage leaves; they are not primary leaves in the ordinary acceptation of the term, but secondary leaves borne on an undeveloped branchlet surrounded at the base by bud-scales which form the "basal sheath."* Besides this distinct form of foliation, there is an homogeneity of structure in the reproductive organs of all the species, so that both floral and vegetative characters unite to establish the genus firmly.

The Pines are trees, often of large size; shrubs only under the severe climatic conditions of high altitudes and high latitudes. In warm and even in temperate climates the larger Pines grow rapidly for the first thirty to fifty years, and during that period the proportion of sapwood to heartwood is greater than in any other coniferous trees, and it is often strongly impregnated with resin. At and near the extreme vertical limit the growth of the alpine species is extremely slow throughout life; and even when transplanted in lower altitudes, with a higher annual temperature, their growth is not only not accelerated but they soon perish under its stimulus.

* See page 24; also Engelmann, Revision of the Genus Pinus in Transactions of the Academy of Science of St. Louis, U.S.A. IV. 1; and Masters in Journal of the Linnean Society, XXVII. 267.

In respect of branching, the Pines conform to the general law observed throughout the Abietineae.

The primary branches are produced in pseudo-whorls, the lowermost of which, even when the trees are standing alone, are gradually cast off with advancing age; when the trunk ceases to ascend there is usually an irregular development of the topmost branches. The branchlets are whorled and always continue upturned during their development, after which they gradually assume a horizontal position. The foliage leaves are mostly produced in definite numbers; fascicles of two, three and five are most common, but in *Pinus monophylla* the leaves are mostly solitary and terete; in *P. mitis*, *P. cembroides* and one or two others, fascicles of two and three occur regularly, and in *P. Parryana* fascicles of four are most frequent. The shape of the leaves is determined by the number in each fascicle: where there are two they are semi-terete or plano-convex; where there are three, the ventral (inner) side is usually sharply keeled and the dorsal (outer) side convex or nearly flat; and where there are five they are regularly triangular in section. The stomata are mostly disposed in longitudinal rows indicated by white lines and usually on the inner or flat sides, but in *P. Pinaster* and its allies they occur on both surfaces. The persistence of the leaves varies in the different species from two to twenty years.

The following diagnosis of the flowers and fruits is abridged from Engelmann's Revision of the "Genus Pinus."

Flowers monœcious on different branches. Staminate flowers either crowded together into a kind of capitulum (head) or elongated into a spike, cylindric or oval-cylindric, surrounded at the base by few or many (three—fifteen) involucral bracts. Anthers with an orbicular or sub-orbicular connective bearing two anther cells.

Ovuliferous flowers sub-terminal, sub-sessile or pedunculate, solitary or in clusters of two—five or more, composed of numerous scales of a two-fold structure, the sporophyll (seed-scale) and bract, the former bearing two pendulous ovules on the lower part of the inner face and the latter concealed and disappearing in the ripe cone.

Cones maturing at the end of the second, rarely in the third season, pendulous in some species, horizontal or erect in others; in shape conical, sub-globose or cylindric, often more or less oblique so that the scales become unequal. Scales at first closely imbricated, the exposed part more or less thickened (apophysis) and terminating in a blunt point or rhomboidal swelling armed with a weak or strong prickle. Seeds obovate or more or less triangular and compressed, winged, the wing sometimes reduced to a narrow rim.

In most species the cones open their scales soon after maturity, drop their seeds and then fall off: in others the open cones remain on the trees for years after shedding their seeds, as in *Pinus Sabiniana*; whilst in others belonging to the Pinaster and Tædæ sections, the cones remain closed on the trees for an indefinite period until opened by the heat of a forest fire or an exceptionally hot season.

The grouping of the species of Pinus into sections is not free from difficulty. The older botanists used the number of leaves in a bundle as marks of sectional divisions, and neglecting all other characters divided the Pines into three sections, the two-leaved, three-leaved and five-leaved, thus leaving the position of the subsequently discovered species *P. monophylla* (one-leaved), *P. Parryana* (four-leaved), *P. cembroides*, *P. Elliottii* and others (two—three leaved) ambiguous. Cognisance has since been taken of other characters in connection with those of the leaves, and among the most useful of these for classificatory purposes are the form of the cone scales, the seeds and the anatomical structure of the leaves, especially the position and number of the resin canals. Combining these and some subordinate characters, the late Dr. Engelmann of St. Louis, U.S.A., elaborated the most scientific sectional arrangement of the Pines that has yet been published,* and which in a more or less modified form is adopted by recent authors. In a practical sense Dr. Engelmann's sections have the disadvantage of occasionally grouping together trees of very different habit and aspect on account of the greater value set upon the anatomical characters of the leaves, and which can be ascertained only with the aid of the microscope.

The following sectional arrangement of species cultivated in Great Britain is framed in respect of the leaves and cones only which are for the most part easily accessible, and it may thence serve for practical use.†

STROBI. Leaves in bundles of five. Cones pendulous, much longer than broad; scales relatively thin and terminating in a blunt point. Seeds prominently winged:

Ayacahuite, excelsa, Lambertiana, monticola, pentaphylla, Peuke, Strobus.

CEMBRÆ. Leaves in bundles of five. Cones erect or horizontal, not much longer than broad; scales with or without a thickened apophysis. Seeds large and obscurely winged:

Albicaulis, Balfouriana, Cembra, flexilis, koraiensis, parviflora.

EDULES. Leaves in bundles of one—five. Cones sub-terminal, globose, the central scales only fertile, thickened, with a prominent and armed apophysis. Seeds large with rudimentary wings:

Cembroides, edulis, monophylla, Parryana.

TÆDÆ. Leaves in bundles of three. Cones sub-terminal or lateral, ovoid, occasionally elongated; scales much thickened, the apophysis often with a stout armed umbo. Seeds prominently winged:

Bungeana, Coulteri, Gerardiana, palustris, patula, ponderosa, radiata, rigida, Sabiniana, Tæda, tuberculata.

PINASTER. Leaves in bundles of two. Cones lateral and mostly persistent, often large and clustered; scales much thickened, the apophysis blunt or armed with a sharp spine. Seed wings variable:

Contorta, mitis, muricata, Pinaster, pungens, pinea, pyrenaica.

SYLVESTRES. Leaves in bundles of two. Cones sub-terminal and mostly falling off, ovoid-conic and relatively small; scales slightly

* Revision of the Genus Pinus in the Transactions of the Academy of Science of St. Louis, Vol. IV. (1880).

† Several of the Mexican Pines with leaves in bundles of five, of which the best known in this country is *Pinus Montezumæ*, cannot be included in either of the sections STROBI or CEMBRÆ in consequence of the scales of their cones having a distinct apophysis with a central umbo; they thence come under the section *Pseudo-Strobus* of Endlicher.

thickened with apophysis unarmed or with deciduous prickles. Seeds small with elongated wings:

Banksiana, densiflora, halepensis, inops, Laricio, montana, resinosa, sylvestris, Thunbergii.

Upwards of seventy species of Pinus are distinguished by botanists; they are spread over the northern hemisphere from the limits of arborescent vegetation in the arctic and sub-arctic regions to beyond the northern Tropic. Of these seventy species, twenty-four are endemic in the eastern, and the remainder in the western continent. On the eastern continent, with the exception of *Pinus sylvestris* which is spread over the great plains of Europe and northern Asia, the Pines mostly follow the great mountain ranges, in places forming forests of considerable extent, covering rocky slopes unsuitable for tillage and occasionally ascending to the timber line. Two outlying species occur within the eastern tropics: *P. Merkusii* in Sumatra and the Malay peninsula, and *P. insularis* in the Philippine Islands; and a third *(P. canariensis)* is confined to the Canary Islands. In North America the Pines also follow the great mountain chains, in places forming forests of immense extent; but they likewise spread into the plains except in the prairie region of the central Mississippi and the elevated plains east of the Rocky Mountains. The high plateau and mountains of central Mexico are covered with Pine forests where twelve or fourteen species have their home and one more inhabits the West India Islands.

The existing Pines are the descendants of former races, traces of whose ancestral forms first appear in the Jurassic system; the oldest discovered Pines belong to the Strobus section in which the scales have no apical thickening. In Tertiary times Pines became very abundant, and in the Miocene Age species with two, three and five leaves in a bundle were common in Europe, including Great Britain.*

The economic value of the Pines is very great. Many species, especially *Pinus sylvestris, P. Strobus, P. ponderosa, P. monticola*, afford timber of the highest importance in constructive work, and Pine timber is the staple article of commerce with many ports of northern Europe and British North America. The resinous secretions of several species, notably *P. palustris, P. Pinaster* and *P. longifolia*, are very abundant, from which turpentine, resin and tar are obtained in immense quantities. In arboriculture, as landscape planting, some of the most ornamental and picturesque of trees are to be found among the Pines, whilst other species are greatly valued for afforesting waste lands, for forming screens for shelter, etc.

The name Pinus is adopted from classical authors, by whom it was applied indiscriminately to the species inhabiting the Mediterranean region. In modern times, as shown in our Botanical Retrospect, it has been understood by different authors in widely different senses, before the present very natural circumscription of the genus became generally adopted.

* Fossil Botany, by Solms-Laubach, Garnsey's Translation, p. 57.

Pinus albicaulis.

A tree of variable height, usually 20—30, rarely 60 feet high, with a trunk 2—4 feet in diameter; at high altitudes reduced to a low shrub with spreading stems. Bark thin, broken by narrow fissures into light brown or creamy white scales. Branchlets stoutish, reddish brown. Buds broadly ovate, acute, with chestnut-brown perulæ loosely imbricated. Leaves quinate (in fives), persistent five—eight years, stout, rigid, slightly incurved, 1·5—3 inches long, dark green. Staminate flowers in short spikes, oval, with scarlet anthers and surrounded at the base by eight—nine involucral bracts. Cones sessile, ovoid or sub-globose, 1·5—3 inches, with much thickened, gradually pointed scales, the exposed portion contracted on both sides to a sharp edge, and bearing a stout, nearly triangular, incurved tip. Seeds nearly 0·5 inch long, with very narrow, thin wings.—Sargent, *Silva of North America*, XI. 39, t. 548.

Pinus albicaulis, Engelmann in Trans. Acad. Sc. St. Louis. II. 209 (1863). Lawson, Pinet. Brit. I. 1. with figs. Hooker fil in Gard. Chron. XXIV. (1885), p. 9. with fig. Beissner, Nadelholzk. 274. Macoun, Cat. Canad. Plants, 465. Masters in Journ. R. Hort. Soc. XIV. 225.

P. flexilis var. albicaulis, Engelmann in Brewer and Watson's Bot. Califor. II. 124.

An alpine tree spread over the high mountains of north-west America at altitudes ranging from 5,000 to 12,000 feet, growing on the most exposed ridges where it forms the timber line on many of them. It is abundant on the mountains of southern British Columbia, whence it spreads southwards into the United States along the Rocky Mountains to Wyoming, and along the Cascade mountains of Washington and Oregon into California, reaching its southern limit on the San Bernardino mountains.

Pinus albicaulis affords a remarkable instance of endurance and tenacity of life under exceptionally severe conditions, and in places where probably no other vegetation could exist. On bleak and lofty ridges, and in wind-swept passes battling with perpetual snows, its trunk is stunted, and its branches gnarled; it is also exposed in places to fierce winds thickly charged with sand, which denude the trunk of its bark and erode and furrow its hard wood. Under these adverse influences the trees sometimes become flat-topped, and so close-roofed with condensed branchlets and foliage that one may walk safely on them. The short, thick stems of some of these trees are probably over five hundred years old.*

The species was discovered in 1851 on the mountains of North Oregon by Jeffrey the collector of the Scottish Oregon Association and introduced by him; but the unsuitableness of the British climate for it has long since been proved, and very few plants of it are to be seen in this country. Its place is better filled by its nearest affinity *Pinus flexilis* from which it differs chiefly in its paler bark and smaller globose cones, the scales of which are much more thickened and terminate in a short incurved tip.

* Lemmon. North-west American Cone Bearers, 25.

Pinus Ayacahuite.

A lofty tree, attaining a height of 100 feet on the mountains of Oaxaca with a trunk 3—4 feet in diameter, and much resembling *Pinus Strobus* in habit and aspect. In Great Britain the young trees are not unlike *P. excelsa*, the primary branches spreading and more or less upturned at the extremity. Branchlets with pale orange-brown bark, the herbaceous shoots devoid of leaves at the base and covered with a ferruginous pubescence which soon disappears. Buds conic, acute, chestnut-brown with narrowly lanceolate, acuminate perulæ which are afterwards reflexed and fall off. Leaves quinate, persistent about three years, filiform with scaberulous margins, 3·5—6 inches long, bright green on the convex side, with three—five silver-grey stomatiferous lines on the flat sides; basal sheath about an inch long, deciduous. Staminate flowers not seen. Cones solitary or in clusters of twos and threes, sub-cylindric, gradually tapering to an obtuse point, 9—12 inches long. Scales elliptic-oblong, 2 inches long and 1 inch broad with a reflexed thickened tip, the exposed apical part strongly striated longitudinally. Seeds ovoid, compressed, about 0·5 inch long, furnished with a pale testaceous obliquely truncate wing about an inch long.*

Pinus Ayacahuite. Ehrenberg ex Schlechtendal in Linnaea, XII. 492 (1838). Endlicher, Synops. Conif. 149 (1847). Carrière, Traité Conif. ed. II. 402. Parlatore, D. C. Prodr. XVI. 406. Gordon, Pinet. ed. II. 292. Masters in Gard. Chron. XVIII. (1882), p. 492, with fig.; and Journ. R. Hort. Soc. XIV. 225. Lawson, Pinet. Brit. I. 9, t. 2.

P. Loudoniana, Gordon, Pinet. ed. II. 311.

P. Don Pedri, and others, Roezl.

Mexican vernacular, Ayacahuite.

Pinus Ayacahuite is the common White Pine of Mexico: it is spread over the country from Oaxaca northwards to, and probably beyond the United States frontier line, and southwards into Guatemala, always at a considerable elevation. On the high mountain slopes of northern Mexico it forms in places extensive forests, and supplies the most useful timber of the region. It was first detected by Ehrenberg, in 1836, in southern Mexico, and three years later by Hartweg on the mountains of Santa Maria near the town of Quezaltemango in Guatemala, where he obtained a supply of ripe cones which he forwarded to the Horticultural Society of London. Plants raised from the seeds of these cones were subsequently distributed among the Fellows of the Society.†

Pinus Ayacahuite has been a denizen of this country for more than half a century, and although the plants originally distributed by the Horticultural Society of London have been decimated by the recurrence of exceptionally severe winters, cone-bearing trees presumably of Hartwegian origin are still standing in the Pinetum at Bicton; at St. Austell in Cornwall; at Westonbirt in Gloucestershire; in the nursery of Messrs. Paul and Son at Cheshunt, and probably in other

* Materials for description communicated by Captain Holford from Westonbirt, Gloucestershire.

† Transactions of Horticultural Society of London, vol. III. ser. II. p. 136.

Pinus Ayacahuite at Westonbirt, Gloucestershire.

places. Younger trees in vigorous health are also growing in the grounds of Col. Bowdler at Camberley in Surrey; at Batsford, near Stratford-on-Avon; at Castlewellan, Co. Down, Ireland; and in the Royal Botanic Gardens at Glasnevin. All these afford evidence of its adaptability for the British climate under certain conditions, and as it is one of the most graceful of Pines for the decoration of the lawn, it may be planted for that purpose where the situation is well sheltered.

Closely allied to *Pinus Ayacahuite* and apparently only a geographical modification of it is the White Pine of southern Arizona, figured and described in Professor Sargent's "Silva of North America," XI. 33, tt. 544, 545, from which the following particulars are taken.

Pinus strobiformis.

Engelmann in Bot. Append. 102 to Wislizenus, "Tour in Northern Mexico." Carrière in Van Houtte's Flore des Serres, IX. 201. P. reflexa, Engelmann in Bot. Gaz. VII. t.

Pinus strobiformis is sparingly scattered over the rocky ridges of the Santa Rita, Chiricahua and other mountains of southern Arizona at elevations of from 6,000 to 8,000 feet. It was discovered by Dr. Wislizenus, in Chihuahua in northern Mexico, in 1846. It differs from *P. Ayacahuite* chiefly in its smaller dimensions, due to the drier climate of the region it inhabits; also in its short, slender, often pendulous branchlets and in its smaller cones.

Pinus Balfouriana.

"A tree usually 30—40 feet in height with a short trunk 1—2 feet in diameter, but occasionally much higher with a tall, straight, tapering stem 5 feet in diameter; at high elevations reduced to a low shrub with gnarled semi-prostrate stems." Bark of young trees thin, white, smooth; of old trees thicker, red-brown and much fissured. Branches short, stout, and spreading horizontally or upturned at the apical end; in old age irregular in length and direction, and often contorted. Branchlets in whorls of three—five, stoutish, covered with reddish brown, obliquely furrowed bark that is almost concealed by the close-set foliage. Buds ovoid-conic, acute, 0·5—0·75 inch long, with narrowly lanceolate, acuminate pale chestnut-brown perulæ often coated with pale limpid resin. Leaves quinate, persistent several years, crowded, incurved, and pressed against the branchlets, triquetral, with entire margins, 1—1·5 inch long, dark green on the outer convex side, marked with silver-grey stomatiferous lines on the two inner faces; basal sheath about one-eighth of an inch long, and soon falling off. Staminate flowers ellipsoid, about 0·5 inch long, in short crowded spikes, with orange-brown anthers and surrounded at the base by five ovate, acute, involucral bracts. Cones sub-erect or horizontal,

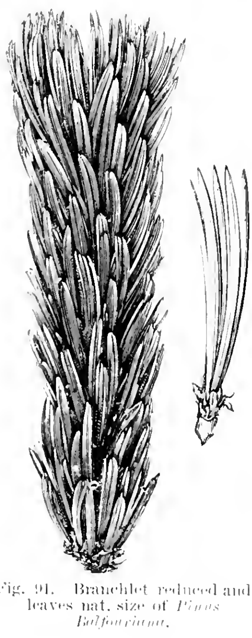


Fig. 91. Branchlet reduced and leaves nat. size of *Pinus Balfouriana*.

sub-cylindric, slightly tapering, 3·5—5 inches long, composed of narrow elongated scales with a rhomboidal apophysis transversely keeled and terminating in an awn-like prickle.

Pinus Balfouriana, Murray, Oregon Exped. I. t. 3, fig. 1 (1853); and in Gard. Chron. V. (1876), p. 332, with fig. Carrière, Traité Conif. ed. II. 425. Gordon, Pinet. ed. II. 293. Engelmann in Brewer and Watson's Bot. Califor. II. 125. Lawson, Pinet. Brit. I. 11, with figs. Beissner, Nadelholzk. 272. Masters in Journ. R. Hort. Soc. XIV. 225. Sargent, Silva N. Amer. XI. 59, t. 553.

P. aristata, Engelmann in Trans. St. Louis Acad. II. 205 t. 506 (1863). Carrière, Traité Conif. ed. II. 424. Parlatore, D. C. Prodr. XVI. 400. Lawson, Pinet. Brit. I. 5, with figs. Gordon, Pinet. ed. II. 291. Sargent, Silva N. Amer. XI. 63, t. 554.

P. Balfouriana var. aristata, Engelmann in Brewer and Watson's Bot. Califor. II. 125. Beissner, Nadelholzk. 273. Masters in Journ. R. Hort. Soc. XIV. 225.

Eng. Professor Balfour's Pine, Awned Pine. Amer. Foxtail Pine. Germ. Fuchsschwanzkiefer.

The habitat of this singular Pine may be stated in general terms to be included within the region lying between the Sierra Nevada of California and the outer or eastern range of the Rocky Mountains of Colorado, and between the 35th and 40th parallels of north latitude. It is essentially an alpine species, and always occurs on rocky slopes and ridges at elevations varying from 5,000 to 12,000 feet, but nowhere very abundant except on Mount Whitney in south California, where it forms extensive groves associated below with *Pinus contorta*, and above with *P. monticola*.

Pinus Balfouriana was originally discovered in 1852 on Scott Mountain, in California, by Jeffrey, who forwarded a few seeds to the Scottish Oregon Association. This, the typical form, was named in compliment to the late John Hutton Balfour, Professor of Botany in the University of Edinburgh. In 1861 it was discovered on Pike's Peak in Colorado by Dr. Parry, and to his discovery Engelmann gave the name *Pinus aristata*, in reference to the bristle-like awns on the scales of the cone. Seeds were subsequently introduced from this locality into Great Britain. In this country both the Californian and Colorado forms are quite rare, and very few have attained a considerable size. Although the growth of *P. Balfouriana* is very slow, the leader shoot rarely increasing more than six inches in one season, it is so distinct from every other Pine in its snake-like branches clothed with appressed persistent foliage, the terminal shoots of which have a fancied resemblance to a fox's brush, as scarcely to merit the neglect it has hitherto received.

Professor Sargent has described and figured in the "Silva of North America" the Californian and Colorado forms as distinct species. That they are geographically separated by the arid treeless tracts of western Nevada is indisputable, but no structural differences of sufficient value to be accepted as specific are discernible in the flowers and fruits. Engelmann, the author of the species *aristata*, abandoned it in his "Revision of the Genus Pinus" on the ground that the leaf structure and staminate flowers are identical with those of *P. Balfouriana*; but in Brewer and Watson's "Botany of California" gave it varietal rank, distinguishing it from the type by "its ovate cones with thinner scales and longer awn-like prickles." The specimens of *P. Balfouriana* and *P. aristata* growing in Great Britain are practically identical if true to their respective names.

Pinus Banksiana.

A tree of variable size and habit according to the locality in which it is growing, from a straggling shrub 3—5 feet to a tall tree 60—70 feet high with a trunk 2 feet in diameter covered with dark grey bark. In Great Britain a slender tree 26—30 feet high, the trunk covered with light greyish brown bark fissured into irregular thin plates. Branches horizontal, ascending, or curved downwards; branchlets short, slender, and often curved; buds cylindric, obtuse, 0·25 inch long, light brown usually covered with a film of whitish resin. Leaves geminate (in twos), regularly distributed over the shoot, persistent four—five years, semi-terete with a mucronate tip, obscurely concave on the inner side, more or less twisted, about an inch long, with a short lacerated basal sheath, dull dark green. Staminate flowers in dense clusters, sub-cylindric, about 0·5 inch long, yellowish brown. Cones ovoid-conic, sessile, erect, incurved, 1·5—2 inches long; scales oblong-cuneate, the apical thickening rhomboidal with a transverse ridge and small, obtuse, central umbo.

Pinus Banksiana, Lambert, Genus Pinus, I. t. 3 (1803). London, Arb. et. Frut. Brit. IV. 2190, with figs. Forbes, Pinet Woburn. 13, t. 3. Hooker, W. Fl. Bot. Amer. II. 161. Carrière, Traité Conif. ed. II. 485. Hoopes, Evergreens, 78. Gordon, Pinet. ed. II. 230. Beissner, Nadelholzk. 218. Macoun, Cat. Canad. Plants, 468. Masters in Journ. R. Hort. Soc. XIV. 221. And many others.

P. rupestris, Michaux, Hist. Arb. Amer. I. 49, t. 2 (1810).

P. hudsonica, Parlatore, D. C. Prodr. XVI. 380 (1868).

P. divaricata, Sargent, Silva N. Amer. XI. 147, t. 588 (1897).

Eng. Sir Joseph Banks' Pine. Amer Scrub Pine, Grey Pine, Jack Pine. Germ. Strauchkiefer.

Pinus Banksiana is distributed over an immense area in North America. From its southern limit on the coast of Maine, at about 44° N. lat., it spreads northwards into Labrador and the Barren Lands of Canada, and across the continent in a north-westerly direction as far as the eastern slopes of the Rocky Mountains and northwards through the Mackenzie valley to the Arctic Circle. It is abundant in the barren plains of Michigan, growing in places where no other tree can live; it often replaces along the northern States and adjacent parts of the Dominion the more valuable Pines that have been cleared by lumber-men or by forest fires. The kind of estimation in which it is held in America finds expression in the vernacular names given to it, as "Scrub Pine," "Jack Pine," etc. The wood is used for little else than fuel.

Pinus Banksiana is worthless for the British Arboretum as it soon becomes unshapely under the stimulus of the milder climate of this country, and it is but rarely seen in other than botanic gardens. The date of its introduction has not been recorded; but Aiton states that it was in cultivation prior to 1783.* The species was dedicated by Mr. Lambert to Sir Joseph Banks, than whom no one more worthy to be held in remembrance can be found in the annals of British science.

* Hortus Kewensis, ed. II. Vol. V. p. 315.

JOSEPH BANKS (1743—1820) was born in London and was educated first at Harrow and afterwards at Eton, whence he proceeded to Christ Church College, Oxford. His love of Botany commenced before he entered the University, where it became so great that finding no lectures were given on that subject, he applied to Dr. Sibthorp, the botanical professor, for permission to procure a proper person to instruct him. He left Oxford in 1763. His father having died in 1761 he came into possession of his paternal fortune in 1764, and from that time till his death, his whole time and means were well-nigh devoted to the advancement of science. In 1766 he made a voyage to Newfoundland for the purpose of collecting plants, returning in the following summer; and in 1768 he accompanied, in the capacity of assistant naturalist, Dr. Solander being the principal, the first expedition under the command of Captain Cook, the chief objects of which were to observe a transit of Venus and to discover new countries. After leaving Tahiti, where the transit had been successfully observed, the vessel, a bark of 370 tons called the *Endeavour*, traversed the seas surrounding New Zealand and Australia, returning to England in 1771; Banks and Solander were thence the first botanists who became acquainted with the remarkable Australian flora. In 1772, accompanied by Dr. Solander, he made a scientific expedition to Iceland; passing among the Hebrides on their return they were induced to examine them, and during their investigation they came upon the basaltic pillar and natural caverns of Staffa till then unknown to naturalists. In 1777 he was elected President of the Royal Society, to which by much exertion he procured a great accession of men of rank and talent. In 1781 he was created a baronet, which was soon after followed by other honours. All the voyages of discovery made under the auspices of the Government during the last thirty years of his life were either suggested by him or received his approbation. He was a zealous promoter of the Horticultural Society of London founded in 1804 and took a leading part in the management of the Royal Gardens at Kew. During his forty-two years' tenure of the Presidency of the Royal Society, he was indefatigable as an officer and trustee of the British Museum, to which institution, in addition to innumerable other gifts, he bequeathed his scientific library and foreign correspondence.

Pinus Bungeana.

A tall tree 80—100 feet high, the trunk frequently divided at a short distance from the ground into several ascending stems that are covered with whitish bark. In Great Britain a low or medium-sized tree of pyramidal outline and with diffuse ascending branches, the trunk with smooth brown bark that falls away in thin flakes of irregular shape and size as in the common Birch and oriental Plane, exposing a whitish inner cortex. Branchlets usually in pseudo-whorls of three with smooth greenish brown bark. Buds conic, acute, 0·5 inch long, with ovate-lanceolate, acuminate, chestnut-brown perulæ. Leaves ternate (in threes), persistent three—four years, spirally and distantly inserted along the upper two-thirds of the shoot, which is without pulvini; rigid, spreading, triquetral, 3—4 inches long, dark lustrous green; basal sheath about 0·5 inch long, deciduous. Staminate flowers in a lax spike 3—5 inches long, sub-cylindric, obtuse, about 0·25 inch long, surrounded at the base by linear, acuminate bracts longer than the staminal axis. Cones ovoid-conic, 2·5 inches long, 1·5 inch in diameter; scales broadly obovate, the thickened apex with a transverse keel on the exposed side and with a short reflexed umbo in the centre. Seeds with a short broad wing.

Pinus Bungeana, Zuccarini ex Endlicher, Synops. Conif. 166 (1847). Murray, Pines and Firs of Japan, 18, with figs. (1863). Carrière, Traité Conif. ed. II. 434. Parlatore, D. C. Prodr. XVI. 398. Gordon, Pinet. ed. II. 263. Lawson, Pinet. Brit. I. 13, with figs. Beissner, Nadelholzk. 252. Masters in Gard. Chron. XVIII. (1882), p. 8, with fig.; and Journ. R. Hort. Soc. XIV. 226.

Nothing is definitely known of the geographical distribution of this Pine beyond the simple fact that it is a native of North China between Peking and the Western Hills, "one of the coldest and most desolate-looking districts in winter which an inhabited and cultivated country can well be," where it was detected by Fortune, by whom it was introduced into Great Britain about the year 1846 or a little later, and into France in quantity in 1860 by M. Simon. It is still comparatively rare in British gardens owing to the difficulty of procuring seeds. It has proved quite hardy, and its neat habit and bright green foliage impart to it a very ornamental and distinct appearance.

Mr. Fortune gives the following description of *Pinus Bungeana* in his "Yedo and Peking":—"Near the royal tombstones (at Peking) I observed a species of Pine tree having a peculiar habit and most striking appearance. It had a thick trunk which rose from the ground to the height of three or four feet only; at this point some eight or ten branches sprung out, not branching or bending in the usual way, but rising perpendicularly as straight as a Larch to a height of 80 or 100 feet. The bark of the main stems and secondary stems was of a milky white colour, peeling off like that of the Arbutus, and the leaves, which were chiefly on the top of the tree, were of a lighter green than those of the common Pine. Altogether this tree had a very curious appearance, very symmetrical in form, and the different specimens which evidently occupied the most honourable places in the cemetery, were as like one another as they possibly could be. In all my wanderings in India, China and Japan, I had never seen a Pine tree like this one. What could it be? Was it new? And had I at last found something to reward me for my journey to the far north? I went up to the spot where two of these trees were standing like sentinels, one on each side of a grave. They were both covered with cones, and therefore were in a fit state for a critical examination of the species. But although almost unknown in Europe, the species is not new. It proved to be one already known under the name of *Pinus Bungeana*."

Pinus Bungeana is named after Alexander von Bunge, a Russian botanist who accompanied Ledebour in his travels through Siberia, and who was afterwards (1830) sent by the Russian Government as naturalist with a mission to Peking, where he first met with this Pine and many other plants not previously known to Europeans. He subsequently (1836) succeeded Ledebour as Professor of Botany and Director of the Botanic Garden at Dorpat.

Pinus Cembra.

A large tree of variable height and habit according to altitude and exposure, at its greatest development on the Swiss Alps attaining an average height of 60—70 feet, individual trees occasionally 20 feet higher. Primary branches spreading but turned upwards at the tip; in some localities, as on the Riffelberg, the lowermost branches sometimes attaining great dimensions, at first horizontal with a downward curvature and then rising parallel in direction with and not much smaller than the main trunk. In Great Britain rarely exceeding 50 feet high, with a broadly columnar or elongated conical outline till the top becomes enlarged and rounded by age. Bark of trunk greyish brown, usually fissured into numerous thin plates. Branches short, horizontal or tortuous, the lowermost sometimes ascending. Branchlets short with pale reddish brown bark, the herbaceous shoots pubescent. Buds conic, acute, 0·25—0·4 inch long, pale reddish brown; perulæ linear-lanceolate, acuminate, fringed with whitish hairs. Leaves quinate (in fives), persistent four—five years, triquetral with a rather prominent keel on the inner, convex on the outer side, minutely serrulate at the edge, 3·5—4·5 inches long, dark green with white stomatiferous lines; basal sheath short and deciduous. Staminate flowers in dense heads, cylindric, obtuse, about 0·75 inch long, brownish red, surrounded at the base by six—eight involucral bracts; connective of anther reniform and sharply crenulate. Cones erect, ovoid. obtuse, 2·5—3 inches long and 2 inches in diameter, purplish violet during growth, brown when mature: scales sub-orbicular, the exposed part slightly convex and terminating in an obtuse umbo. Seeds obovoid, compressed, about 0·5 inch long with a hard testa and rudimentary wing.

Pinus Cembra. Linnæus. Sp. Plant. II. 1000 (1753). Miller. Dict. ed. VIII. No. 6 (1768). Pallas. Fl. Ross. I. 3. t. 2 (1784). Lambert. Genus Pinus, I. tt. 23. 24 (1803). Loudon. Arb. et Frut. Brit. IV. 2274. with figs. Forbes, Pinet. Woburn. 69. t. 27. Link in Linnæa. XV. 513. Endlicher. Synops Conif. 141. Carrière. Traité Conif. ed. II. 386. Parlatore. D. C. Prodr. XVI. 402. Lawson, Pinet. Brit. I. 17, t. 3. with figs. Willkomm, Forstl Fl. ed. II. 169. Beissner, Nadelholzk. 276, with figs. Masters in Journ. R. Hort. Soc. XIV. 226. And many others.

Eng. Cembra Pine, Swiss Stone Pine. Fr. Cembrot, Tinier. Swiss. Alvier, Arolle. Arolla. Germ. Zürbelkiefer, Arve. Zirme. Ital. Pino Zimbro.

var.—pumila.

A dwarf stunted bush 2—6 feet high with greatly elongated branches, and thence assuming a creeping habit. Leaves crowded, 1—2 inches long, silvery grey, pale green on the convex side. Cones much smaller than in the type, about 1·5 inch long.

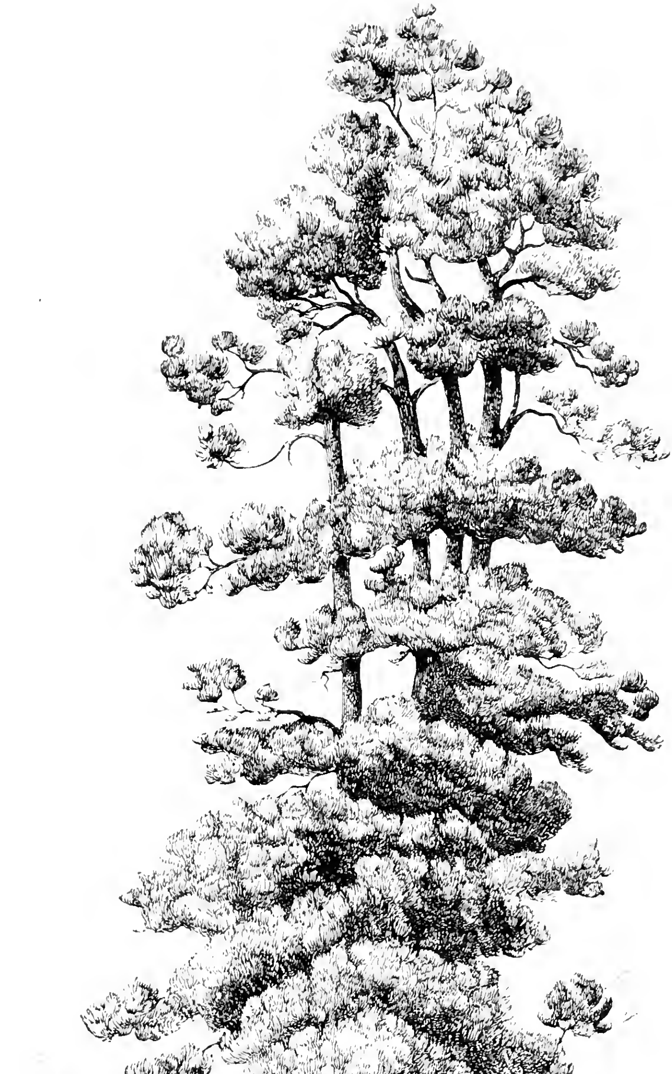
P. Cembra pumila, Pallas. Fl. Ross. I. 5. t. 2. Parlatore. D. C. Prodr. XVI. 403. And others. P. Cembra pygmæa. Loudon. Arb. et Frut. Brit. IV. 2276. P. pumila. Mayr. Abiet. des Japanischen Reiches. 80. P. Mandschurica. Lawson, Pinet. Brit. I. 61.

var.—sibirica.

Distinguished in German gardens from the Swiss type by its more vigorous growth, its more slender habit, shorter leaves, longer cylindric cones, and larger seeds.

P. Cembra sibirica. Loudon. Arb. et Frut. Brit. IV. 2275. Beissner. Nadelholzk. 279. P. Cembra Mandschurica, Carrière. Traité Conif. ed. II. 390 (not Regel).

The geographical distribution of *Pinus Cembra* is very extensive; in northern Asia it is said to spread from the Ural mountains to Kamtschatka, having its northern limit near the Arctic Circle and its southern the Altai mountains; throughout this vast region it is a tree both of the plains and mountains, in places ascending to 2,500—3,000 feet. In Europe it grows spontaneously only on the Carpathian mountains and the Alps; on the former, where its



Pinus Cembra in the valley of Turtmann.

(From the *Gardeners' Chronicle.*)

distribution is much restricted, its vertical range is from 3,500 to 5,000 feet, and on the latter from 4,000 to 6,000 feet above sea-level; its western limit is on the Vosges of Dauphiné in France, where it is quite rare.

In the valleys of the higher Alps *Pinus Cembra* was formerly very abundant, but it is yearly decreasing and becoming more and more rare; it is now seldom seen in forests; it is even rare to see well-shaped individual trees. Being the only tree capable of living at so high an elevation, the herdsmen have no other firewood, and in order to extend the pasturage for their milk industry they have destroyed whole forests, and young trees when they spring up are eaten by sheep and goats. In several of the cantons, the Cembra forests have already disappeared, whilst in others the government has been obliged to take steps to prevent their total destruction. In the Val Arola, on the Riffelberg, and in other parts of the canton of Valais, fine old trees are still numerous, but felling is going on recklessly, and in many areas the number of stumps of felled trees exceeds the number of plants coming up to replace them. Moreover, whilst a few seedlings struggle through the protecting undergrowth, yet they seem to be destroyed by some cause before attaining any great height. The storm-tossed Cembras riven by lightning, decapitated by falling boulders, maimed and mutilated by winter storms and snows, riddled by pine beetles, and subject to numberless other evils, valiantly struggle to repair the injuries they receive. On the whole, a melancholy feeling attaches to these interesting trees, whose decadence and ultimate extinction seem by no means remote.*

In Siberia the Cembra Pine differs but little from the Swiss type; in the damp swampy grounds of eastern Russia it attains a height of 100 feet, with a smooth trunk free of branches for two-thirds of the height, above which it forms a spreading crown. Beyond the Ural mountains it conforms to the general law of diminishing dimensions as it approaches its northern limit, where it finally dwindles to the low straggling bush described as the variety *pumila*. This form also inhabits the highest summits of the Japanese mountains, in places covering hundreds of acres, and spreads northwards through Yeso, Saghalien, the Kurile Islands and Kamtschatka. The better class of inhabitants in western and southern Siberia plant the Cembra Pine as an ornamental tree in front of their houses and in their gardens; it is not known to succumb to the severe cold of that region which in ordinary winters often sinks to −40° C.

The economic value of *Pinus Cembra* is very considerable throughout the regions in which it abounds; the wood is white, soft, and fine in grain; it has also an agreeable fragrance, which is at the same time obnoxious to insects; it is used chiefly for indoor carpentry, for wainscotting and upholstery, especially for lining clothes' chests, etc. The large seeds are much eaten in Russia and Siberia where other fruit is scarce, and an oil is expressed from them which is used for lamps. In the Tyrol, the seeds are collected by the peasantry and offered for sale in the fruit markets as Cembra nuts (Zirbelnüsse).

Pinus Cembra was cultivated by Archibald, Duke of Argyll, in 1746, and is thence supposed to have been introduced by him, and many

* Gardeners' Chronicle, XXIV. ser. 3 (1898), p. 236.

old and picturesque trees are to be seen in the parks of family seats throughout the country. The chief if not the sole use of the Cembra Pine in Great Britain is for ornamental planting, for which it is a distinct and beautiful tree whether standing singly or in groups. Its growth is slow, rarely exceeding a foot in one season under the most favourable circumstances; it requires but little room, and is always well furnished with foliage which emits a pleasant fragrance during the growing season.

Pinus cembroides.

A bushy tree with a short stem rarely more than a foot in diameter and a broad round-topped head, usually 15—20 feet high, but in the sheltered cañons on the mountains of Arizona occasionally 50—60 feet high. Branchlets slender, orange-brown, and covered with deciduous hairs, gradually growing darker till the end of four or five years, when they are almost black and roughened with the scars of the fallen leaves. Leaves geminate or ternate, persistent three—four years, incurved with callous tips, 1—2 inches long, dark green; basal sheath scarious, about 0·25 inch long. Staminate flowers about 0·25 inch long in short compact clusters, with yellow crested anthers and surrounded by an involucre of four bracts. Cones sub-globose, sessile or very shortly stalked, 2—2·5 inches in diameter; fertile scales rounded at the apex, much thickened and quadrangular on the back with a prominent horizontal keel. Seeds 0·5—0·75 inch long with a narrow light brown wing.—Sargent, *Silva of North America*, XI. 47, t. 550.

Pinus cembroides, Zuccarini, Abhand. Acad. Munich, I. 392 (1832). Endlicher' Synops. Conif. 182. Gordon in Journ. Hort. Soc. Lond. I. 236, with fig. Carrière, Traité Conif. ed. II. 460. Parlatore, D. C. Prodr. XVI. 397. Masters in Journ. R. Hort. Soc. XIV. 227.

P. Llaveana, Schlechtendal in Linnæa, XII. 488 (1838).

P. osteosperma, Engelmann, Bot. App. 89, to Wislizenus' Memoir.

Pinus cembroides is widely distributed over the drier mountain systems of south-western North America between the 18th and 35th parallels of north latitude, covering the higher slopes often unmixed up to 6,500 feet elevation, and towards its southern limit in Mexico up to 10,000 feet. From Arizona and Lower California it spreads southwards over the mountains of northern Mexico as far as Orizaba.

It is the longest known in this country of a group of Pines including four species characterised by their low stature, short leaves, and small globose cones of which the central scales only are fertile and bear large edible seeds which are largely consumed throughout the dry region which these Pines inhabit, and where they are known under the common name of Piñons or Nut Pines. The four species are *Pinus cembroides*, *P. edulis*, *P. monophylla* and *P. Parryana*; the three first-named were introduced many years ago, but owing doubtless to climatic causes they refuse to grow for any length of time and have now nearly or quite disappeared from British gardens. *P. Parryana* is a later introduction, and although native of a warmer climate than that of Great Britain, grows in Devon and Cornwall much better than the other three, and on account of its distinctness is deserving of further trial. The descriptions of *P. edulis*, *P. monophylla* and *P. Parryana* which may properly follow here are all abridged from Professor Sargent's monumental work "The Silva of North America," as no specimens are known to exist in this country of sufficient age to afford satisfactory materials for the purpose.

Pinus edulis.

A low tree, not more than 12—15 feet high with a short divided trunk and round-topped broad head, rarely 30—40 feet high. Branchlets stoutish, orange-brown; buds ovate, acute, less than half-an-inch long with light chestnut-brown scales. Leaves geminate, rarely ternate, persistent three—four years, semi-terete or triquetral, rigid, incurved, entire with a callous tip 0·75—1·5 inch long. Staminate flowers about 0·25 inch long, in short, dense spikes, with dark red anthers and surrounded by four involucral bracts. Cones 1—1·5 inch in diameter, the larger fertile scales broadly cuneate, rounded and much thickened at the apex, with a transverse keel on the back, and a small, four-angled, central knob, terminating in a concave umbo with a minute incurved tip. Seeds about 0·5 inch long with a pale reddish brown narrow wing.

Pinus edulis. Engelmann (1848), ex Sargent. Silva N. Amer. XI. 55, t. 552. Parlatore. D. C. Prodr. XVI. 398. Hooker fil in Gard. Chron. XXVI (1886), p. 300, with fig. Beissner. Nadelholzk. 252. Masters in Journ. R. Hort. Soc. XIV. 228.

Pinus edulis is distributed over the Rocky Mountain States from southern Wyoming to New Mexico and western Texas, spreading westwards to the eastern borders of Utah and over the mountains of northern and central Arizona at 6,000—7,000 feet elevation. The wood is of little value except for fuel.

Pinus monophylla.

A low tree, usually 15—20 but occasionally 40—50 feet high with a short trunk rarely more than a foot in diameter and often divided near the ground into several stout, spreading stems. Branchlets stout, at first light orange-brown, changing to dark brown at the end of three or four years. Buds ovate, obtuse, about 0·25 inch long with chestnut-brown scales. Leaves persistent four—five years, solitary and terete, occasionally geminate and semi-terete, rigid, incurved with long callous tips, 1·25—2·25 inches long, pale glaucous green, with a loose basal sheath nearly 0·5 inch long. Staminate flowers oval, about 0·25 inch long, dark red surrounded by six involucral bracts. Cones 1·5—2·5 inches in diameter, the fertile scales broadly oblong, rounded at the apex, much thickened and four-angled, terminating in a truncate or slightly concave umbo with a minute, incurved tip. Seeds full and rounded at the base, acute at the apex, more than 0·5 inch long, and furnished with a narrow wing.

Pinus monophylla, Torrey (1845), ex Sargent, Silva N. Amer. XI. 51, t. 551. Lawson. Pinet. Brit. I. 65, t. 9 and figs. Engelmann in Brewer and Watson's Bot. Califor. II. 124. Masters in Gard. Chron. XX. (1883), p. 18, with fig. Beissner, Nadelholzk. 254

P. Fremontiana. Endlicher, Synops. Conif. 183 (1847).

Widely distributed over the south-western States. From Utah it spreads westwards over the mountains of Nevada to the eastern slopes of the southern Sierra Nevada. In California it is abundant on the desert mountains of the south and south-east, crossing the boundary into Lower California; it is also common on the western slopes of the Virgin Mountains of Arizona. The wood is largely used for fuel and for the manufacture of charcoal.

Pinus Parryana.

A tree 30—40 feet high with a trunk occasionally 18 inches in diameter. The stout, spreading branches form a compact pyramid, and in old age a loose, round-topped, irregular head. Branchlets stout, at first covered with a short, soft pubescence, the bark becoming dark brown with a reddish tinge at the end of the third year. Leaves persistent three—four years, in fascicles of three—five, but usually four, incurved, sharp pointed with callous tips, 1·25—1·75 inch long, pale glaucous green with short, deciduous, basal sheaths. Staminate flowers in elongated spikes, about 0·25 inch long, surrounded at the base by four involucral bracts. Cones 1—1·5 inch in diameter, the exposed portion of the broadly oblong scales much thickened, keeled transversely and narrowed into a central knob terminating in a truncate umbo with a minute recurved tip. Seeds more than 0·3 inch long with a thin, narrow wing.

Pinus Parryana, Engelmann in Amer. Journ. Sc. ser. 2, XXXIV. 332 (1862), not Gordon; and Brewer and Watson's Bot. Califor. II. 124. Parlatore, D. C. Prodr. XVI. 402. Beissner, Nadelholzk. 255. Masters in Journ. R. Hort. Soc. XIV. 236. P. quadrifolia, Sudworth (1897), ex Sargent, Silva N. Amer. XI. 43. t. 549.

Pinus Parryana is abundant on the low mountain slopes of Lower California where, in places, it is almost the only tree: it spreads northwards into south California where, however, it is quite rare. It is named after Dr. C. C. Parry, one of the botanists of the Commission appointed to establish the boundary between the United States and Mexico.

Pinus contorta.

A small tree 5—15, rarely more than 30 feet high, the trunk covered with thin, irregularly fissured bark and much branched, the branches often arrested in their growth and distorted by sea-winds. In Great Britain a low, erect tree of conical outline. Primary branches mostly horizontal, the secondaries short and more or less curved. Branchlets with reddish brown bark, marked with the cicatrices left by the fallen leaves, and with short cortical ridges decurrent from them. Buds ovoid-conic, 0·5—0·75 inch long, with closely imbricated ovate, obtuse perulae, often covered with a film of resin. Leaves geminate, persistent four—five years, close-set around the distal half of each season's growth, 1·5—2 inches long, semi-terete with a short callous tip, dark lustrous green; basal sheath loose and scarious, 0·25 inch long. Staminate flowers in short crowded spikes, sub-cylindric, 0·5 inch long, surrounded by six involucral bracts: anthers yellowish brown. Cones usually in pairs, sometimes solitary or in pseudo-whorls of three, elongate-ovoid, more or less decurved, 2—2·5 inches long; scales with a thick rhomboidal apophysis marked with a transverse ridge, from the centre of which protrudes an awl-shaped prickle about 0·25 inch long.

Pinus contorta, Douglas ex Loudon, Arb. et Frut. Brit. IV. 2292 (1838). Carrière, Traité Conif. ed. II. 474. Parlatore, D. C. Prodr. XVI. 381. Gordon, Pinet. ed. II. 232. Engelmann in Brewer and Watson's Bot. Califor. II. 126. Macoun. Cat. Canad. Plants, 466. Beissner, Nadelholzk. 219. Masters in Gard. Chron. XIX. (1883), p. 45, with fig.; and in Journ. R. Hort. Soc. XIV. 227. Sargent, Silva N. Amer. XI. 89, t. 567.

P. Boursieri, Carrière, Revue Hort. (1854), p. 223. Van Houtte's Flore des Serres, IX. 200, with fig.

P. Bolanderi, Parlatore, D. C. Prodr. XVI. 379 (1868).

Amer. Oregon Scrub Pine. The var. Murrayana: Lodge-pole or Tamarack Pine.

var.—Murrayana.

A much taller tree with a straighter trunk, usually 70—80 but not infrequently 100—150 feet high and 4—6 feet in diameter, with thin, scaly, greyish bark, a conical head, longer leaves, and larger and more deciduous cones.

P. contorta Murrayana, Engelmann in Brewer and Watson's Bot. Califor. II. 126. P. Murrayana, Balfour, Rep. Oregon Exped. 2, t. 3 (1853).

Pinus contorta inhabits the sandy dunes and exposed promontories of the Pacific coast from Mendocino northwards to Alaska. Spreading inland it gradually assumes the form of var. *Murrayana* on the Californian Sierras and on the mountains of British Columbia, Wyoming, and around the Yellowstone National Park, in places forming pure forests of considerable extent; its southern limit is on the San Jacinto mountains in south California.

As seen on the sandy dunes and sphagnum-covered bogs of the Pacific coast, *Pinus contorta* is a small scrubby tree with gnarled branches, narrow leaves, and oblique cones that are singularly variable on the same tree, and which sometimes cover the tree so completely that scarcely any foliage is visible, persisting and remaining closed for many years. In places the trees are almost prostrate by the action of the wind, and always when exposed to its force, have close-set contorted branches and a dense foliage, affording effectual protection from the wind on the land side to the more tender herbaceous plants. Inland it is greatly changed by its surroundings in different localities, and becomes the tall pyramidal tree described above as var. *Murrayana*.

The economic value of the typical *Pinus contorta* is scarcely appreciable, as the tree does not grow large enough to afford timber. The wood of the inland larger tree is light, straight-grained and easily worked, but not strong and durable; it is largely used all over the region where it is abundant for fuel, and in places for railway ties, and out-of-door carpentry. It is comparatively a worthless Pine as regards its timber, but it is covering the lands in Colorado and on the Rocky Mountains which have been cleared of better timber trees by forest fires, and it is thence preserving the integrity of the mountain slopes and protecting the flow of mountain streams.

The species was first seen by Lewis and Clark during their journey across the Rocky Mountains in 1805, but it was not known to science till it was discovered by David Douglas near Cape Disappointment during his first mission to the Far West, 1825—1827. There is no evidence of its having been introduced by him, and the actual date of introduction, which must have been many years later, does not appear to have been recorded.*

In Great Britain *Pinus contorta* is planted solely as a decorative tree; it is of slow growth, shapely, dense in habit, not taking up much room, and clothed with a rather persistent dark foliage; the distorted state so frequent on the Pacific coast is here altogether absent. The variety *Murrayana* forms a larger tree with a more diffuse habit.

Pinus Coulteri.

A large tree 50—80 feet high with a trunk 3—5 feet in diameter, covered with thick blackish bark deeply fissured into numerous plates of irregular shape. Branches of almost timber-like size, long and horizontal, often curved, sometimes towards one side and sometimes towards the other. Branchlets stout with rough blackish bark spirally furrowed, the herbaceous shoots with a bluish violet tint that changes with age to pale orange-brown. Buds ovoid-conic, terminating in a rather slender point, 1·25 inch long: the perulæ narrowly lanceolate, acuminate, yellowish brown. Leaves ternate, persistent two—three years, triquetral, rigid, serrulate along the distal half and terminating in a small mucro; in Great Britain 9—11 inches long and dull greyish green; basal sheath more than an inch long, pale brown and smooth but becoming much corrugated and blackish in the second year. Staminate flowers in crowded clusters, sub-cylindric, 1·25 inch long, straight or slightly incurved, surrounded by eight—ten involucral bracts. Cones ovoid-conic, 9—12 inches long and often 6 inches in diameter near the base and weighing five—seven pounds, in Great Britain rarely attaining these dimensions. Scales wedge-shaped, prolonged at the apex into a strongly incurved spine, pale yellowish brown, of very hard ligneous texture and closely adherent. Seeds oval, compressed, with broad wings an inch long.

Pinus Coulteri. Don in Trans. Linn. Soc. XVII. 440 (1836). Loudon, Arb. et Frut. Brit. IV. 2250, with figs. Forbes, Pinet. Woburn, 67, tt. 25, 26. Carrière, Traité Conif. ed. II. 437. Parlatore, D. C. Prodr. XVI. 392. Gordon, Pinet. ed. II. 266. Lawson, Pinet. Brit. I. 23, with figs. Engelmann in Brewer and Watson's Bot. Califor. II. 127. Masters in Gard. Chron. XXIII. (1885), p. 415, with fig.; and Journ. R. Hort. Soc. XIV. 227. Beissner, Nadelholzk. 257. Sargent, Silva N. Amer. XI. 99, tt. 571, 572.

P. macrocarpa, Lindley in Bot. Reg. XXVI. misc. 61 (1840). Hoopes, Evergreens, 115. Kent in Veitch's Manual, ed. I. 166. And others.

Pinus Coulteri inhabits the coast range of California at elevations varying from 3,000 to 6,000 feet from Mount Diabolo and the Santa Lucia southwards to the San Bernardino and San Jacinto

* In the former edition of this Manual it is stated at page 145 that *Pinus contorta* was introduced by David Douglas in 1831; but this is incorrect, as it had not been introduced at the date of publication of Loudon's "Arboretum et Fruticetum Britannicum" in 1838.

mountains. Along the northern portion of its range it occurs only in small groves in the midst of other coniferous vegetation; on the southern mountains it is more abundant and attains its largest size.

This remarkable Pine was discovered by Dr. Thomas Coulter in 1832 on the west side of the Santa Lucia at 3,000—4,000 feet elevation: but there is evidence of its having been previously seen in the same locality by David Douglas who sent seeds and herbarium specimens of it to the Horticultural Society of London under the name of *Pinus Sabiniana*, and from these seeds were raised the oldest specimens growing in Great Britain. Seeds were subsequently collected in the same locality by Hartweg, 1846—1847, and by William Lobb, 1851—1852.

In Great Britain the largest specimens of *Pinus Coulteri* present a broad outline with a rounded top; the branches grow faster in proportion to the trunk than in most other Pines, and the foliage being clustered at the extremities of the branchlets the tree has always a bare and unfurnished appearance. The large cones, although a striking feature of the species, are produced too sparingly in this country to modify the general effect. The wood is said to be useless for constructive purposes.

THOMAS COULTER (1793—1843) was born near Dundalk in Ireland, and at an early age evinced a liking for Natural History. He completed his education at Trinity College, Dublin, where he showed a marked proficiency in Botany and Entomology. After leaving the University he went to Geneva where he continued his botanical studies under the elder De Candolle. In 1823 he undertook the elaboration of the Dipsaceæ which formed the basis of the monograph of the Order subsequently published in the "Prodromus." In the following year he returned to Ireland, and soon after accepted the position of medical officer to the Real del Monte Mining Company for three years. He arrived in Mexico towards the end of 1824, but scarcely anything is recorded of his proceedings until he arrived at Monterey in 1831 where he met David Douglas, and the two worked together till the Spring of the following year, when Douglas left for the Sandwich Islands and Coulter proceeded on a botanical excursion to Arizona, returning again to south California and continuing his collections till 1834, when he returned to England bringing with him over fifty thousand specimens representing between fifteen hundred and two thousand species, besides a collection of woods, botanical manuscripts, journals, etc. He soon after accepted the Curatorship of the Herbarium of Trinity College whither his collections were transferred, but all his manuscripts were, in some unaccountable way, lost in transmission between London and Dublin. Suffering from the loss and broken in health from the hardships he had undergone during his travels, he devoted himself for the remainder of his life to the arrangement of his collections which, after his death, became the property of Trinity College. Coulter was one of the most laborious botanical collectors of his time, but no living plants were introduced by him into Great Britain.*

Pinus densiflora.

A medium-sized tree of which the average height may be estimated at 50—70 feet, but in the warm valleys of central Japan attaining a height of 100 feet, the upper part of the trunk and the primary branches covered with light reddish bark separating into thin scales. In Great Britain the bark of the oldest trees is rugged and fissured into small plates. Primary branches spreading, often curved laterally, ramified at the distal end only. Branchlets in whorls of three—four, but often two and opposite, relatively slender, with brownish bark

* Chiefly from the Botanical Gazette, XX. 519 (1895).

marked with the scars of the fallen leaves. Buds sub-cylindric, acute, 0·5 inch long, reddish brown; perulæ lanceolate, sub-acuminate, fringed with silky hairs, at first imbricated, afterwards loose and reflexed. Leaves geminate, persistent three—four years, slightly twisted, with obtuse tip, 3—4 inches long, dull grass-green; basal sheath 0·25 inch long, not falling off. Staminate flowers in dense spikes 2—3 inches long, sessile, ovoid-cylindric, obtuse, 0·25 inch long; involucral bracts few, lanceolate acute, nearly as long as the staminal axis. Cones solitary or clustered (in Great Britain usually opposite a branchlet), ovoid-conic, 1·5—2 inches long; scales oblong-cuneate, 0·75 inch long; apophysis rhomboidal with a transverse ridge and sharp central umbo.

Fig. 92. A Japanese dwarfed Pine.

Pinus densiflora. Siebold and Zuccarini, Fl. Jap. II. 22. t. 112 (1842). Endlicher, Synops. Conif. 172 (1847). Carrière, Traité Conif. ed. I. 376 (1855); ed. II. 486. Murray, Pines and Firs of Japan, 32, with figs. Parlatore, D. C. Prodr. XVI. 388. Gordon, Pinet. ed II. 233. Masters in Journ. Linn. Soc. XVIII. 503; and Journ. R. Hort. Soc. XIV. 228. Mayr, Abiet. des Jap. Reiches, 72. Beissner, Nadelholzk. 247.

Eng. Japanese Red Pine. Germ. Japanische Rothkiefer. Jap. Aka-matsu.

Pinus densiflora is met with throughout Japan south of Yeso, but it is found wild only on the central mountains, in places forming small stretches on granite and volcanic debris or mixed with other trees. On the higher slopes of Fuji-yama are large groves of singular beauty, the trunks often rising to a height of 70 to 80 feet and free of branches to beyond the middle, the effect being greatly heightened by the brick-red tinge of the bark. Everywhere else it has been planted by the Japanese, almost universally associated with *P. Thunbergi* with which it plays an important part in the decoration of their gardens. These Pines are dwarfed, distorted, and trained into the most fantastic shapes, a practice which will be again adverted to under *P. Thunbergi*. The wood of *P. densiflora* is coarse-grained but moderately strong; it is used for every description of carpentry by the Japanese.

Pinus densiflora was introduced to European gardens in 1854 through the horticultural establishment founded by Dr. Siebold at Leyden, but it was not generally distributed in Great Britain till after 1861, in which year seeds were brought from Japan by the late John Gould Veitch. It occupies quite a subordinate place in British Arboriculture: it grows slowly in the drier climate of this country, and possesses no especial features distinct from the common European Pines as an ornamental tree.

As distinguished from *Pinus Thunbergi*, *P. densiflora* is a more slender tree with bark of a different colour; the buds are smaller, reddish brown (not white) with looser scales; the leaves are thinner and softer to the touch, the cones somewhat smaller, the scales of which have a pungent umbo; it also differs from *P. Thunbergi* in the position of the resin canals of the leaf which are placed immediately on the epidermis and not within the parenchyma.

Pinus excelsa.

A tree, of which the trunk varies in height according to altitude and environment, 50—150 feet, and in diameter 2—3 feet; bark greyish brown fissured into small, rather regular plates about 0·25 inch thick.* Branches spreading horizontally, the higher ones ascending; ramification verticillate but sometimes lateral only. Branches slender with smooth greyish brown bark, the younger growths greenish brown; buds conic-cylindric, 0·25—0·4 inch long with lanceolate, acuminate pale brown scales. Leaves quinate, persistent three—four years, filiform, triquetral, with minutely serrulate margins, 5—7 inches long, bright green on the convex side, greyish white on the flat sides; basal sheath pale brown, 0·75 inch long, deciduous. Staminate flowers in dense clusters of twenty or more, cylindric, obtuse, 0·4 inch long, rose-pink; involucral bracts numerous, ovate, imbricated. Cones solitary or two—three together, shortly pedunculate, pendulous, sub-cylindric, 6—8 inches long, at first pale purple changing to light brown when mature; scales elongated, wedge-shaped with a rounded apical margin, the exposed part striated longitudinally and terminating in a small umbo. Seeds with an oblong wing 0·75 inch long.

Pinus excelsa, Wallich, Plant. Asiat. Rar. III. t. 201 (1832). Loudon, Arb. et Frut. Brit. IV. 2285, with figs. (1838). Forbes, Pinet. Woburn, 75, t. 29. Link in Linnæa, XV. 515. Endlicher, Synops. Conif. 145. Carrière, Traité Conif. ed. II. 397. Parlatore, D. C. Prodr. XVI. 404. Gordon, Pinet. ed. II. 299. Brandis, Forest Fl. N.W. India, 510. Hooker fil. Fl. Brit. Ind. V. 651. Beissner, Nadelholzk. 283, with fig. Masters in Journ. R. Hort. Soc. XIV. 22.

Eng. Himalayan Pine. Fr. Pin pleureur. Germ. Thränen-Kiefer.

* Gamble, Manual of Indian Timbers, 398.

Pinus excelsa inhabits the temperate Himalaya from Bhotan to Kuram in Afghanistan with a vertical range of from 7,000 to 12,000 feet elevation. It does not occur uninterruptedly throughout this long stretch of mountain country, but there is a break in the continuity in Sikkim, and it is altogether absent from central and west Kumaon. Towards its eastern limit it usually occurs on southern slopes above *Pinus longifolia* and below *Picea Smithiana*; in western Nepal it forms unmixed forests of great extent: in Kashmir it is associated

Fig. 93. *Pinus excelsa* at The Frythe, near Welwyn, Herts.

with *Cedrus Deodara* and *Abies Pindrow*; in Afghanistan it forms a forest belt between 8,000 and 12,000 feet elevation where it is reduced to a low straggling shrub; and towards its western limit it comes into contact with *Pinus Gerardiana* and *Juniperus excelsa*. *Pinus excelsa* is the only Conifer that is spread through the entire length of the Himalayan range, and it is one of the most valuable timber trees of the region.

Pinus excelsa first became known to science in 1802 through Dr. Buchanan Hamilton, who mentions it in his "Account of Nepal" under the name of *P. Strobus*; some years later it was discovered by Captain Webb in Bhotan and afterwards by Dr. Wallich in Nepal, by whom its specific characters were determined and by whom it was introduced about the year 1827. It has since occupied a foremost place in Great Britain among the ornamental Pines for the park and landscape, and even for the lawn where sufficient space can be allowed for it, which should never be less than a radius of from 25 to 35 feet from the bole. *P. excelsa* may now be seen throughout the length and breadth of the land, in the warmer and more humid districts rising to a height of 60 to 75 feet, not infrequently feathered with branches from the ground; in the drier midland and eastern counties not so high but with a much greater spread of branches. The illustration represents a fine specimen of which the lowermost branches cover more than one-eighth of an acre of ground.

Pinus flexilis.

A medium-sized tree 40—50 feet high with a trunk 2—4 feet in diameter. In Great Britain the largest specimens at present scarcely exceed 25 feet in height and have straight tapering trunks covered with pale brown bark. Branches horizontal or slightly curved upwards; the branchlets whorled or lateral only, and often inflexed towards their primaries. Buds ovate, acute, 0·5 inch long; perulæ broadly lanceolate with ciliolate margins, reddish brown. Leaves persistent four—five years, quinate, somewhat distant and evenly distributed over the shoot, triquetral, acute, 2—3·5 inches long, the younger leaves glaucous on the ventral flat sides, the older ones of a uniform dark bluish green; basal sheath short and deciduous. Staminate flowers in short spikes, ellipsoid, 0·5 inch long, surrounded at the base by seven—nine involucral bracts. Cones ovoid-cylindric, obtuse, 3—5 inches long and 1·5 inch in diameter; scales obovate oblong, the exposed part striated and terminating in a rather sharp edge with a small umbo at the apex. Seeds nearly 0·5 inch long, of compressed ovoid shape with a narrow persistent wing.

Pinus flexilis, James in Long's Exped. II. 34 (1823). Nuttall, Sylva, III. 107, t. 112. Carrière, Traité Conif. ed. II. 392. Parlatore, D. C. Prodr. XVI, 403. Hoopes, Evergreens, 131, with fig. Gordon, Pinet. ed. II. 302. Murray in Gard. Chron. IV. (1875), p. 356, with figs. Lawson, Pinet. Brit. I. 33, with figs. Engelmann in Brewer and Watson's Bot. Califor. II. 124. Beissner, Nadelholzk. 273. Masters in Journ. R. Hort. Soc. XIV. 229. Sargent, Silva N. Amer. XI. 35, t. 546.

An alpine tree distributed over the higher slopes of the mountain system of western North America known under the general name of Rocky Mountains; it has a meridional range extending from western Texas to Alberta and British Columbia with a lateral spread into eastern California. Its vertical range is also very great, ascending to 10,000 feet on Pike's Peak and to 12,000 feet on the Sierra Nevada, but rarely seen below 4,000 feet above sea-level. Throughout so extensive a range some variability in size and habit is observable at different altitudes and in different latitudes.

It is usually a small stunted tree frequently growing singly or in small groves among other Conifers. On the eastern slopes of the Rocky Mountains of Montana and on many of the ranges of central Nevada between 7,000 and 10,000 feet altitude it is the principal and most valuable timber tree, forming in places extensive forests. It attains its largest size on the mountains of northern Arizona and New Mexico where it sometimes produces cones 8—10 inches long. At its highest limit on the mountains of central Nevada it is frequently reduced to a spreading shrub two to three feet high.* The wood is light, close-grained and compact, of a light clear yellow turning to red on exposure.

Pinus flexilis was first discovered by Dr. James who accompanied Long's Expedition to the Rocky Mountains in 1820—1821; it was subsequently met with in other parts of the mountain chains over which it is spread by botanists and others who were attached to the various Pacific Railroad explorations, and through whom it became better known. Seeds were introduced into Great Britain by Jeffrey in 1851, and afterwards by others, but nothing is recorded of the earlier seedlings. The excellent specimens growing in the Royal Gardens at Kew and in a few other places should induce a more extended trial of it for ornamental planting in this country.

Pinus Gerardiana.

A medium-sized tree with a short round crown and grey bark peeling off in large flakes, occasionally attaining a height of 50—60 feet with a stout trunk 12 feet in girth: usually 40—50 feet high with a short straight trunk free of branches to 8—10 feet, and with a girth of 6—7 feet. Branches strong, horizontal or decurved, and upturned at the ends.† Ramification pseudo-whorled or sub-distichous and alternate. Branchlets stoutish, with pale grey-brown bark. Leaves ternate, persisting three—four years, stiffish, triquetrous, 3—4 inches long, dark green; basal sheath 0·5 inch long, entire, deciduous. Staminate flowers not seen. Cones on short scaly peduncles, erect, ovoid-cylindric, 6—9 inches long and 4—5 inches in diameter; scales obtusely triangular with a spine-tipped umbo 1—1·5 inch long and 1 inch broad at the recurved tip. Seeds with a short caducous wing.

Pinus Gerardiana, Wallich in Lambert's Genus Pinus, ed. II. Vol. II. t. 79 (1837). Loudon, Arb. et Frut. Brit. IV. 2254. Royle, Illus. Him. Plant. 353, t. 85. Forbes, Pinet. Woburn. 53, t. 19. Endlicher, Synops. Conif. 159. Carrière, Traité Conif. ed. II. 433. Parlatore, D. C. Prodr. XVI. 391. Brandis, Forest Fl. N.W. Ind. 508, t 67. Gordon, Pinet. ed. II. 268. Hooker fil. Fl. Brit. Ind. V. 652. Beissner, Nadelholzk. 250. Masters in Journ. R. Hort. Soc. XIV. 229.

This Pine inhabits the north-west Himalaya from Kunawar westwards, occurring locally in the eastern portion of its range in the inner valleys that are beyond the influence of the periodical rains. Its vertical range is from 6,000 to 12,000 feet, the higher elevation being reached in Kafristan and Afghanistan, where it is common and frequently associated with the Deodar Cedar.

* Garden and Forest, V. 1; and X. 162.
† Brandis, Forest Flora of North-west India. 508.

As seen in the Kuram district, *Pinus Gerardiana* is a very handsome tree that does not branch as Pines usually do, the trunk and branches being more like those of a well-formed Oak. It is easily recognised at a distance by its nearly white ash-grey bark which, on close examination, is seen not to be of one colour but consists of patches of all tints from light green to autumnal reds and browns; this is due to the peculiar way in which the bark falls off.* According to Sir Dietrich Brandis, the timber is seldom used, and no part of the tree is applied to any economic use to any extent, except the edible seeds, large quantities of which are stored for winter use; these form a staple food of the inhabitants of Kunawar, being ground and mixed with flour. An oil is extracted from them and used in native medicines.†

The date of the introduction of *Pinus Gerardiana* into Great Britain is not accurately known. Cones were sent to England by Dr. Wallich and others at different times, but apparently mixed with those of *P. longifolia.* The first seedlings that proved to be true were raised by Messrs. Lawson of Edinburgh and by Messrs. Low of Clapton, a short time previous to the publication of Loudon's "Arboretum," but which have long since disappeared, as have most of the specimens in the south-west of England mentioned in the former edition of this Manual. Seedlings have been repeatedly raised in the Royal Gardens at Kew, but they refuse to grow for any length of time. The finest existing tree in the British Islands known to the author is in the grounds of Lord Ardilaun at St. Anne's, Clontarf, near Dublin. The species commemorates its discoverer, Captain Gerard of the Bengal Native Infantry, one of the earliest explorers of the north-west Himalaya.

Pinus halepensis.

A tree of variable height and habit, according to situation and aspect: in the lower grounds in good soil attaining a height of 50—60 or more feet with a slender trunk, open head, and irregularly disposed branches: the bark of the trunk usually smooth, greyish or ash-coloured; in Great Britain irregularly fissured, the fissures exposing a reddish brown inner cortex. On the arid, rocky shores of the Mediterranean Sea often in the form of a large spreading bush with the branches sometimes curiously distorted by the wind. Branchlets slender with the foliage clustered at the extremities; buds small, conic-cylindric; perulæ deltoid, acuminate, with lacerated margins. Leaves geminate, sometimes ternate, persistent about two years, filiform with short callous tips, 2·5—3·5 inches long, dark green; basal sheaths whitish, about 0·5 inch long, but soon becoming corrugated and brown. Staminate flowers in dense clusters of thirty—forty or more, from one-eighth to one-sixth of an inch long, reddish brown. Cones shortly pedunculate, usually solitary but sometimes two — three together, cylindric-conic, 2—3 inches long, yellowish brown, often with a greyish tinge; scales broadly oval-oblong, abruptly cuneate at the base, the apophysis rhomboidal with a transverse keel. Seeds small with a lenticular wing.

* Aitchison in Journal of the Linnean Society. XVIII. 97.
† Forest Flora of North-west India, 509.

Pinus halepensis, Miller, Dict. ed. VIII. No. 8 (1768). Lambert, Genus Pinus, I. t. 11. (1803). Loudon, Arb. et Frut. Brit. IV. 2231, with figs. Forbes, Pinet. Woburn, 25, t. 8. Link in Linnaea, XV. 496. Endlicher, Synops. Conif. 180. Carrière, Traité Conif. ed. II. Parlatore, D. C. Prodr. XVI. 383. Gordon, Pinet. ed. II. 236. Boissier, Fl. orient. V. 695. Beissner, Nadelholzk. 223. Masters in Gard. Chron. XXII. (1884), p. 552, with fig.; and Journ. R. Hort. Soc. XIV. 238. And many others.

Pinus halepensis is spread almost continuously throughout the Mediterranean region from Portugal to Palestine and Egypt, and eastwards into the Trans-Caucasian provinces of Russia as far as Georgia: it is also common in west and south Anatolia, covering the sand dunes of the Cilician coast westwards from Mersina. Its association with the maritime scenery of the region, especially with classic structures of ancient, and sacred buildings of medieval times has frequently attracted notice. In photographs of Greek temples this Pine occurs singly or in small groups with picturesque effect as regards its surroundings, but individually of no especial beauty; as thus represented it usually has a slim trunk bare of branches for more than one-half of its height with a gaunt crown of short irregularly disposed branches clothed with a sparse foliage tufted at the extremities of the branchlets.

Pinus halepensis has been in cultivation in Great Britain since the beginning of the eighteenth century, but owing to climatic causes it is now but rarely seen in this country; the few specimens still standing in the Royal Gardens at Kew and other places have to sustain a continuous struggle with British winters to which, doubtless, they will ultimately succumb. In the Australian colonies where it was introduced many years ago, *P. halepensis* grows faster and attains a larger size than in its native habitat, but it has the same unfurnished aspect. There are specimens in the Botanic Gardens of South Australia, Victoria and New South Wales from 70 to 80 or more feet high.

The economic value of *Pinus halepensis* in southern Europe and the Levant is locally considerable; the wood is white, with a fine grain, and is used for joinery in Provence and Piedmont; the resinous products are in places much utilised and yield, it is said, a finer turpentine than *P. Pinaster*. The late M. Carrière strongly recommended the planting of *P. halepensis* near the sea in the south and south-west of France, especially in places where no other tree will thrive; on rocks almost denuded of soil, and in places where no native plant will take root this Pine will grow: it supplies excellent fire-wood to the peasantry throughout the region.

Pinus inops.

A tree of variable height and habit; at its greatest development with a trunk 75—100 feet high and 2—3 feet in diameter near the ground; on the Atlantic littoral of the United States much less. In Great Britain a short-lived, medium-sized or low tree rarely exceeding 40 feet in height, oftener much less, the trunks sometimes forked at a short distance from the ground, slender, with dingy brown bark fissured into numerous oblong plates. Primary branches short, mostly horizontal, often curved or tortuous; branchlets opposite or in whorls of three—four, the bark of the herbaceous shoots tinged with glaucous violet. Buds small, fusiform, reddish brown, often covered with a film of whitish resin. Leaves geminate, persistent three—four years, more or less twisted, mucronate, with scaberulous margins, 2—2·75 inches long, dark green; basal sheath 0·4 inch long, falling off the second year. Staminate flowers in crowded clusters, 0·5 inch long, surrounded at the base by seven—nine involucral bracts; the anther connective reniform and fimbriated. Cones solitary or in whorls of two—four, ovoid-cylindric, 2·5—3 inches long and 1—1·25 inch broad near the base; scales oblong-cuneate, the thickened apex with an acute transverse ridge and armed with a short straight prickle at the middle. Seeds small, with a narrowly oblong wing.

Pinus inops, Solander ex Aiton, Hort. Kew. ed. I. Vol. III. 367 (1789). Lambert, Genus Pinus, I. t. 13 (1803). Michaux, Hist. Arb. Amer. I. 58, t. 4 (1810). Loudon, Arb. et Frut. Brit. IV. 2192, with figs. Forbes, Pinet. Woburn, 15, t. 1 Endlicher, Synops. Conif. 167. Carrière, Traité Conif. ed. II. 471. Parlatore, D. C. Prodr. XVI 380. Hoopes, Evergreens, 84. Gordon, Pinet. ed. II 238. Beissner, Nadelholzk. 215. Masters in Journ. R. Hort. Soc XIV. 230. And many others.

P. virginiana, Miller, Dict. ed. VIII. No. 9 (1768).* Sargent, Silva N. Amer. XI. 123. t. 587.

Eng. New Jersey Pine. Amer. Scrub Pine. Fr. Pin chétif. Germ. Jersey-Kiefer.

The geographical range of *Pinus inops* extends from the Hudson river southwards through the Atlantic States to the valley of the Savannah in central Georgia, spreading westwards through Kentucky to southern Indiana where it attains its greatest development.

In the Atlantic States *Pinus inops* is a small tree for the most part of a stunted and unshapely habit, covering the barren lands and spreading rapidly over fields exhausted by agriculture; in this region it is used only for fuel. West of the Alleghanies it attains a timber-like size, and its wood is used for various kinds of carpentry, especially in connection with water-works. The date of introduction into Great Britain does not appear to have been recorded; it was cultivated by Philip Miller in the "Physic" garden at Chelsea in 1739.

Pinus koraiensis.

A medium-sized tree, usually 40—50 feet high, occasionally much higher, with a more or less elongated pyramidal head, the trunk covered with reddish grey bark peeling off in scaly plates 4—5 inches long and about half as broad. In Great Britain the bark of the oldest trees is either smooth or more rarely marked with resinous blisters in transverse lines. Branches stoutish, spreading or ascending; branchlets in whorls of three—four; buds small with pale brown perulæ. Leaves quinate, crowded along the distal half of the shoot, persistent three—four years, slender, almost filiform, triquetrous, 3·5—4·5 inches long, green on the convex side, with five—eight whitish stomatiferous lines on the flat sides. Staminate flowers clustered, sub-cylindric, 0·5—0·75 inch long, pale rose-pink. Cones erect,

* Miller's name is thence the most ancient, but as it was not taken up by any subsequent authors for more than a century afterwards, the inexpediency of reviving it is sufficiently evident.

sub-sessile, ovoid-cylindric, obtuse, 4—5 inches long, and 2·5—3 inches in diameter near the base; scales broadly rhomboid-cuneate, reflexed at the apex, rugose or striated. Seeds relatively large with a narrow rudimentary wing.

Pinus koraiensis, Siebold and Zuccarini, Fl. Jap. II. 28, t. 116, excl. figs 1—4 (1842). Endlicher, Synops. Conif. 140 (1847). Carrière, Traité Conif. ed. II. 385. Murray, Pines and Firs of Japan, 1, with figs. Parlatore, D. C. Prodr. XVI. 404. Gordon, Pinet. ed. II. 306. Masters in Journ. Linn. Soc. XVIII. 504; and Journ. R. Hort. Soc. XIV. 231. Beissner, Nadelholzk. 280, with fig. Mayr, Abiet. des Jap. Reiches, 73, t. V. fig. 18.

Eng. Corean Pine. Germ. Korea-Zurbel. Jap. Chosen-matzu.

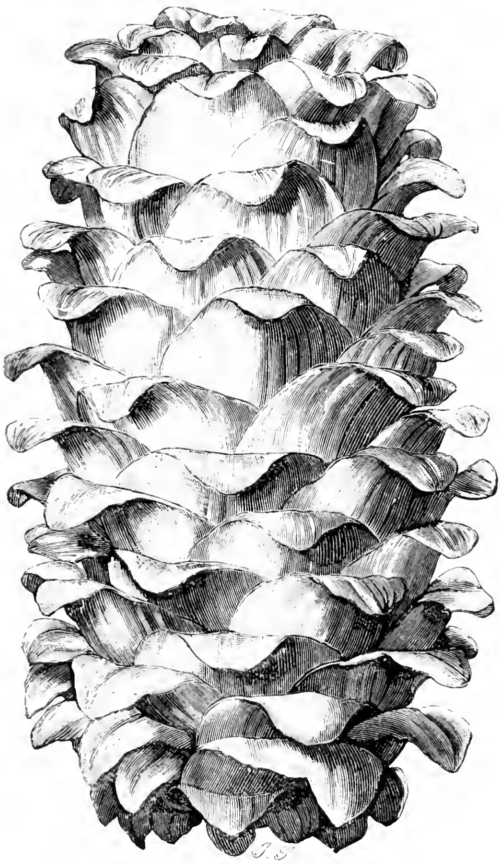


Fig. 94. Cone of *Pinus koraiensis.*

An eastern Asiatic species spread over the Corea, parts of China and Japan. It has been asserted by several authors that it is not endemic in the last named country, but an introduced plant from the neighbouring peninsula of Corea; Dr. Mayr, however, found this Pine scattered through the mountain forests of Japan, notably at Kisso, and on Mount Kotzuke, in situations where the trees could not have been planted by the hand of Man, nor is their presence in these places to be accounted for by any circumstances arising out of the length of time that this Pine has been cultivated by the Japanese.* Its presence in a wild state in Corea was verified by Mr. James Herbert Veitch during his adventurous journey through the country in 1892; he saw it in several localities, notably on the Diamond mountains where it is very abundant. In 1899 it was gathered by Messrs. Veitch's botanical collector, E. H. Wilson, in Yuen-Chiang, in south China, a locality so remote from Corea as to indicate an extensive distribution of this species.

* Abietineen des Japanischen Reiches. *loc. cit.*

Pinus koraiensis sometimes attains imposing dimensions in Japan; one standing near a monastery in Nikko is nearly 100 feet high, with a trunk three feet in diameter, but in Japanese gardens it is generally much less. It was introduced into Great Britain, in 1861, by the late John Gould Veitch; its growth in this country is relatively slow, but the tree is quite hardy almost everywhere, and should be selected for ornamental planting where the larger Pines are unsuitable, except in dry, sandy or heavy wet soils. Good specimens are growing in places so widely apart as the Royal Gardens at Kew, Ochtertyre in Perthshire, Fota Island near Cork, and Hamwood in Co. Meath. Nothing is known of the quality of the wood, which in Japan is too scarce to be available for use.

Pinus Lambertiana.

A gigantic tree, with an almost cylindrical trunk 150—300 feet high, and 10—15 feet in diameter, usually free of branches for two-thirds of its height. Bark smooth, ash-brown, fissured into small, oblong plates. Branches spreading, or more or less deflexed; the branchlets short and flexible, the whole ramification forming an elongated, pyramidal crown. Buds sub-fusiform, with an acute point at the apex; perulæ closely imbricated, lanceolate, red-brown, downy at the edges. Leaves quinate, persistent four — five years, triquetrous, mucronate, scaberulous along the margins, 3—5 inches long, bright green on the convex side, with three—six stomatiferous lines on each of the flat sides; basal sheath short, deciduous, usually split into three teeth at the margin. Staminate flowers in rather dense spikes, surrounded at the base by ten—fifteen involucral bracts, cylindric, 0·5 inch long, light yellow brown. Cones pendulous, cylindric, tapering at the apex, 15—20 or more inches long, and 3—3·5 inches in diameter; scales somewhat fan shaped, 2·5 inches long, and 1·75 inch broad. Seeds about 0·5 inch long, with a dark brown roundish oblong wing as long again as the seed.

Pinus Lambertiana, Douglas, Trans. Linn. Soc. XV. 500 (1828). Lambert, Genus Pinus, ed. II. Vol. I. 57, t. 34. Loudon, Arb. et Frut. Brit. IV. 2288, with figs. Forbes, Pinet. Woburn, 77, t. 30. Endlicher, Synops. Conif. 150. Carrière, Traité Conif. ed. II. 403. Parlatore, D. C. Prodr. XVI. 486. Hoopes, Evergreens, 134. Gordon, Pinet. ed. II. 30. Lawson, Pinet. Brit. I. 47, t. 7 and figs. Engelmann in Brewer and Watson's Bot. Califor. II. 123. Beissner, Nadelholzk. 294. Masters in Gard Chron. I. s 3 (1887), p. 772, with fig.; and Journ. R. Hort. Soc. XIV. 231. Sargent, Silva N. Amer. XI. 27, tt. 542, 543.

Eng. and Amer. Sugar Pine. Fr. Pin gigantesque. Germ. Riesen-Kiefer, Zucker-Kiefer. Ital. Pino zucchero.

Pinus Lambertiana occurs throughout the States of Oregon and California from the Columbia river to the San Jacinto mountains, whence it passes into Lower California, reaching its southern limit on Mount San Pedro. It is an alpine tree that follows the Cascade and Sierra Nevada mountains with a vertical range of 2,500—8,000 feet elevation and also the trend of the coast range as far as the Santa Lucia mountains near Monterey; its best development being attained at 5,000—6,500 feet. It does not form pure forests but is usually mingled in small isolated groves with the Redwood, *Pinus ponderosa* and *Abies concolor*, and towards its northern limit it is mixed with *Abies grandis*, *Thuia gigantea*, and other coniferous trees.

Pinus Lambertiana is the loftiest of all Pines; its column-like, perpendicular trunk towers in some places to a height of 300 feet, thus rivalling the stature of the gigantic Sequoias with which it is in places associated; the usual height, however, ranges from 120 to 250 feet. As seen at a distance on the western slopes of the Sierra Nevada its aspect is that of a tall column "with a lanky contour and sparse ramification, wanting the picturesqueness of *P. ponderosa* and the bulk in proportion to height of a Sequoia,"* but when approached nearer this unfavourable impression is modified by the strikingly beautiful living cones which hang from the tips of the branches, bending them by their weight, and which, in the sunshine, sparkle like pendents of diamonds owing to the high refractive power of the resin that copiously exudes from them and hangs in drops from the scales.

The timber yielded by *Pinus Lambertiana* is of excellent quality; the wood is solid, straight-grained, very fragrant and easily worked; it does not crack or warp, and is on that account much used for cabinet work and indoor carpentry. The sap that exudes from the trunk when cut or wounded thickens into a whitish substance with a sugar-like flavour, whence this tree has obtained the name of the Sugar Pine. The Indians sometimes utilise the exuded substance for food, but it is not much relished by the whites; the seeds too are eaten by the Indians. On account of its valuable timber the destruction of the Sugar Pine has been rapid and often wanton, but by the recent enactment of sufficiently stringent laws, it is now more or less secure against criminal waste. Nevertheless seedlings and young trees are scarce on account of the seeds being devoured in prodigious quantities by squirrels, parrots, crows, and other animals.

The Sugar Pine was discovered by David Douglas in south-west Oregon in October 1826, and was introduced by him in the following year. He had previously seen one of its large cones which had been brought to him by an Indian, and this induced him to make an excursion southwards for the express purpose of gathering cones and seeds; during the journey he suffered great hardships, and when securing his first cones he was in danger of losing his life from the hostility of the Indians. *Pinus Lambertiana* has now been a denizen of the British Isles for more than seventy years; in the drier and colder climate of this country it shows no indication of rivalling the gigantic dimensions of its parents in western America; its growth is slow and the best specimens have for the most part an irregular outline caused by the furcation of the trunk at an early age and by the unequal development of the branches.† To ensure a good specimen of this noble tree it should be planted in a situation sheltered from winds blowing from the

* Sir J. D. Hooker in Gard. Chron. XXIII. (1885), p. 11.

† The largest specimens of *Pinus Lambertiana* known to the author are:—In England at Bayfordbury, Hertford; Dropmore, Eastnor Castle, Elvaston Castle, Kenfield Hall, Canterbury; Tortworth Court, Revesby Abbey. In Scotland at Keir and Methven Castle, Perthshire; and at Poltalloch in Argyllshire. In Ireland at Woodstock, Kilkenny; and Powerscourt, Wicklow.

north, north-east, and east, and a clear space having a radius of not less than from 25 to 30 feet should be allowed for it.

The specific name was given by Douglas, in compliment to Mr. A. B. Lambert, a munificent patron of science, and the author of a beautifully illustrated folio work entitled "The Genus Pinus." This work, together with the encouragement he gave to the discovery and introduction of new kinds, has associated Mr. Lambert's name with coniferous plants.

AYLMER BOURKE LAMBERT (1761—1842), the only son of Edward Lambert of Boyton House, Heytesbury in Wiltshire, was born at Bath. He was educated at St. Mary's Hall, Oxford, and early devoted his attention to Botany. He was one of the founders of the Linnean Society, of which he was one of the Vice-Presidents; he was also a Fellow of the Royal Society. When he came to his paternal estate, he formed a large herbarium, which was for many years under the charge of David Don. This collection, as well as Mr. Lambert's extensive library, was made available to all men of science. There was an open reception of scientific men every Saturday at Mr. Lambert's house. He was anxious to encourage science, and his ample means enabled him to gratify his taste in this respect. For many years his health was feeble, and he retired to Kew, where his proximity to the Royal Gardens afforded the means of gratifying his botanical tastes. Besides the work above mentioned, he published a description of the genus Cinchona, and contributed many papers to the "Transactions of the Linnean Society." After his death his herbarium was sold by public auction, when a small portion of it was purchased for the British Museum.

Pinus Laricio.

A lofty tree 80—120 or more feet high with a relatively slender trunk and open pyramidal crown: in old age often with a rounded or umbrella-like top. Bark of trunk dark grey, rugged and fissured into irregular, thinnish plates, which on being cast off, expose a smooth, pale reddish brown inner cortex. Branches spreading or deflexed, often upturned at the ends. Branchlets stoutish, at first pale green changing to reddish brown at the end of the second year. Buds conic, acute, 0·5—0·75 inch long, with lanceolate, acuminate, reddish brown perulæ fringed with silky hairs. Leaves geminate, persistent three—four years, semi-terete, with serrulate margins and rather obtuse apex, 4—6 inches long, rigid or waved, dark green; basal sheath 0·5 inch long, whitish; shorter, darker and corrugated the second year. Staminate flowers densely clustered, cylindric, 1—1·5 inch long, pale yellow.* Cones solitary or two—three together, conic-cylindric, 2—3 inches long, and usually a little more than an inch in diameter above the base: scales oblong, the apical thickening rhomboidal with a transverse keel and a small central depression in which is a minute pyramidal umbo.

Pinus Laricio, Poiret, Dict. Encycl. V. 339 (1804). Lambert, Genus Pinus, ed. II. Vol. I. 9 (1828). Loudon, Arb. et Frut. Brit. IV. 2200, with figs. Link in Linnaea, XV. 494. Endlicher, Synops. Conif. 178. Carrière, Traité Conif. ed. II. 491. Parlatore, D. C. Prodr. XVI. 386. Gordon, Pinet. ed. II. 239. Lawson, Pinet. Brit. I. 55, t. 8. Willkomm, Forstl. Fl. ed. II. 226. Boissier, Fl. orient. V. 697. Beissner, Nadelholzk. 238, with fig. Masters in Gard. Chron. XXI. (1884), p. 18, with fig.; and Journ. R. Hort. Soc. XIV. 232. And many others.

Eng. Corsican Pine, Larch Pine. Fr. Pin de Corse, Laricio de Corse. Germ. Schwarzkiefer. Ital. Pino di Corsica.

var.—austriaca.

In Great Britain usually a smaller tree of denser habit, with stouter and longer horizontal branches, and shorter but stouter and more rigid leaves of a darker green. In the forests of Austria attaining dimensions

* The staminate and ovuliferous flowers of *Pinus Laricio* are fully described in pp. 37—38.

equalling those of the typical form on the mountains of Corsica, denuded of branches for more than half the height and with a dome-shaped crown.

P. Laricio var. austriaca. Endlicher, Synops. Conif. 179. P. austriaca, Höss, Monogr. der Schwarzföhre, Wien (1831). Loudon, Arb. et Frut. Brit. IV. 2205. P. Laricio nigricans, Parlatore, D. C. Prodr. XVI. 387. P. leucodermis Antoine. Austrian Pine. Pin noir d'Autriche. Oesterreichische Schwarzkiefer, etc

var. monspeliensis.

A more slender tree with more slender leaves of a brighter green; the bark of the branchlets with a more decided orange-red tinge than in any of the Laricio forms; the habit of the tree during the first twenty—thirty years an elongated pyramid, which, with the bright green foliage, gives it a distinctive character among Pines.

P. Laricio var. monspeliensis,* Beissner, Nadelholzk. 242. P. pyrenaica, Gordon Pinet. ed. II. 255 (not Lapeyrouse). P. Laricio tenuifolia, Parlatore, D. C. Prodr. XVI. 387. P. Laricio leiophylla. Christ. Europ. Abiet. 15.

var.—Pallasiana.

A broader tree with stout branches springing from near the ground which sometimes ascend parallel with the trunk, but more frequently (in dry localities) spread out so as to impart to the tree a broadly pyramidal habit. The terminal buds more elongated than in the typical *Pinus Laricio*, the leaves frequently longer and more slender, and the cones larger and of more ovoid shape.

P. Laricio Pallasiana, Endlicher, Synops. Conif. 179. P. Pallasiana, Lambert. Genus Pinus. II. t. 1. Loudon, Arb. et Frut Brit. IV. 2206, with figs. P. Laricio caramanica, Spach. Hist. Veg. Phan. XI. 385. P. Fenzlii, Antoine. And many others. Crimean or Tartarian Pine. Laricio de Caramanie. Taurische Schwarzkiefer.

The three varieties here described are geographical or climatic forms, of which a fourth is admitted by some authors under the name of *calabrica*, but which is unknown in the British Pinetum. Besides these climatic forms, a considerable number of deviations from them and also from the type have appeared in the seed beds of horticulturists, as *Laricio pendula*, *Laricio pygmaea*, *austriaca aurea*, etc., but none of them are probably perpetuated in British nurseries at the present time.

The geographical area inhabited by *Pinus Laricio* in a wild state comprehends central and southern Europe, and western Asia within the same latitude; it extends in a longitudinal direction from the Cilician Taurus to the Sierra de Cazorla in Spain, and in a meridional direction from the Wiener Wald to Sicily. Its distribution over this region is very unequal, and much interrupted; on the mountains it forms in places pure forests of considerable extent; in other districts it occurs in groups or groves only. The form here regarded as the type, *P. Laricio* proper, grows chiefly on the mountains of Corsica and the maritime Alps of France and Italy. The variety *austriaca* is a more inland tree, spread over the Austrian provinces of Lower Austria, Carniola, Croatia, the Banat, and also the northern half of the Balkan peninsula. The variety *monspeliensis*

* This varietal name is preferred to *pyrenaica*, the name by which this Pine is best known in Great Britain, to avoid confusion with the true *Pinus pyrenaica*.

represents the species in the western portion of the area of its distribution, on the Spanish Sierras, the Pyrenees and the Cevennes; and *Pallasiana*, in the eastern portion, from the Cilician Taurus to the mountains of Bithynia. The vertical range of *P. Laricio* and its varieties varies in the different regions over which they are spread; in Spain it is estimated to be approximately 1,000—3,500 feet elevation, in Corsica 3,000—5,000 feet, on Mount Etna 4,000—6,500 feet, in Albania 2,500—3,000 feet, on Olympus and the Cilician Taurus 4,000—6,000 feet.

The type, *Pinus Laricio* proper, was introduced into Great Britain in 1759 under the name of *P. sylvestris maritima*, and many fine old trees scattered over the country attest its adaptability to the British climate, of which one standing near the principal entrance to the Royal Gardens at Kew is worthy of mention. The variety *austriaca* was introduced in 1835 by Lawson of Edinburgh, *monspeliensis* about the same time, and *Pallasiana* first became known in British Arboreta towards the end of the eighteenth century.

The Corsican Pine is recommended by the best forestry authorities for profitable planting in this country. For quality, quantity, general utility and early maturity it may have equals, but no superiors among the true Pines. It is constitutionally hardy, of very rapid growth, surpassing its congeners, and a rival to the frequently diseased Larch; of large dimensions, attaining heights of from 80 to 100 feet, arriving at maturity in sixty to eighty years, but will produce timber fit for any purpose in about thirty or forty years. It is not fastidious as to soil or situation, and excepting in spongy marsh or soft peat, there is no description of soil not surcharged with stagnant water in which it would not grow and produce wood of as good quality and equal quantity, and yield as quick and profitable a return as any timber tree extant. Its wood, when young or newly cut, is creamy white; when matured and seasoned, brownish yellow; very resinous, elastic, and tough; very durable, long grained, and though a little coarse in texture, is easily worked and capable of receiving a tolerably good polish. It is less subject to the ravages of insects, fungi, game or vermin than any other Pine, which may be accounted for by the bitter aromatic flavour with which its juices are impregnated. It is a sparse tap-rooted Pine when in a young state, but it is not on that account bad to transplant. If the seedling plants are transplanted in the autumn or winter, after their first summer's growth, and again every succeeding autumn or winter till removed to their permanent quarters, the failures are nil.

The Austrian Pine is a fast-growing dense-habited tree of great accommodative power on the poorer classes of soils and for bearing shade; it is one of the best of Pines for forming shelter screens and for planting on chalk hills. The wood of the Austrian Pine is coarser in grain than that of *P. Laricio* proper, and is apt to be knotty when the trees have been grown in poor soils: it is better adapted for out-of-door work as rough fencing than for the better kinds of carpentry. The varieties *monspeliensis* and *Pallasiana* are effective park and landscape trees, for which purpose alone they should be used in Great Britain and Ireland.

The specific name *Laricio* is the common name of the tree in southern Europe. It is often called the Corsican Pine in England, for no assigned reason except that considerable quantities of seed have been received from the island of Corsica.

Pinus longifolia.

A large tree 100 or more feet high, with symmetrical branches high up on the trunk forming a rounded head of light foliage, but often stunted and gnarled. Bark rough, fissured into polygonal plates by deep, dark-coloured furrows. Leaves ternate, persistent two—three years, slender, 9—12 inches long, the inner face keeled so as to be nearly triquetrous, and with a rounded convex back; basal sheath persistent, greyish brown, fimbriate at the edge with long fibres. Staminate flowers in crowded clusters, cylindric, about an inch long. Cones on short stiff stalks, spreading or recurved, solitary or in whorls of three—five, ovoid-conic, 4—7 inches long, and 3 inches in diameter above the base; scales 1·5—2 inches long, and 0·75 inch broad, the apophysis forming a spreading or recurved, obtuse, pyramidal beak with four—six distinct rounded faces. Seeds with a thin membraneous wing 0·75—1 inch long, oblanceolate obtuse, and unequal sided. — Brandis, *Forest Flora of North-west India*, p. 506.

Pinus longifolia, Roxburgh, Fl. Ind. III. 651 (1832). Loudon, Arb. et Frut. Brit. IV. 2252, with figs. Endlicher, Synops. Conif 158. Parlatore, D. C Prodr. XVI. 390. Gordon, Pinet. ed. II. 275. Hooker fil. Fl. Brit. Ind. V. 652.

Pinus longifolia inhabits the outer Himalaya and foot-hills from Bhotan to the Indus at elevations ranging from 1,500 to 6,000 feet, attaining its greatest development in Kumaon where it ascends to 7,500 feet, and is one of the most beautiful trees of the district. It forms pure forests in many places, often with a scanty undergrowth of Andromeda, Berberis, *Rhus Cotinus*, and a few others.

In an economic sense, *Pinus longifolia* is the most valuable of the Himalayan Coniferæ to the inhabitants of the region: the wood is easy to work, and is extensively used on the hills for building and out-of-door carpentry, but soon decays on exposure to the weather. It yields large quantities of turpentine and resin, the collection of which is an important industry of the districts in which the tree is abundant: the stumps of the trees that have been tapped for their resinous products are often so full of turpentine that the wood is used as torches instead of candles in houses and mines; the bark is used for tanning leather; charcoal is made of the wood, and the charcoal of the leaves mixed with rice-water is used instead of ink; the seeds are much eaten by the poorer inhabitants, but they have a strong flavour of turpentine.* As may be inferred from its geographical position, this Pine is too tender for the climate of Great Britain. According to Loudon it was introduced in 1801, and was long cultivated as a greenhouse plant; its long, slender, bright green, pendulous leaves render it a distinct and beautiful object for the conservatory, for the decoration of which it is still occasionally used while in a young state. It has its analogue in the beautiful *P. patula* of Mexico, which is hardier and attains a large size in Devon, Cornwall and the south of Ireland.

* Brandis, Forest Flora of North-west Ind *loc. cit. supra.*

Pinus mitis.

A tree with a slightly tapering trunk 80—120 feet high, but frequently much less, with a short, pyramidal, truncate head of comparatively slender branches that depend more or less. Bark roughish, fissured into irregular plates. Branchlets stout, at first pale green or pale violet and glaucescent, changing with age to reddish brown. Buds ovoid, obtuse, about 0·25 inch long, with small orange-brown, imbricated perulæ. Leaves geminate, frequently ternate on young trees, persistent two—three years, flexible, slender with a cartilaginous tip and serrulate margins, 2·5—4 inches long, grass-green; basal sheath at first white, 0·5 inch long, much shorter and lacerated the second year. Staminate flowers in short crowded clusters, oblong-cylindric, about 0·75 inch long, with pale pink anthers and surrounded at the base by ovate, acute, involucral bracts in about three series. Cones in pairs or in clusters of three—four, ovoid or cylindric-ovoid, shortly stalked, 1·5—2·5 inches long and a little more than an inch in diameter near the base; scales obovate-cuneate with but a slightly thickened apophysis terminating in a transverse ridge with a short pale, pyramidal umbo. Seeds prism-shaped, with a pale brown fragile wing about 0·5 inch long.

Pinus mitis, Michaux, Hist. Arb. Amer. I. 52, t. 3 (1810). Loudon, Arb. et Frut. Brit. IV. 2195, with figs. Endlicher, Synops. Conif. 167. Carrière, Traité Conif. ed. II. 472. Parlatore, D. C. Prodr. XVI. 243. Beissner, Nadelholzk. 216. Masters in Journ. R. Hort. Soc. XIV. 233. And others.

P. echinata, Miller, Dict. ed. VIII. No. 12 (1768).* Sargent, Silva of N. Amer. XI. 143, t. 587.

P. variabilis, Lambert, Genus Pinus. I. 22, t. 15 (1803). Pursh, Fl. Amer. 643.

Eng. Soft-leaved Pine. Amer. Yellow Pine, Short-leaved Pine, Spruce Pine. Fr. Pin jaune, Pin-Sapin. Germ. Glatte-Kiefer, Fichten-Kiefer, Gelb-Kiefer.

Pinus mitis is the most widely distributed of the Pines of eastern North America. From New Jersey and eastern Pennsylvania it spreads southwards to northern Florida and westwards to the Mississippi river. "West of the Mississippi river it is most abundant and attains its noblest size, often forming pure forests over great areas in its range from north-eastern Texas and western Louisiana to south-western Illinois." †

The Short-leaved or Spruce Pine is one of the most valuable timber trees of the eastern and Mississippi States; the wood is heavy, hard, strong and coarse-grained, but varies considerably in quality and in the thickness of its sapwood; it is used for building purposes generally, also for cabinet work, the interior finish of houses, car-building, railway ties, etc. Professor Sargent states that *Pinus mitis* spreads rapidly over abandoned fields in the southern and Gulf States,

* *Pinus echinata* is by far the oldest published name, but it was not taken up by any author of note till the publication of Vol. XI. of Professor Sargent's Silva of North America in 1897. There is some uncertainty respecting the identification of Lambert's *P. variabilis*, some authors referring it to *P. inops*, others to *P. mitis*. As Michaux's name has now been in continuous use for nearly a century, the great inconvenience of relinquishing it is sufficiently obvious.

† Silva of North America, *loc. cit. supra.*

which it soon covers with healthy forests, and seems destined to play an important part in restoring fertility to the lands of those States, and in supplying new crops of valuable timber.

Whatever may be its value and destiny in America, very little can be said in its favour on this side of the Atlantic. It is not known when it was introduced into Great Britain, but it was in cultivation in 1739 and perhaps earlier: it has rarely, if ever, been seen to thrive for long in this country, and old trees have become exceedingly rare. The nearest affinities of *Pinus mitis* are *P. inops* and *P. rigida*, between which it may be said to form a connecting link. Young plants of *P. mitis* and *P. inops* are scarcely distinguishable: the herbaceous shoots of *P. mitis* are sometimes violet tinted like those of *P. inops*, sometimes green like those of *P. rigida*: the leaves are frequently in fascicles of three as in *P. rigida*, and like that Pine short branchlets are sometimes produced from the stem and older parts of the branches.

Pinus montana.

Usually a prostrate or semi-prostrate shrub with crooked or gnarled stems and branches, the former 6—9 or more inches in diameter, and covered with dark brown bark: sometimes a low tree of pyramidal outline and spreading branches, a habit which it retains in old age. Branchlets short with pale brown bark, corrugated with short cortical outgrowths below the bases of the leaf fascicles. Buds sub-cylindric, about 0·5 inch long, with reddish brown perulæ usually coated with a film of whitish resin. Leaves geminate, persistent four—five years, rigid, often more or less twisted, mucronate, 2—2·5 inches long, dull green; basal sheath about 0·5 inch long, much wrinkled, and blackish the second year. Staminate flowers crowded in a short spike: anthers pale yellowish brown with an orbicular toothed connective. Cones sessile or shortly stalked, solitary or two and three together, variable in size and shape, those produced in Great Britain ovoid, obtuse, 1·25—1·5 inch long: scales obovate-oblong, the thickened exposed apex rhomboidal with a transverse ridge and prominent central umbo.

Pinus montana, Miller, Dict. ed. VIII. No. 5 (1768). Parlatore, D. C. Prodr. XVI. 386. Willkomm, Forstl. Fl. ed. II. 209. Kent in Veitch's Manual, ed. I. 151. Beissner, Nadelholzk. 233. Masters in Journ. R. Hort. Soc. XIV. 234.

P. Pumilio, Haenke, Reise ins Riesengebirge, 68 (1791). Lambert, Genus Pinus, I. t. 2 (1803). Loudon, Arb. et Frut. Brit. IV. 2186, with figs. Forbes, Pinet. Woburn. I. t. 1. Endlicher, Synops. Conif. 169. Carrière, Traité Conif. ed. II. 478.

P. Mughus, Wildenow, Baumz. 205 (1805). Forbes, Pinet. Woburn. I, t. 2. Gordon, Pinet. ed. II. 244 (Mugho). P. pumilio Mughus, Loudon, Arb. et Frut. Brit. IV. 2187, with figs.

P. uncinata, Ramond in D. C. Flor. Franc. III. 726 (1805). Cook-Widdrington, Travels in Spain, II. 236. Endlicher, Synops. Conif. 170.

P. humilis, Link in Abhandl. Berl. Akad. 171 (1827). Kerner in Nat. Hist. Pl. I. 519 (Oliver's Translation). And many others.*

Eng. Mountain Pine. Fr. Pin nain. Germ. Bergkiefer, Krummholzkiefer, Zwergkiefer. Ital. Pino dei Monti.

* The number of literary references to this Pine is unusually great. Very many of them occur in local Floras, either as a description of the species, or a *nomen nudum* only. In both cases the Mountain Pine is designated under a bewildering multiplicity of names.

The area of distribution of the Mountain Pine comprises the greater part of the mountain ranges of central and southern Europe from Thuringen in central Germany to Calabria in southern Italy, and from the Sierra de Cuença in central Spain to the Carpathians, the Bokovine Alps and the mountains of Servia. Its vertical range varies from 500 to 8,000 feet elevation, the lowest limit occurring in Silesia, and the highest in the Tyrol. On the Swiss Alps its vertical range is from 3,000 to 5,000 feet, and on the Pyrenees from 4,500 to 6,500 feet.

The Mountain Pine in its various aspects has been studied by Willkomm who has conclusively shown that the shrubby and arborescent forms result from climate, altitude, soil and aspect, and that they cannot be distinguished as varieties as the one passes imperceptibly into the other—that the cones from different localities although exhibiting an infinite diversity of form and size, preserve an identity of structure and therefore all the forms must be united under one specific name.* The different specific names under which the Mountain Pine is still known had their origin in different localities, thus:—*Pumilio* was first applied to the form that occurs on the Inselsberg in Thuringen and on the Carpathians, *Mughus* to the Mountain Pine of the Tyrolese and Venetian Alps, and *uncinata* to that of the Pyrenees and Spanish mountains. In British Pineta, *uncinata* is used occasionally to designate the arborescent form.

The Mountain Pine exhibits some remarkable phenomena incident on the high altitude at which it grows. The following account of it as seen on the Tyrolese Alps is taken from Kerner's "Natural History of Plants," Oliver's Translation, Vol. I. p. 549:—

"On the slopes of the mountains, the growing end of the stem is always directed towards the valley. The boughs and twigs which curve upwards from the main stems are exceedingly elastic and when pressed down stretch themselves along the ground. Since all the boughs of the crown turn upwards, we get here a considerable accumulation, so that in many old clumps of Mountain Pine, the numerous boughs are so thickly crowded and so closely interwoven that progress through them is impossible. The extensive tracts of Mountain Pine are therefore avoided and left alone, and many of them have never been penetrated by the foot of man during their whole existence. Frequently these Pines grow so high that one is over-topped, even when standing upright, by the highest prickly branches. If we mount on one of the curved ascending boughs in order to see above the highest branches, the bough bends down to the earth under our weight along with the stem from which it arises, and we again sink despairingly into the sea of dark green crowns. Just such a down-bending occurs under the burden of the winter snow; if then, by chance, the ordinary mantle is added to by that from avalanches, the pressure increases so much that the branches are pressed down to the soil. This process may go on to such an extent, that even many branches, which in summer stand more than a yard above the ground, lie in the winter directly

* Forstliche Flora von Deutschland und Oesterreich, ed II. (1887)

on the soil on account of the snow pressure. When the snow melts in the following spring and the branches are gradually lightened, they rise up again in consequence of their extraordinary elasticity and resume that position which they occupied in the preceding summer. In the summer, the old leaves on the ends of the Pine branches which wave above the ground more than a yard high, may be frequently seen plastered over with earth and small stones, and any one knowing nothing of the process above described would not easily understand how these small stones came to be found in these situations. As a matter of fact, the soil on which the branches lie through the winter, moistened by the snow-water, forms the adhesive agent which is so efficient, that stones more than half-an-inch in diameter are attached by it to the old tufts of leaves."

The Mountain Pine was in cultivation in Great Britain prior to 1779 at which date plants were growing in the garden of Mr. John Blackburn, at Orford Hall, near Warrington.* More generally cultivated formerly than at present, it has receded before the more attractive species introduced during the last half-century from western North America and Japan. Clumps of Mountain Pine, both of the shrubby and arborescent forms, may be seen in the Royal Gardens at Kew.

Pinus Montezumæ.

A lofty tree 60—80 or more feet high with a rounded top when old. Bark of trunk (as seen in England) greyish brown, rugged and much fissured into irregular plates. Branches spreading or ascending; branchlets stout, much roughened with the blackish remains of the sheaths of the fallen leaves. Buds conic, acute, an inch long, covered with lanceolate, imbricated, brown perular scales. Leaves quinate, persistent three—four years, triquetral, rigid, mucronate with serrulate margins, 7—10 inches long, bluish green; basal sheath whitish, 1·25—1·95 inch long, with lacerated margin the first year; much shorter, blackish and corrugated the second year. Staminate flowers in dense clusters, cylindric, 1·25 inch long, fawn-yellow. Cones in clusters of two—five, very variable in size even in the same locality, conic or ovoid-conic, 2·5—5 inches long and 1·5—2 inches in diameter near the base; scales obovate-oblong, closely imbricated, the exposed thickened apex rhomboidal with a transverse ridge and broadly pyramidal central umbo armed with a short deciduous prickle.

Pinus Montezumae, Lambert, Genus Pinus, ed. II. Vol. I. 39. t. 22 (1828). Loudon, Arb. et Frut. Brit. IV. 2272. with figs. Endlicher. Synops. Conif. 154. Gordon in Journ. Hort. Soc. Lond. I. 234. with fig.; and Pinet. ed. II. 313. Carrière, Traité Conif. ed. II. 414. Parlatore, D. C. Prodr. XVI. 399. Masters in Gard. Chron. VIII. ser. 3 (1890). p. 466, with fig; and Journ. R. Hort. Soc. XIV. 234.

P. Devoniana, P. Russelliana, P. macrophylla, Lindley in Bot. Reg. 1839, misc. pp. 62, 63. Endlicher, Synops. Conif. 152—154. And others.

P. Lindleyana, Gordon in Journ. Hort. Soc. Lond. V. 215; and Pinet. ed. II. 309.

P. protuberans, P. Wincesteriana, Gordon. Pinet. ed. II. pp. 319 and 325.

Pinus Montezumæ is the common Pine of the mountains and highlands of Mexico between the 17th and 25th parallels of north

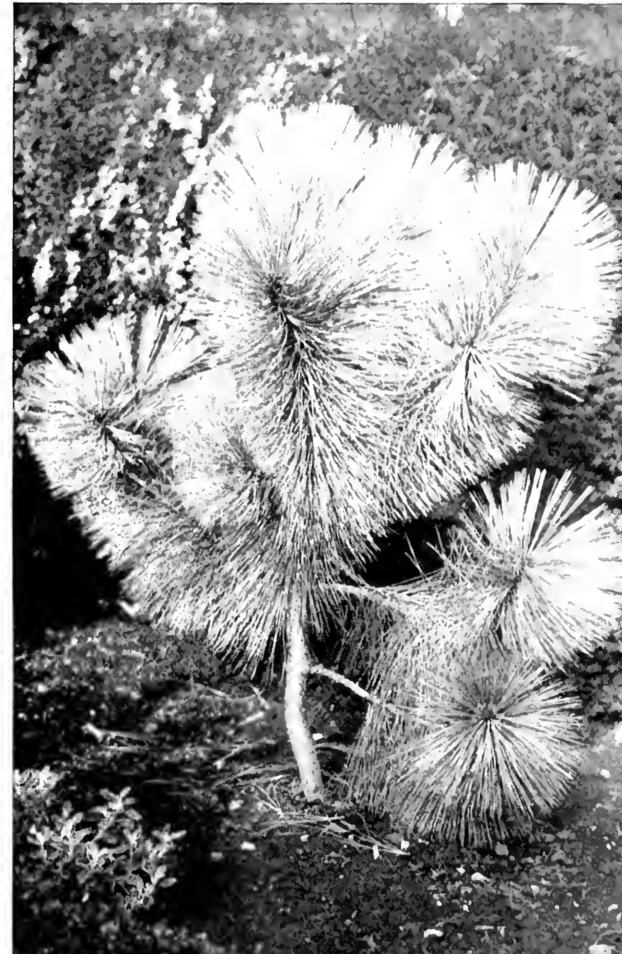
* Aiton, Hortus Kewensis. ed. II. Vol. V. p. 314.

latitude, where it has a vertical range of 4,000—12,000 feet elevation. To the different conditions of climate and environment under which it occurs throughout this region may unquestionably be assigned that variability in aspect, in the length and colour of the leaves and in the size and shape of the cones to which it is subject, and which has been so fruitful in the multiplication of the specific names given to it. Of these names the synonyms quoted above are still in use, but they unfortunately form but a small portion of the number that were at one time thrust upon botanists and cultivators of coniferous trees, most of which are now properly well-nigh forgotten. As seen on the slopes and mountain tops of the Sierra Madre near its northern limit where it is very abundant, *P. Montezumæ* is a valuable timber tree with a trunk 40 to 50 feet high and 12 to 18 inches in diameter; further south and at lower altitudes it exceeds these dimensions, but the wood is said to be inferior in quality.

Pinus Montezumæ was originally discovered near the city of Mexico in the beginning of the nineteenth century by Humboldt and Bonpland, who, however, mistook it for the *P. occidentalis* of Swartz, a species inhabiting the mountains of San Domingo and Cuba. It was afterwards seen by Schiede and other botanical explorers in Mexico, but it was not introduced till 1839, when the Horticultural Society of London received seeds from their collector, Hartweg, and plants were subsequently distributed among the Fellows of the Society. The belief at first entertained that so beautiful and distinct a Pine would prove hardy in many parts of Great Britain has not been realised. The oldest specimens that still remain in the west and south-west of England show, with very few exceptions, a constant struggle with climate for existence. The two trees shown in the illustration were, at the date of publication of this Manual, in faultless health and vigour: the older one is in the grounds of the Right Hon. A. H. Smith Barry at Fota Island near Cork, and the younger at Castlewellan, Co. Down, the seat of the Earl of Annesley.* The species commemorates the last unfortunate monarch of the Aztecs of Mexico who lost his life in a revolt of his subjects against the Spanish domination, A.D. 1520.

Although the leaves of *Pinus Montezumæ* are in bundles of five, the species is not included in either of the sections *Strobi* or *Cembræ* in consequence of the scales of the cone having a distinct apophysis with a central umbo, and the leaves not being slender and flaccid but rigid and spreading. It thence comes under Endlicher's section, *Pseudo-Strobus*, which includes other Mexican Pines that have been introduced into Great Britain but have proved quite unsuitable for the climate. Among these the three following may still be lingering on in sheltered spots in Devon and Cornwall.

* Several trees of *Pinus Montezumæ* in a more or less thriving condition are standing in the Pinetum of the Hon. Mark Rolle at Bicton in south Devon (under different names). There are others at Menabilly, Cornwall; Strete Ralegh, near Exeter; Kitley, near Plymouth; Eastnor Castle, Ledbury; Highnam Court, Gloucester; Essendon, Hatfield, and probably other places.



Pinus Montezumae.

At Fota Island, Cork.

At Castlewellan, Co. Down.

Pinus Hartwegii.

Lindley in Bot. Reg (1839) misc. 63. Endlicher. Synops. Conif. 152. Carrière. Traité Conif. ed. II. 410. Gordon. Pinet. ed. II. 304. Masters in Journ. R. Hort. Soc. XIV. 230.

This is described as a medium-sized tree 40—50 feet high with stout spreading branches and branchlets, the latter clothed with dark green leaves, 7—9 inches long, that are frequently in bundles of four; the cones are of ovoid shape, 4—5 inches long, the apophysis of the scales with a transverse keel and depressed umbo. It is a native of the mountains of Orizaba in central Mexico at a considerable elevation, whence it was introduced by the Horticultural Society of London in 1839. The species, if separable from *Pinus oocarpa*, commemorates its discoverer Theodor Hartweg, one of the most successful of the Society's collectors and the introducer of several Mexican and Californian Conifers, including *Pinus patula*, *P. muricata*, *Cupressus Benthamii* and *C. Goreniana*.

Pinus oocarpa.

Schiede in Linnaea. XII. 491 (1838). Endlicher. Synops. Conif. 152. Carrière, Traité Conif. ed. II. 411. Parlatore. D. C. Prodr. XVI. 401. Masters in Journ. R. Hort. Soc. XIV. 235.

A medium-sized tree, 40—50 feet in height, with a spreading head and branchlets clothed with leaves in bundles of five, 8—10 inches long, and egg-shaped, fawn-yellow cones (whence the specific name) about 2·5 inches long and 2 inches in diameter at the broadest; the scales very closely imbricated with a rhomboidal apophysis keeled transversely and the central umbo depressed. It is said to be abundant on the mountains of central Mexico especially on the volcano Jorullo which is covered with it up to the limit of arborescent vegetation. *Pinus oocarpa* was introduced by the Horticultural Society of London at the same time as *P. Hartwegii*, but it had been previously discovered by the German explorer Schiede.

Pinus Torreyana.

Parry in Bot. Mex. Bound. Surv. 210. tt. 58, 59 (1859). Carrière, Traité Conif. ed. II. 423. Engelmann in Brewer and Watson's Bot. Califor. II. 125. Sargent. Silva N. Amer. X. 71. tt. 557, 558. P. lophosperma. Lindley in Gard. Chron. (1860), p. 46. Gordon. Pinet. ed. II. 310.

A medium-sized tree 30—40 feet high with a trunk about a foot in diameter and stout spreading branches; occasionally much larger. The leaves, which are in bundles of five, are among the stoutest in the genus, often a foot long and quite rigid; and the broadly ovoid cones much resemble those of the European Stone Pine, *Pinus pinea*, in size, shape and colour, but the scales of the exposed side have a much more prominent apophysis tipped by a minute spine. Its habitat is the most restricted of all the North American Pines, being confined to a small area in south California near the mouth of the Soledad river. It was named by its discoverer Dr. C. C. Parry, in compliment to Dr. John Torrey, "one of the wisest, most clear-sighted and industrious, systematic botanists America has produced."

Pinus monticola.

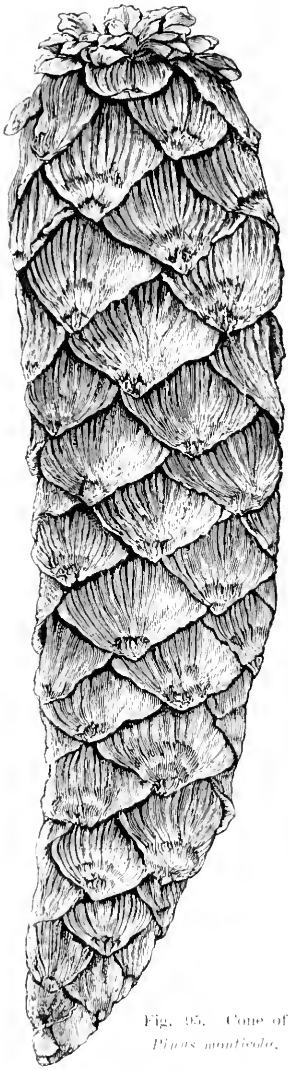


Fig. 95. Cone of *Pinus monticola*.

A tall tree 80—100 feet high, with a trunk 4—5 rarely 6—7 feet in diameter, furnished with slender, sub-pendulous branches that impart to the tree a narrowly pyramidal outline, but in old age this is greatly modified by the greater development of some of the uppermost branches. In Great Britain a somewhat slender tree of denser habit than *Pinus Strobus*, which it otherwise much resembles. Bark of trunk greyish brown, much fissured into small plates infinitely varied in size and shape, the deeper longitudinal fissures exposing a chocolate-brown inner cortex. Branches spreading or more or less depressed; branchlets with reddish brown bark, bearing the scars of fallen leaves. Buds ovoid-cylindric, sub-acute, 0·35—0·5 inch long, with reddish brown perulæ. Leaves quinate, persistent three — four years, clustered round the apical half of each season's growth, slender, 4—5 inches long, trigonal, the margins obscurely serrulate, the dorsal convex side bright green, the ventral flat sides marked with three—five white stomatiferous lines; basal sheath deciduous, pale brown, 0·75 inch long. Staminate flowers in dense clusters of twenty—thirty or more, immediately below the apex of shoots of the preceding year, cylindric, obtuse, 0·5 inch long, pale yellow, surrounded at the base by eight—ten minute involucral bracts in two series. Cones pendent, 6—8 inches long, sub-cylindric, often curved, tapering to a sub-acute point; scales obovate-oblong, slightly thickened and striated towards the apex, which is tipped with a sub-quadrangular acute umbo. Seed wings three-fourths of the length of the scale, narrowly oblong, rounded on one side.

Pinus monticola, Don in Lambert's Genus Pinus, III. t. 87 (1837). Loudon, Arb. et Frut. Brit. IV. 2291, with figs. Forbes, Pinet. Woburn. 81, t. 31. Endlicher, Synops. Conif. 148. Carrière, Traité Conif. ed. II. 401. Parlatore, D. C. Prodr. XVI. 405. Hoopes, Evergreens 135. Gordon, Pinet. ed. II. 314. Engelmann in Brewer and Watson's Bot. Califor. II. 123. Lawson, Pinet. Brit. I. 69, with figs. Sargent in Garden and Forest, V. (1891), p. 1. with fig.; and Silva N. Amer. X. 26. tt. 540, 541. Beissner, Nadelholzk. 293. Masters in Journ. R. Hort. Soc. XIV. 235

P. Strobus var. monticola, Nuttall, Sylva III. 118 (1849).

P. porphyrocarpa,* Murray in Lawson's Pinet. Brit. I. 83, with figs.

* Distinguished from the typical *Pinus monticola* by its young cones being purple instead of pale green. Known only from a tree cultivated in Scotland.

Pinus monticola is spread over all the mountain ranges of western North America lying between the 36th and 50th parallels of north latitude from the Rocky Mountains to the Pacific Ocean. It attains its greatest size and is most abundant at 2,000—2,500 feet elevation around Lake Pend d'Oreille in north-west Montana; in British Columbia it is less abundant and generally mixed with other coniferous trees: on the Cascade range it ascends to 5,000 feet, and on the Californian Sierras to nearly 10,000 feet. The wood is very light, soft, close- and straight-grained, and is used for the same purposes as the White Pine of the eastern States (*P. Strobus*).*

Pinus monticola was originally discovered by David Douglas in 1831, and introduced by him shortly afterwards to the garden of the Horticultural Society at Chiswick, but in extremely restricted numbers. It was not generally distributed over Great Britain till a quarter of a century later, when a large number of plants were raised from seeds collected by Jeffrey, Lobb, Bridges and others, between 1851 and 1855. It is perfectly hardy and well suited for this country, growing most freely in the more humid climate of parts of Scotland and Ireland. Exceptionally fine specimens are to be seen in Perthshire, notably at Scone Palace (over 75 feet high), The Cairnies, Keir House, Abercairney, near Crieff; and especially in the grounds of Murthly Castle where it has been planted in considerable numbers, the tallest now over 80 feet high, but some of the trees have unfortunately become infested with a destructive fungus which has necessitated the felling of some of the finest specimens.† In Ireland there is a superb specimen at Hamwood, Co. Meath, and one of smaller dimensions at Woodstock, Kilkenny. In the drier climate of England *P. monticola* grows more slowly, but many excellent specimens bear witness to its usefulness as a lawn and park tree, notably those at Orton Hall, Peterborough; Revesby Abbey, Boston; Kenfield Hall, Canterbury; Adhurst St. Mary, Petersfield; and other places.

Pinus muricata.

A medium-sized tree of varying height, 25—50 or more feet with a slender trunk 1—2 feet in diameter covered with reddish brown, roughish bark which becomes very thick in trees protected from the sea-wind. Branches spreading, in Great Britain usually of very unequal development, irregularly ramified and often bent; branchlets mostly short with pale brown bark roughened by the scars of the fallen leaf-fascicles. Buds ovoid-conic or cylindric-conic, acute, 0·5—1 inch long, dark reddish brown, often covered with a film of resin: the perulæ lanceolate, acute and closely imbricated. Leaves geminate, persistent two—three years, semi-terete, rigid, 3·5—5 inches long, the basal half of the young leaves light yellow-green, the apical half grass-green, the whole of a uniform dark green the second year; basal sheath smooth, pale brown, 0·5 inch

* Silva of North America, XI. 24.

† James Laurie in Gard. Chron. XXIII. ser. 3 (1898), p. 244.

long; shorter, darker and lacerated the second year. Staminate flowers in an elongated spike, 3—4 inches long, oval, about 0·5 inch long, pale yellow: involucral bracts six—eight, linear-lanceolate, chestnut-brown. Cones in whorls of five—six or more at the base of the current year's shoots and persisting many years, obliquely and broadly ovoid, obtuse, 3—3·5 inches long and about 1·5 inch broad above the base, composed of very hard, enduring, closely adherent scales of which the exposed swollen apex is of rhomboidal shape with a transverse keel enlarged at the centre into a strong sharp prickle.

Pinus muricata, Don in Trans. Linn. Soc. XVIII. 441 (1836). Lambert, Genus Pinus, ed. III. t. 84. Loudon, Arb. et Frut. Brit. IV. 2269, with fig. Carrière, Traité Conif. ed. II. 413. Parlatore, D. C. Prodr. XVI. 379. Gordon, Pinet. ed. II. 246. Masters in Gard. Chron. XXI. (1884), p. 49, with figs.; and Journ. R. Hort. Soc. XIV. 235. Beissner, Nadelholzk. 213. Sargent, Garden and Forest, X. 232, with fig.; and Silva N. Amer. XI. 139, tt. 585, 586.

P. Edgariana, Hartweg in Journ. Hort. Soc. Lond. III. 217. 226 (1848).

Eng. Bishop's Pine.* Amer. Prickle-coned Pine, Obispo Pine. Germ. Bischofs Kiefer.

Pinus muricata is a maritime Pine found wild only in the vicinity of the Californian coast exposed to the fogs and winds from the Pacific Ocean. From Mendocino its northern limit and where it attains its largest size, it spreads southwards with numerous interruptions to San Luis Obispo and thence into Lower California where it finds its southern limit. South of Monterey it occurs only in clumps or copses on the parched and sandy coast of the region. It was first described by Don in the "Transactions of the Linnean Society" from specimens gathered by Coulter in the neighbourhood of Monterey in 1832; it was introduced by the Horticultural Society of London in 1846 through Hartweg who named it *P. Edgariana* in compliment to Mr. Thomas Edgar, the Treasurer of the Society on the assumption that the species was new to science and horticulture.

Not much can be said of *Pinus muricata* as a tree for the parks and landscapes of Great Britain. The oldest specimens are medium-sized or low trees with flattened tops and straggling curved or crooked branches but sparsely ramified and with the foliage clustered at the extremities of the branchlets. A peculiarity of *P. muricata* but which it possesses in common with *P. pungens*, *P. Pinaster* and a few others is the persistency of its hard prickly cones which remain on the tree for an indefinite time or so long as the branch remains uninjured, without shedding their seeds; twenty-four clusters of cones have been counted along a single branch of one of the oldest trees in England, and as many as thirty such clusters have been observed on trees in California. The wood is resinous, light and coarse-grained, and of little use except for fuel, except near its northern limit when it is occasionally used for out-of-door carpentry. The specific name, from *murex*, a sharp point or prickle, refers to the sharp spines with which the cones are armed.

* An inappropriate name, a corruption of Obispo Pine and not connected with any ecclesiastical dignitary.

Pinus palustris.

A tall tree with a trunk 50—100 or more feet high and 1·5—3 feet in diameter near the ground, covered with reddish brown bark fissured into oblong plates, and "with a massive tap-root penetrating deep into the ground and thick lateral roots spreading widely near the surface." Branches thick, spreading horizontally, sometimes attaining a length of 20 feet, but generally less even when the trees are not crowded, often gnarled or curved, and imparting to the tree an unsymmetrical habit. Branchlets stoutish, prominently marked with short-keeled, cortical outgrowths spirally arranged around them. Buds sub-conic, acute, 1·5—2 inches long; the perulæ lanceolate, acuminate, with ciliate margins, and reflexed at the apex. Leaves ternate, sometimes pseudo-geminate by the cohesion of two, persistent two—three years, 7—10 inches long, triquetrous, mucronate, with minutely serrulate margins, bright grass-green; basal sheath 1—1·25 inch long, much shortened and lacerated the second year. Staminate flowers densely clustered, cylindric, incurved, 1·5—2 inches long, rose-purple. Cones ovoid-cylindric or cylindric-conic, 6—9 inches long and 2—3 inches in diameter near the base; scales oblong, 2 inches long, reddish brown, the apophysis rhomboidal with a transverse keel and low pyramidal umbo in the centre terminating in a sharp prickle. Seeds oval, with a narrow elongated wing nearly as long as the scale.

Pinus palustris, Miller, Dict. ed. VIII. No. 14 (1768). Lambert, Genus Pinus, I. t. 20 (1803). Forbes, Pinet. Woburn. 59. t. 22. Link in Linnæa, XV. 507. Mohr in Garden and Forest, I. 261. Masters in Journ. R. Hort. Soc XIV. 236 Sargent, Silva N. Amer. XI. 151. tt. 589, 590.

P. australis, Michaux, Hist. Arb. Amer. I. 64, t. 6 (1810). Loudon, Arb. et Frut. Brit. IV. 2255, with figs. Endlicher, Synops. Conif. 165. Carrière, Traité Conif. ed II. 450 Parlatore, D. C. Prodr. XVI. 392. Gordon, Pinet, ed. II. 260.

Eng. and Amer. Long-leaved Pine. Southern Pitch Pine.

Pinus palustris is almost the sole ingredient of the immense forests stretching uninterruptedly along the Atlantic seaboard from south-east Virginia to the Everglades in Florida, and also along the northern littoral of the Gulf of Mexico as far as Trinity Valley in south Texas. This belt, known in the United States as the southern "Pine Barrens," varies from 80 to 125 miles in breadth in the Atlantic States, but is much narrower along the Gulf coast; it is estimated to have once covered upwards of 130,000 square miles, an area greater than that of Great Britain and Ireland, and to have represented an amount of wealth which if properly husbanded would have made the States of South Carolina and Georgia among the richest in the Union. But "invaded from every direction by the axe, a prey to fires which weaken the mature trees and destroy the tender saplings, wasted by the pasturage of domestic animals, and destroyed for the doubtful profits of the turpentine industry, the forests of Long-leaved Pines appear hopelessly doomed to lose their commercial importance at no distant day." *

* Silva of North America, XI. 156.

Every evening during the collecting season (in Carolina and Georgia) the sky is illumined by a dull red glare, and in the daytime the horizon is obscured by a thick veil of smoky haze. This is caused by the turpentine workers. They leave immense areas of land, robbed not only of its natural resources, but in a worse condition for cleaning and culture than before their invasion. The loss from fire is enormous: the turpentine workers are so careless and indifferent as to allow fires to run through the tracts they have worked. The resin on the scarified surface of the trees burns like kerosene; a spark, a blaze, and all at once a disastrous conflagration sweeps through the Pine forests with great fury, destroying millions of feet of marketable timber, and leaving hundreds of acres a scene of awful ruin.*

Pinus palustris is by far the most valuable Pine of the Atlantic States, and it is still the most abundant. It supplies nearly the whole of the turpentine, pitch, tar and resin of American commerce as well as for home consumption, and its timber is used for all sorts of constructive purposes, including ship-building, house carpentry, fencing, railway ties, etc. The wood is heavy, very hard, strong and durable, but somewhat coarse-grained.† The valuable Pitch Pine used in Great Britain for roofing and other constructions is obtained wholly from this tree. The tops of young saplings with their tufts of bright green foliage are used in New York and other large cities in the northern States for the decoration of churches and other buildings in winter.

It has long been noted by the inhabitants dwelling near the Pine Barrens that the cones of *Pinus palustris* are much more abundant in some seasons than in others, fruitful seasons usually occurring at intervals of three or four years: even a complete failure of the crop for several years in succession has been recorded. The seeds are eagerly devoured by birds, squirrels, and other denizens of the forest.

Pinus palustris cannot be said to have a place in the British Pinetum only under such exceptional climatic conditions as exist in Devon and Cornwall and the southern counties of Ireland. Although it has been in cultivation since 1730,‡ it is now but rarely seen in this country.

Pinus parviflora.

A low or medium-sized tree, but sometimes attaining a height of 40—50 feet towards its southern limit, the trunk covered with smooth greyish bark falling off in small thin scales, and with a pyramidal head of spreading branches. In Great Britain the oldest trees have a bluntly pyramidal head and leaden grey bark more or less corrugated by resinous blisters. Branches in close-set pseudo-whorls, long and stout in proportion to height and thickness of trunk, horizontal or slightly

* L. J. Vance in Garden and Forest, VIII. 278.
† Sargent, Woods of the United States, p. 126.
‡ Aiton, Hortus Kewensis. ed. II. Vol. V. p. 317.

ascending. Branchlets tufted, short, and covered with light brown bark, the herbaceous shoots pubescent. Buds small, ovoid, obtuse, with lanceolate, acuminate, obscurely ciliolate perulæ that are reddish brown and free at the apex. Leaves quinate, persistent three—four years, clustered on the distal half of the branchlets, slender, triquetral, 1—2 inches long, the convex side bright green, the flat sides with four—five silvery white stomatiferous lines; basal sheath reddish brown, about 0·5 inch long, deciduous. Staminate flowers not more than 0·5 inch long, in a dense cylindric spike 1—2 inches long, sub-sessile, yellowish, and surrounded at the base by four—five lanceolate, acute, involucral scales. Cones solitary or in clusters of two—three, erect, ovoid, 2—2·5 inches long, and 1—1·5 inch in diameter near the base. Scales broadly wedge-shaped with a rounded entire outer edge, at the middle of which is a slight thickening, pale reddish brown with longitudinal striations on the dorsal side, and bearing two seeds with rudimentary wings on the inner (ventral) side.

Pinus parviflora, Siebold and Zuccarini, Fl. Jap. II. 27, t. 115 (1842). Endlicher, Synops. Conif. 138 (1847). Murray, Pines and Firs of Japan, 11, with figs. Carrière, Traité Conif. ed. II. 384. Parlatore, D C. Prodr. XVI. 404. Masters in Journ. Linn. Soc. XVIII. 504; and Journ. R. Hort. Soc. XIV. 236 Syme in Gard. Chron. X. (1878), p. 624, with fig. Mayr, Abiet. Jap. Reiches, 76, t 5, fig. 19 Beissner, Nadelholzk. 280.

P. Cembra, Thunberg, Fl. Jap. 274 (not Linnæus) (1784).

Eng. Small-flowered Pine, Japanese Short-leaved Pine. Germ. Mädchen Zirbel, Kleinblütige Kiefer. Jap. Himeko-matsu.

Pinus parviflora is a native of Japan; it occurs wild in the southern islands of Kiushiu and Shiskoka in considerable numbers, and in the central island northwards to about the 38th parallel of north latitude, ascending to 5,000 feet, forming an ingredient of the mountain forests, either scattered singly or in small groves, in places mixed with Hemlock Firs and Cypresses. It is cultivated everywhere throughout Japan; when planted for decoration and left to itself, it rarely exceeds 25 feet in height, but it is more frequently used for pot culture, dwarfed to the smallest possible dimensions, and trained into all kinds of fanciful shapes. The wood is soft, straight-grained and easily worked, but not much used on account of the inaccessibility of the larger trees.

In Great Britain and the north-eastern States of America *Pinus parviflora* is one of the most ornamental of Pines; it is quite hardy and thrives generally in many situations. On account of its small size, well furnished trunk and light foliage, it is the best Pine that can be selected for a small lawn and places where the larger and more rapid-growing species are inadmissible; it flowers and cones freely in a young state, and the young shoots are sometimes so loaded with yellow staminate flowers or young purple cones as to add considerably, for the time, to its decorative effect.

Pinus parviflora was first detected by Thunberg who referred it in his "Flora Japonica" to *P. Cembra*; it became more definitely known to science in 1842 through Dr. Siebold, by whom it was specifically distinguished. *P. parviflora* was introduced to British gardens by the late John Gould Veitch in 1861.

Pinus patula.

A large tree 60—80 feet high with stout spreading branches: in old age with an irregularly branched, rounded top. In the south-west of England and the south of Ireland, a medium-sized tree 35—50 feet high, the trunk usually dividing at a short distance from the ground into two or more trunk-like stems which send out stout spreading branches 15—20 or more feet long. Bark of trunk greyish brown, rugged and irregularly fissured. Branchlets slender, at first green, changing to light reddish brown at the end of the second year; buds cylindric-conic, acute, 0·75—1 inch long, the perulæ linear-lanceolate, acuminate, fringed with silky hairs, pale chestnut-brown. Leaves persistent three—four years, usually in fascicles of three, but sometimes four—five, filiform, triquetral, 9—12 inches long, flaccid and pendulous, bright grass-green; basal sheath 1—1·25 inch long, pale brown the first year, much shorter, darker and crumpled the second year. Staminate flowers densely clustered, cylindric, obtuse, about an inch long. Cones shortly stalked, in pairs or in clusters of three—five, conic-cylindric, tapering to an obtuse apex, about 4 inches long, and 1·5 inch in diameter above the base. Scales oblong, slightly thickened at the apex, the exposed part rhomboidal with a tranverse keel and circular central depression in which is a small pyramidal umbo. Seeds small with a narrow wing an inch long.

Pinus patula, Schiede ex Schlechtendal in Linnaea, XII. 488 (1838). Loudon, Arb. et Frut. Brit. IV. 2266, with figs. Endlicher, Synops. Conif. 157. Carrière, Traité Conif. ed. II. 426. Parlatore, D. C. Prodr. XVI. 397. Gordon, Pinet. ed. II. 278. Masters in Gard. Chron. XXIII. (1885), p. 108, with figs.; and Journ. R. Hort. Soc. XIV. 286.

Pinus patula inhabits the high plateau and mountains of central Mexico at elevations ranging from 6,000 to 12,000 feet above the level of the sea; the limits of its distribution have not been ascertained. It was discovered by Schiede and Deppe about the year 1828 and probably introduced by them, as Mr. Lambert had a plant of it at his residence at Boyton in Wiltshire that was six feet high in 1837.* In the following year seeds were collected by Hartweg in the Real del Monte district for the Horticultural Society of London from which plants were raised and subsequently distributed among the Fellows.†

This fine Mexican species is one of the most ornamental of Pines; it bears a strong resemblance to *Pinus longifolia* of the Himalayan region, but unlike that species it is sufficiently hardy for the climate of Devon, Cornwall and the south of Ireland. Excellent specimens are growing at Carclew, Tregehan, Pencarrow, Lamorran, Bicton and Fota Island.

Mention may here be made of a closely allied species inhabiting the same region, of which there is a tree in the Pinetum at Bicton, probably the only one in this country.

* Loudon, Arboretum et Fruticetum Britannicum, *loc. cit. supra.*
† Transactions of the Horticultural Society of London, Vol. III. ser. 2, p. 125.

Pinus Teocote.

Schlechtendal in Linnaea, V. 76 1831 Lambert, Genus Pinus, ed. II. Vol. III. 145, t. 62. Loudon, Arb. et Frut. Brit. IV. 2266, with figs. Endlicher, Synops. Conif. 156. Gordon, Pinet. ed. II. 287.

A tall tree, said to attain a height of 80—100 feet; as seen by Pringle on the mountains of Oaxaca at 9,000 feet elevation where it forms pure forests of considerable extent, it is a slender tree of medium size.* It was discovered about the same time as *Pinus patula* by Schiede and Deppe, from whose herbarium specimens it was described and figured by Mr. Lambert who also had a living plant at Boyton at the date of the publication of Loudon's "Arboretum"; it is chiefly distinguished from *P. patula* by its much shorter leaves and smaller cones.

Pinus pentaphylla.

A tall tree, 70 80 or more feet high. Bark of trunk fissured into thin plates averaging 4—5 inches long and 2—3 inches broad, reddish brown with a whitish surface. Branches with their ramifications and also the leaves as in *Pinus parviflora* but longer and stouter. Staminate flowers shortly stipitate, sub-cylindric, about 0·4 inch long, reddish at the apex. Cones pendent, sub-sessile, sub-cylindric, slightly tapering from beyond the middle to the apex, 3—3·5 inches long and 1 inch in diameter at the broadest; scales broadly obovate or suborbicular, nearly flat with a crenulate margin and striated longitudinally, about an inch long and somewhat less broad. Seed wing rhombic, 0·75 inch long.

Pinus pentaphylla, Mayr, Abiet. Jap. Reiches, 78. t. 6. fig. 20 (1890). Sargent, For. Fl. Jap. 80. Pinus parviflora in part, of some authors.

Eng. Japanese Strobus Pine. Germ. Japanische Weymouthskiefer. Jap. Goyō-matsu.

Pinus pentaphylla, like *P. parviflora*, is endemic in Japan, taking the place of the latter north of the 38th parallel of north latitude and in Yeso, but it is nowhere abundant. It is cultivated in Japanese gardens under many names and in various forms, and often confused with *P. parviflora* to which it has much resemblance, so much, indeed, that all the earlier European botanists who visited Japan mistook it for that species. It has recently been specifically distinguished and figured by Dr. Heinrich Mayr of the Forest Department, Munich,† who has conclusively shown that it is a Strobus, not a Cembra Pine, a fact confirmed by a cone brought home by the late John Gould Veitch and still preserved in the Veitchian collection. A few seeds were introduced by Mr. Maries in 1879, and plants were subsequently distributed from the Coombe Wood nursery as *P. parviflora*, but their destination is now unknown.

* Garden and Forest. IX. 102. † Abietineen des Japanischen Reiches. *loc. cit.*

Pinus Peuke.

A low or medium-sized tree, 30–45 feet high, with a trunk rarely exceeding a foot in diameter at its greatest development; reduced to a small bush or shrub at its highest vertical limit. Branches relatively short and spreading horizontally, except the uppermost which are more or less ascending. Branches numerous, slender, the herbaceous shoots glaucous green, and destitute of leaves near the base. Buds elongate, ovoid-conic, with lanceolate, acuminate perulæ, reflexed at the tip. Leaves quinate, persistent three–four years, filiform, triquetrous with minutely serrulate margins, 3–4 inches long, dark green on the convex dorsal side, greyish on the flat, ventral sides; basal sheath 0·75 inch long, whitish brown, deciduous. Staminate flowers in dense clusters around the apical half of shoots of the preceding year, cylindric, 0·5 inch long, yellowish brown; involucral bracts relatively large, broadly ovate. Cones sub-cylindric, obtuse, 4–5 inches long; scales broadly cuneate with a small protuberance at the apex. Seeds with an oblong wing.

Pinus Peuke, Grisebach, Spicileg. Flor. Rumel. II. 349 (1844). Endlicher, Synops. Conif. 144. Carrière, Traité Conif. ed. II. 394. Gordon, Pinet. ed. II. 318. Boissier, Fl. orient. V. 698 (1884). Masters in Gard. Chron. XIX. (1883), p. 244, with figs.; Journ. Linn. Soc. XXII. 205, with fig.; and Journ. R. Hort. Soc. XIV. 237.

P. excelsa, Hooker fil in Journ. Linn. Soc. VIII. 145. Parlatore, D. C. Prodr. XVI. 405 (in part).

P. excelsa var. Peuke, Beissner, Nadelholzk. 286.

Pinus Peuke inhabits the alpine and sub-alpine regions of Macedonia and western Roumelia, at elevations ranging from 2,500 to 6,000 feet. It is a curious fact in the botanical history of this Pine that its presence in the Balkan peninsula was not known or even suspected prior to its discovery by the eminent German botanist, Grisebach,* on Mount Peristeri, near Bitolia, during his journey through the Turkish province of Roumelia in 1839. On account of its resemblance in habit to the Arolla of the Alps, *Pinus Cembra*, Grisebach at first referred it to that species, but subsequently gave it the name it now bears, which is literally the Greek πεύκη, the Pine tree. Nothing more was heard of it for many years afterwards till the well-known Erfurt seed firm of Haage and Schmidt received seeds in 1864 from a former Curator of the Botanic Garden at Athens, who had collected them in the same locality in which the tree had been originally discovered by Grisebach. Since then *P. Peuke* has been found on Mount Perindagh and on the Kom mountains, forming the eastern frontier of Montenegro.

In Great Britain *Pinus Peuke* is a useful ornamental tree; its growth is comparatively slow, but it is quite hardy over the greater part of the country; it forms a strictly pyramidal tree, clothed with bright green foliage, and taking but little room, it is especially suitable for

* Grisebach is best known to English readers as the author of "Die Vegetation der Erde nach ihrer klimatischen Anordnung," an elaborate work on geographical botany, and by far the most important of its kind at the date of publication (1872), and for some years afterwards.

lawns and places where the large-growing Pines should be excluded. In its botanical aspect *P. Peuke* is unquestionably an offshoot or geographical form of *P. excelsa*, but long since separated from the ancestral stock, if *P. excelsa* may be so regarded, by the whole region which lies between Afghanistan and Macedonia, in which no allied Pine has yet been found. Nevertheless it is so distinct in habit from *P. excelsa* that practically it may receive specific rank. Structurally all the parts and organs of *P. Peuke* nearly coincide with the same parts of *P. excelsa*, but are smaller in size; in this respect the leaves and cones are well-nigh intermediate between those of *P. excelsa* and *P. Strobus*, which *P. Peuke* in a measure connects.

Pinus Pinaster.

A large tree, attaining a height of 50—80 feet, the dimensions greatly influenced by situation, aspect and environment; the trunk covered from early age with a coarse bark deeply fissured into narrow longitudinal ridges, broken up into numerous small plates. Branches slender in proportion to trunk, spreading or ascending, the lowermost more or less depressed but usually upturned at the distal end. Branchlets much roughened with the scars of the fallen leaves, the herbaceous shoots pubescent. Buds cylindric with a conical apex, 0·75 inch long, with whitish brown reflexed perulæ fringed with woolly hairs. Leaves geminate, persistent three—four years, mostly clustered on the distal half of each year's growth, semi-terete, rigid with slightly serrulate margins and sub-acute tip, 7—9 or more inches long, on old trees frequently not more than 6 inches long, bright grass-green; basal sheath 0·5—0·75 inch long, at first whitish, much crumpled, and blackish the second year. Staminate flowers in a rather lax spike, 4—6 inches long, cylindric, obtuse, about an inch long, and surrounded at the base by three—four involucral bracts; anthers fawn-yellow with a rounded denticulate connective. Cones in whorls of four—eight, conic-cylindric, 4—6 inches long, and 1·5—2·5 inches in diameter at the broadest, more or less oblique owing to greater development on the exposed side, at first purplish, green during the period of growth, fawn-yellow when mature; scales broadly oblong, a little more than an inch long, the apophysis rhomboidal with a transverse keel and central pyramidal umbo.

Pinus Pinaster, Solander in Aiton's Hort. Kew. ed. I. Vol I. 367 (1789). Lambert. Genus Pinus. I. tt. 4, 5 (1803). London. Arb. et Frut. Brit. IV. 2213, with figs. Link in Linnaea. XV. 498. Endlicher. Synops. Conif. 168. Carrière. Traité Conif. ed. II. 465. Parlatore, D. C. Prodr. XVI. 382. Lawson, Pinet Brit. I. 71, t. 10, and figs. Beissner. Nadelholzk. 221. Masters in Journ. R. Hort. Soc. XIV. 237.

P. maritima, Lamarck, Encycl. V. 337 (1804).

P. escarena, Risso, Hist. Nat. Eur. II. 429 (1826).

P. Lemoniana, Carrière. Traité Conif. ed. II. 470 (1868).

Eng. Cluster Pine, Pinaster. Fr. Pin de Bordeaux, Pin maritime, Pin des Landes. Germ. Sternkiefer, Strandkiefer, Igelföhre. Ital. Pino raggrupato.

Several varieties of *Pinus Pinaster* are described by Loudon and other authors, of which one, **Lemoniana**, is a monstrous form that originated at Carclew in Cornwall, formerly the residence of Sir Charles Lemon. In this variety a cone is produced in the place of the leading shoot of the fertile branches, which thence take a zig-zag form, the prolongation consisting of lateral shoots only, and the cones are solitary instead of clustered.

Hamiltoni, introduced by the Earl of Aberdeen from the neighbourhood of Nice in 1825, has broader and shorter leaves and larger cones than the common form; and **minor,** found in the Landes of Bordeaux and other places, has shorter and more slender leaves and smaller cones. They are local deviations from the common type such as occur among most Pines.

Pinus Pinaster inhabits the Mediterranean region from Portugal to Palestine, but the actual limits of its distribution cannot now be defined in consequence of the extensive areas that have been planted with it for purposes of utility, and from which it has occasionally spread spontaneously. It is, however, known to grow wild in the Portuguese province of Estremadura, in Andalusia, in Algeria, on the eastern Pyrenees ascending to 2,500 feet elevation; on the Maritime Alps up to 3,000 feet, in Corsica still higher; and in other southern departments of France; it is also common on the western slopes of the Apennines, in Greece, and in parts of Asia Minor, but its eastern limit has not been ascertained.

In an economic sense *Pinus Pinaster* is by far the most valuable Pine of the Mediterranean region; its timber is, however, but a subordinate factor, the wood being soft, coarse in grain and soon decaying on exposure to the weather; it is used only for the coarser kinds of out-of-door carpentry, and for fuel in the districts where this Pine is abundant. But the collection of its resinous products, already adverted to in page 93, forms one of the most important industries in the south of France; so profitable is this source of wealth that *P. Pinaster* is extensively cultivated on the sandy tracts adjoining the Bay of Biscay, where it grows with great rapidity and soon yields an ample return for the labour bestowed upon it.

Pinus Pinaster will not only grow under exposure to the sea-breeze, but also in shifting sands which it is enabled to do by the form taken by the roots. These roots much resemble those of the American *P. palustris*, which grows under conditions similar to those in which *P. Pinaster* attains its best development in Europe. There is a decided tap-root, and when the soil is dry and sandy it descends perpendicularly into it; in proportion as the perpendicular roots are stronger than those of other Pines, the horizontal roots are weaker, a disadvantage as regards transplanting, which is more than counterbalanced by its firm hold in the soil, whence it is seldom torn up by the roots by storms. In the departments of the Gironde, Landes and Dordogne, the Pine woods afford a most efficacious protection against the encroachments of the sea. Some eighty years ago great apprehension existed of the destruction of the Medoc country by inundation, as the banks of sand, which are the only barriers against the sea, were observed to be yielding; the idea then occurred of planting *P. Pinaster* in order to bind the sand, and the result has been most satisfactory.

Introduced towards the end of the sixteenth century into Great Britain, *Pinus Pinaster* is only useful as an ornamental tree in this country, and for shelter especially in proximity to the sea. When standing alone, with the consequent free circulation of air around it, it attains a height of 60 to 70 feet, retaining its lowermost branches to a great age; the Pinaster is then a tree of stately aspect, wide-spreading and massive, very effective in park and landscape scenery.

There is probably no single species of Pine that has become more widely distributed over the globe than *Pinus Pinaster*, and which has adapted itself more readily to the various conditions of soil and climate in the different countries into which it has been introduced. At the Cape of Good Hope, it has made itself at home as much as any indigenous tree, spreading spontaneously over the sandy plains in the neighbourhood of Cape Town and in other parts of the colony. It has become quite a common tree in many parts of Australia, New Zealand, etc. It has also found its way into China, Japan, northern India, and many other places, where it has been frequently re-introduced into England as new species under the following names, which sufficiently indicate their origin:—*P. nepalensis* (Royle), *P. chinensis* (Knight), *P. japonica* (Hort.), *P. Novæ Hollandiæ* (Loddiges), *P. Novæ Zealandiæ* (Hort.), *P. Sancta Helenica* (London).

Pinus pinea.

A tree 40—80 or more feet high with a spreading head that has been frequently likened to an umbrella; the trunk knotty, covered with thick reddish grey bark deeply fissured longitudinally, the lower portion usually denuded of branches, often forked or divided into three or more ascending secondary trunks at a greater or less distance from the ground. In Great Britain rarely exceeding 25—30 feet high, with a thick trunk covered with dark rugged, deeply fissured bark, the fissures exposing a light reddish brown inner cortex and generally forked or divided into three—five or more spreading or ascending branches which ramify much in the same way. Branchlets rather slender, pale brown marked with the scars of the fallen leaves. Buds conic-cylindric, reddish brown, not resinous. Leaves geminate, persistent two—three years, semiterete with scaberulous margins, straight or slightly twisted, 5—6 inches long, bright green; basal sheath whitish, shorter, darker and much lacerated the second year. Staminate flowers in a crowded spike with numerous scale-like involucral bracts at the base of each, cylindric, about 0·5 inch long. Ovuliferous flowers oval, 0·75 inch long, composed of greenish white scales before fertilisation. Cones maturing the third year, ovoid, 4 inches long and 3 inches in diameter, reddish brown; scales oblong-cuneate, the apophysis rhomboidal with a central depression in which is a small umbo. Seeds large, oblong-ovoid with a hatchet-shaped wing.

Pinus pinea, Linnaeus, Sp. Plant. II. 1000 (1753). Miller, Dict. ed. VIII. No. 2 (1768). Lambert, Genus Pinus, I. tt. 6, 7, 8 (1803). L. C. Richard, Mém. sur les Conif. 58 (1826). Loudon, Arb. et Frut. Brit. IV. 2224, with figs. Forbes, Pinet. Woburn, 31, t. 10. Link in Linnaea, XV. 499. Carrière, Traité Conif. ed. II. 456. Parlatore, D. C. Prodr. XVI 381. Gordon, Pinet. ed. II. 252. Boissier, Fl. orient. V. 694. Beissner, Nadelholzk. 220. Masters in Gard. Chron. IV. ser. 3 (1888), p. 602, with figs.: and Journ. R. Hort. Soc. XIV. 237.

Eng. Stone Pine. Fr. Pin de parasol. Germ. Italienische Steinkiefer. Ital. Pino a pinocchi. Span. Pino real, Pino de comer.

Pinus pinea in the Royal Gardens at Kew.
(From the *Gardeners' Chronicle*.)

Pinus pinea, or the Stone Pine as it is usually called in this country on account of the hard bony shell which encloses the seed, is endemic in the Mediterranean region from Portugal to Asia Minor and Syria: also in several localities in north Africa. On the coast range of Andalusia it ascends to 4,000 feet above sea-level, but usually prefers the lower hills near the coast, in places formerly forming forests of considerable extent but which are now greatly diminished in order to supply wood for constructive purposes and for fuel to the inhabitants of the region.

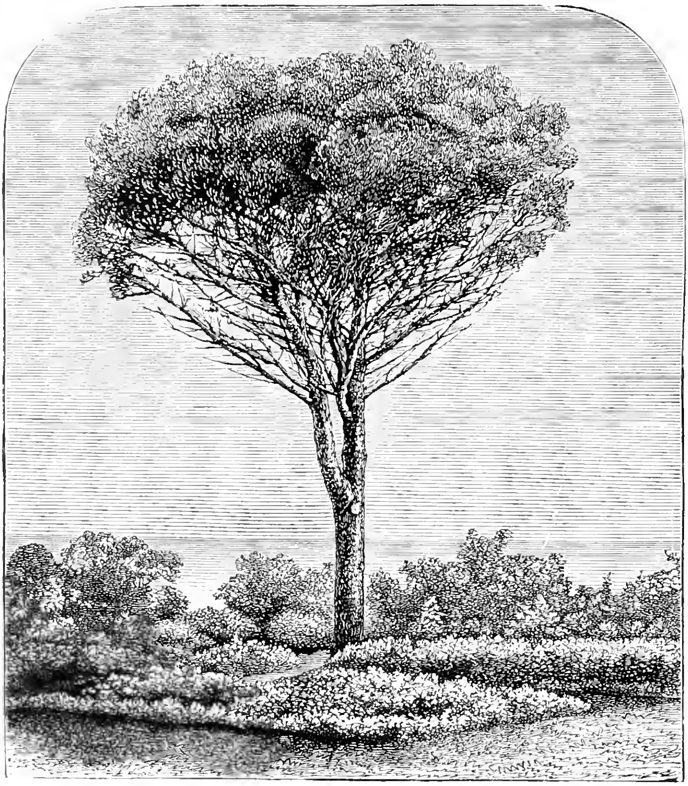


Fig. 96. The Stone Pine at Glenthorne.

As *Pinus pinea* is nowhere found wild north of the 45th parallel of north latitude its power to withstand severe cold is limited. It was introduced into Great Britain prior to 1548, as it is mentioned in Turner's "Names of Herbes" published in that year, but few aged trees are to be seen in this country; those that have survived the severe winters that occur at intervals in our climate show but imperfectly the striking characters that make this Pine so picturesque an object in southern Europe. One of the accompanying illustrations represents the largest specimen in the Royal Gardens at Kew, the other a characteristic tree 35 feet high at Glenthorne in north Devon: a still finer and taller specimen and certainly the most imposing yet seen by the author, is standing in the Trinity College Botanic Garden, Dublin: and there is one at Powerscourt, and another at Charleville in Co. Wicklow worthy of mention.

The extremely picturesque appearance of the Stone Pine in its maturity, has caused it to be much planted in public and private gardens in the south of Europe, and especially in Italy, from a very early period. In the neighbourhood of Rome are many fine and venerable specimens from 70 to 75 feet high, which always attract the attention of visitors. Artists have frequently availed themselves of its peculiar and striking form to give it a prominent place in the foreground of their pictures; and thus we often find it associated with porticos, Ionic pillars, fragments of old temples, and other classic objects in the Italian landscape.

Many varieties of *Pinus pinea* have been noted and described, but none of them are available for the British Arboretum from the same cause that renders the common form so unsatisfactory a tree. One named *fragilis* should be noticed as it differs in the testa or shell of the seeds being so thin as to be easily broken by the fingers. The edible seeds are much used for food by the peasantry throughout the region in which this tree abounds. The wood is whitish, moderately resinous, and very light; it is used in Italy and the south of France for joinery and other constructive work.

A peculiarity in *Pinus pinea*, not observed in any other species of Pinus, may be here noted:—For several years after the seedling state is passed and branchlets with adult foliage are produced, there are also produced among them slender elongated branchlets with protomorphic leaves only; these leaves are solitary, not geminate like the ordinary leaves, nor more than one-half of their length; they are without basal sheath, compressed, sharply angular laterally, and of a bluish glaucous green (*see* page 22). As the young tree advances in age, shoots are produced with protomorphic and adult leaves intermixed; but eventually the former disappear entirely.

Pinus ponderosa.

One of the largest of Pines; in California and Oregon the trunk often 100—150 feet high and 5—6 feet in diameter, exceptionally large trees 225 feet high and 8 feet in diameter; throughout the Rocky Mountains region much less. In Great Britain the trunks of the oldest trees are thick in proportion to height, with rugged bark deeply fissured into irregular plates. Branches spreading, frequently curved or tortuous; branchlets stoutish, the bark furrowed spirally, following the arrangement of the leaf fascicles. Buds sub-cylindric, abruptly tapering to an acute point, 0·75—1 inch long; perulæ linear-lanceolate, with fimbriated margins. Leaves ternate, persistent three—four years, produced on the distal half of the season's growth, and at first parallel with it, afterwards spreading and slightly twisted, 6—12 inches long, rigid, triquetral, mucronate with minutely serrulate margins, dull dark green; basal sheath about an inch long, pale brown;

darker, shorter, and much crumpled the second year. Staminate flowers in dense clusters on the apical end of shoots of the previous year, cylindric, 1·25—1·75 inch long, reddish crimson, surrounded at the base by ten—twelve involucral bracts in two—three series. Cones (British grown) ovoid-conic, 3·5—5 inches long, and 2—2·5 inches in diameter above the base; scales oblong-cuneate, about an inch long and half an inch broad, smaller and much crowded near the base, the apophysis rhomboidal with a transverse keel and short pyramidal umbo terminating in a recurved prickle. Seed wing narrowly oblong, nearly as long as the scale.

Pinus ponderosa. Douglas ex Loudon, Arb. et Frut. Brit. IV. 2243, with figs (1838). Forbes, Pinet. Woburn, 44. t. 13. Link in Linnæa, XV. 506. Endlicher, Synops Conif. 163. Carrière, Traité Conif. ed. II. 415. Parlatore, D. C. Prodr. XVI. 395. Hoopes, Evergreens, 117. Gordon, Pinet. ed. II. 281. Engelmann in Brewer and Watson's Bot. Califor. II. 125. Beissner, Nadelholzk. 261, with fig. Sargent in Garden and Forest, VII. 392; and Silva N. Amer. XI. tt. 560—564. Masters in Gard. Chron. VIII. ser. 3 (1890), p. 557, with figs; and Journ. R. Hort. Soc. XIV. 237.

P. Benthamiana, Hartweg in Journ. Hort. Soc. Lond. II. 189; and IV. 212. with fig.

P. brachyptera. Engelmann in Mem. Wislizenus' Tour in N. Mex. 89 (1848).

P. Beardsleyi. Murray in Edinb. New Phil. Journ. 1855. p. 286.

P. Engelmanni, Torrey in Pacific Ry. Rep. IV. 141 (1856) (not Carrière).

P. Parryana, Gordon. Pinet. ed. II. 277 (1875) (not Engelmann).

Eng. Heavy-wooded Pine. Amer. Yellow Pine, Bull Pine, Western Pitch Pine. Germ. Schwerholzige Kiefer. Gelb Kiefer.

var.—Jeffreyi.

Distinguished in Oregon from the typical *Pinus ponderosa* by its more pungently aromatic resinous secretions, its stiffer and more elastic leaves, persistent for a longer time; its yellow-green staminate flowers and its larger cones armed with stronger reflexed prickles: in Great Britain chiefly by its shorter branches and more strict habit, as well as by the foregoing characters.

P. ponderosa var. Jeffreyi, Engelmann in Brewer and Watson's Bot. Califor. II. 126. P. Jeffreyi. Balfour Rep. Oregon Assoc. 2, with fig. Gordon, Pinet. ed. II. 272. Lawson, Pinet. Brit. I. 45, t. 6. Masters in Journ. R. Hort. Soc. XIV. 231. And others.

var.—scopulorum.

A smaller tree (60—80 feet high) with shorter and more rigid leaves, often in pairs, and persisting a longer time; and smaller cones with thinner scales armed with a slender prickle.

P. ponderosa var. scopulorum. Engelmann in Brewer and Watson's Bot. Califor II. 126. Beissner. Nadelholzk. 263. Masters in Journ. R. Hort. Soc. XIV. 238.

The following account of the geographical distribution of *Pinus ponderosa* and the different aspects under which it is seen throughout the immense area over which it is spread, is taken from the American "Garden and Forest," Vol. VIII. p. 392:—

The western Yellow Pine or *Pinus ponderosa* is the most widely-distributed Pine tree of the mountain forests of western North America, where it spreads from the interior of British Columbia from about latitude 57° N. southwards to Mexico and eastwards to northern Nebraska, the foot-hills of the Rocky Mountains of Colorado and western Texas. Usually an inhabitant of dry elevated slopes, where it often forms open forests of great extent, it flourishes also on the western slopes of the Sierra Nevada in the comparatively humid climate of northern California where it attains its largest size; and in California it grows occasionally in wet and swampy ground. It is the only Pine tree of Nebraska, and is very abundant on the Black Hills of Dakota; in northern Montana it forms a great forest in the valley of the Flat Head Lake, and ranges westwards to the shores of Puget Sound: it dots the slopes of the eastern foot-hills of the Rocky Mountains of Colorado, and clothes the divide between the Platt and Arkansas rivers with a forest pushed far out over the plain. Abundant in similar situations in Utah, and common on the eastern slopes of the Sierras where it attains a great size and beauty. *P. ponderosa* has found the climate of the Great Basin too severe for it, and does not occur on the mountain ranges of central and southern Nevada. The Colorada plateau which has an area of many thousand square miles in southern Colorado and Utah and in northern Mexico and Arizona, is covered with a forest of this tree. This is now the greatest uninterrupted Pine forest of the continent, and one of the largest in the world. South of the Colorado plateau the desert is broken up into short ranges of mountains, and on them on both sides of the Mexican boundary *P. ponderosa* is a common tree, as it is on the mountains of western Texas.

A tree of such enormous range over a region of so many different climates has naturally developed many forms, and no other American Pine tree varies more in size and habit, in the character of the bark, length of leaves and size of cones. Sometimes it is 250 feet high, with a trunk 12 feet in diameter covered with bright cinnamon-red bark broken into great plates; sometimes it attains with a difficulty a height of 50 feet, and its bark is nearly black and deeply furrowed. Such variations in the character of the bark are not always due to climate, and individuals with the red bark of the Californian tree and the black bark of the inhabitant of the arid slopes of the Colorado mountains stand side by side in northern Arizona, to the discouragement of the botanist anxious to understand this tree and the causes of its variations. One hundred photographs would not be too many to illustrate the appearance of *Pinus ponderosa* in the different parts of the country which it inhabits; and an attempt to describe the different forms with any words at our command would be hopeless. Certain characters which botanists consider valuable specifically can be found in all the forms, so that it is most convenient to consider them all geographical varieties of one species, although in size and general appearance and in the character and value of the timber produced, they are as distinct as many of the recognised species of our Pines.

Pinus ponderosa first became known to science and arboriculture through David Douglas during his first mission to north-west America, and by whom seeds were sent to the Horticultural Society of London in 1827, from which a number of plants were raised and distributed among the Fellows.* Douglas had discovered the tree

* One of these may still be seen at Dropmore towering to a height of 90 feet; this is probably the largest specimen in this country. There is a fine tree over 60 feet high at Orton Hall, Peterborough; another about the same height but denuded of its lowermost branches at Linton Park, Maidstone; and a still larger one at Barron Hill, Anglesey. Trees of smaller dimensions are growing at Revesby Abbey, Whittinghame in East Lothian, Scone Palace, Castle Kennedy, etc.

the year previous near the Spokane river in north Oregon (now Washington). Throughout Great Britain, from Perthshire southwards, this Pine has proved quite hardy, and it thrives under various conditions in the many localities in which it has been planted, increasing in height from 12 to 18 inches annually, the slower growth occurring in the midland and south-eastern counties of England. Generally the primary branches grow faster in proportion to the elongation of the trunk in this country than in California, so that *P. ponderosa* in Great Britain rarely has the lank, constricted habit shown in photographs of Californian trees.

The variety *Jeffreyi*, hitherto regarded as specifically distinct from *Pinus ponderosa* by foresters and arboriculturists, and which takes its name from John Jeffrey, who collected seeds of it for the Scottish Oregon Association in 1851, has a considerable range on the high mountains extending from western Montana through Oregon and Idaho into California. On the mountain above the Yosemite valley is a wonderful forest of Pine trees composed of *P. ponderosa* var. *Jeffreyi*; the trees stand sometimes close together, sometimes at a considerable distance apart; they are often 250 to 300 feet high, their massive trunks 10 to 12 feet in diameter, and free of branches except near the top of the tree. There are not many things more impressive or more beautiful than these trunks; the bark is excessively thick and broken by deep fissures into great armour-like plates across which the sunlight as it flickers down through the scanty canopy above, casts long shadows. The branches are few and small in proportion to the trunks, and bear at their ends great brush-like clusters of pale blue-green foliage, and immense quantities of large chestnut-brown cones which in early autumn sometimes cover the ground under the trees.*

The variety *scopulorum* denotes the smaller tree inhabiting the Rocky Mountains from British Alberta southwards through eastern Montana, Wyoming, Nebraska and Colorado to western Texas. In this comparatively dry region *Pinus ponderosa* often becomes a stunted, scraggy-looking tree with gaunt denuded limbs and scanty foliage; such a tree is portrayed in the "Gardeners' Chronicle" of June 22nd, 1878. Another geographical form which occurs on the mountains of southern Arizona, has longer and broader leaves that are sometimes 14 or 15 inches in length. This is the *P. latifolia* of Sargent,† and the *P. Mayriana* of Sudworth; it is described in the "Silva of North America" as *P. ponderosa* var. *Mayriana*.

The wood of *Pinus ponderosa* varies greatly in quality, strength and durability in different parts of the region over which it is distributed; the wood of the western tree is heavy, hard, strong and fine-grained, but not durable in contact with the soil; that of the variety *Jeffreyi* is coarser in grain and very resinous; and that of the var. *scopulorum* is coarser grained, harder and more brittle.† *P. ponderosa* timber is largely used throughout the region for constructive purposes generally, railway ties, fencing, fuel, etc., especially in the States of Washington, Oregon, Idaho and south Dakota.

* Garden and Forest, IV. 457 (1891); *Idem*, II. 496, with fig. (1889).
† Silva of North America, XI. 82.

Pinus pungens.

A medium-sized or low tree 25—40 or more feet high, with stout, horizontal branches and a broad, open, flat-topped head. In Great Britain much resembling the Scots Pine in its young state, but when old more open and spreading. Bark of trunk deeply fissured into irregular plates. Branches of very unequal length, the longest sometimes exceeding 20 feet. Branchlets slender, ridged and furrowed by cortical outgrowths, obliquely decurrent from the pulvini of the leaf fascicles. Buds cylindric, obtuse, about 0·75 inch long, light chestnut-brown, usually covered with a film of whitish resin. Leaves geminate, persistent three—four years, rigid, straight or slightly curved towards the axis, 1·75—2·5 inches long, dark dull green on the convex side, with about six greyish lines on the flat side; basal sheath short with numerous rings and lacerated margin.* Staminate flowers in a lax spike, cylindric, obtuse, about 0·3 inch long, orange-brown, surrounded at the base by seven—nine involucral bracts. Cones ovoid or turbinate, usually in whorls of three—five, horizontal, most developed on the exposed upper side, 3·5 inches long, and 2·25 inches in diameter at the broadest part, persistent on the tree many years; scales oblong-cuneate, with a broadly pyramidal apophysis terminating in a sharp incurved prickle.

Pinus pungens, Michaux, Hist. Arb. Amer. I. 61, t. 5 (1810). Lambert, Genus Pinus, ed. II. Vol. I. t. 17 (1828). Loudon, Arb. et Frut. Brit. IV. 2197, with figs. Forbes, Pinet. Woburn, 17, t. 5. Endlicher, Synops. Conif. 166. Carrière, Traité Conif. ed. II. 470. Parlatore, D. C. Prodr. XVI. 379. Hoopes, Evergreens, 98. Gordon, Pinet. ed. II. 254. Beissner, Nadelholzk. 214, with fig. Masters in Journ. R. Hort. Soc. XIV. 23. Sargent, Silva N. Amer. XI. 135, t. 584.

Eng. and Amer. Table Mountain Pine, Hickory Pine. Germ. Stechende Kiefer.

Pinus pungens inhabits chiefly the Appalachian mountains of the Eastern States. From its southern limit in North Carolina it spreads northwards along the dry slopes and ridges of the mountains through Virginia into Pennsylvania as far as the Schuylkil river and westwards into Tennessee, forming in places extensive forests. Small isolated patches are also reported from distant parts of Virginia, eastern Pennsylvania, and Rosemount in New Jersey.

On the precipices, impending rocks and chasms of the Linville, a branch of the Catawba river in North Carolina, *Pinus pungens* darkens the whole horizon and presents an imposing mass of monotonous verdure. It generally occupies the summits of the highest rocky ridges and sweeps over the most dangerous and inaccessible declivities, some of which are at least 1,000 feet in perpendicular height. In this picturesque region it was originally discovered by Michaux more than a century ago.

The economic value of *Pinus pungens* is unimportant: the wood is light, soft, coarse-grained and not strong, and is used in America chiefly for the manufacture of charcoal. It was introduced into Great Britain about the year 1804; it is now but rarely seen; the few old trees that still remain are unattractive objects of irregular outline and mostly one-sided from contact with other trees.

* The above description from materials communicated by Mr. Marcus Dimsdale from Essendon House, near Hatfield; in the grounds stands one of the largest *Pinus pungens* in the country. Other aged specimens are in the Pineta at Bicton, Dropmore and Bayfordbury.

Pinus pyrenaica.

A tree of variable dimensions, the trunk 60—80 or more feet high with an open diffuse head; smaller trees with a more dense habit. Branches spreading, often curved or tortuous, covered with ash-brown bark; branchlets slender, at first green, afterwards reddish brown, and marked with the scars of the fallen leaves. Buds ovoid-conic, acute, about 0·5 inch long with whitish perulæ. Leaves geminate, persistent about three years, slender, semi-terete with slightly scaberulous margins, 4·5—6·5 inches long; basal sheath whitish, 0·75 inch long, shorter, and darker the second year. Staminate flowers numerous in an oblong spike, cylindric, obtuse, 0·5 inch long, the anthers with an orange-yellow, orbicular and crenulate connective. Cones solitary or in clusters of two—six, sub-sessile, horizontal, ovoid-conic, acute, about 3 inches long and nearly 2 inches in diameter at the broadest part, glossy chestnut-brown; apophysis of scales flattish, rhomboidal with a shallow transverse keel and short pyramidal umbo.*

Pinus pyrenaica., Lapeyrouse. Plant. pyren. 146: and Suppl. 63 (1813). Loudon, Arb. et Frut. Brit. IV. 2209 (in part). Endlicher. Synops. Conif. 180. Carrière, Traité Conif. ed. II. 503. Parlatore, D. C. Prodr. XVI. 384. Beissner, Nadelholzk. 225. Masters in Gard. Chron. IV. ser. 3 (1888), p. 267. with fig.; and Journ R Hort. Soc. XIV. 238.

P. Brutia. Tenore. Fl. neap. V. 266. t 200 1835. Lambert, Genus Pinus. III. 125. t. 82. Loudon. Arb. et Frut Brit. IV. 2234. with figs. Link in Linnæa, XV. 497. Gordon. Pinet ed II. 132. Boissier, Fl. orient. V. 696.

P. carica, Don. Ann. Nat. Hist. VIII. 158.

P. Loiseleuriana. Carrière. Traité Conif. ed. II. 500.

P parolinana, Webb. P. hispanica, Cook-Widdrington.

The geographical range of *Pinus pyrenaica* may be stated in general terms to extend through the Mediterranean region from the Pyrenees to the Levant and Asia Minor whence it spreads eastwards through northern Persia into Afghanistan as far as Herat.† It occurs on many of the mountain ranges throughout this region at altitudes of 2,000 to 6,000 feet; in the more densely inhabited parts of the Mediterranean littoral it is seen only in groups or groves separated by a considerable interval from each other; on the lower slopes of the Cilician Taurus it forms extensive forests for the most part unmixed with other trees.

This Pine was first specifically distinguished under its present name by the French botanist Lapeyrouse who detected it on the Spanish slopes of the Pyrenees in the first decade of the nineteenth century. Some years later it was discovered on the mountains of Calabria in southern Italy by Professor Tenore of Naples who described it in his "Flora neapolitana" under the name of *P. brutia*, he being probably unaware of its identity with the Pyrenean Pine of Lapeyrouse. It was introduced into British gardens in 1834 by Mr. Aylmer Lambert under Tenore's name; and about the same period a variety of *P. Laricio*, described in page 339 as *P. Laricio monspeliensis*, was introduced from Spain by Captain Widdrington and distributed as

* The above description of foliage and cones from materials communicated by the late M. Charles Naudin from the Villa Thuret Botanic garden, Antibes.

† Boissier, Flora orientalis, *loc. cit. supra.*

P. pyrenaica: this *P. Laricio* variety, being much the hardier of the two, has since its introduction been generally cultivated as *P. pyrenaica* in the British Arboretum. Parlatore reduced the *P. brutia* of Tenore to a synonym of the *P. pyrenaica* of Lapeyrouse, and his decision

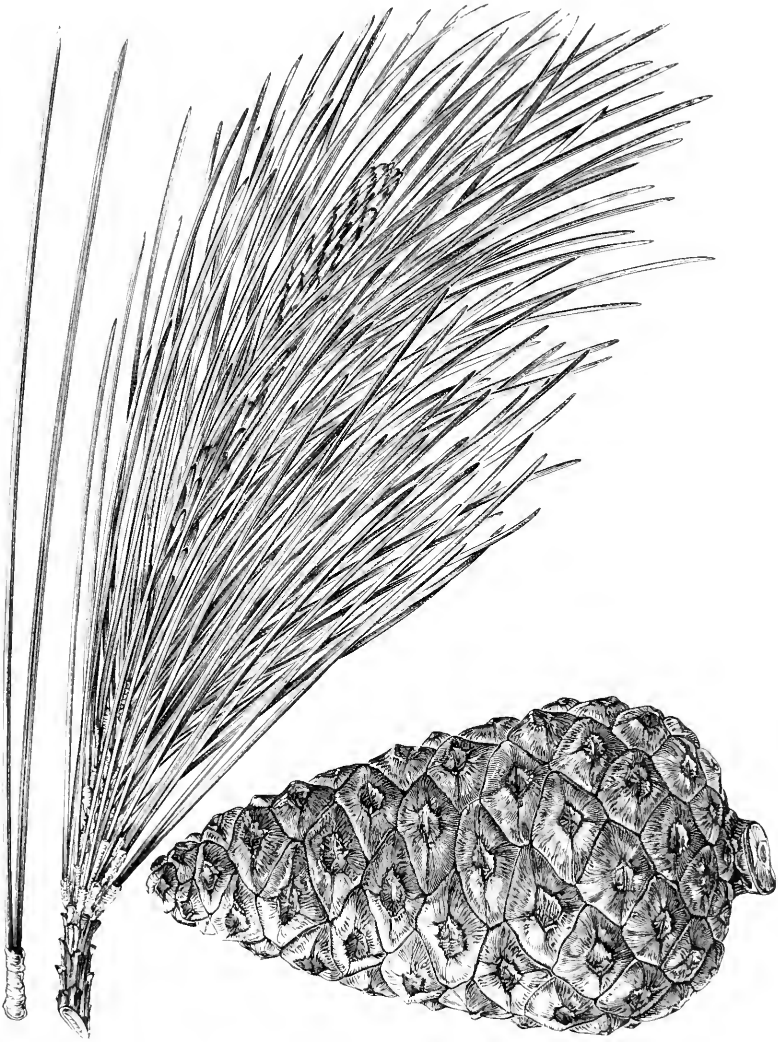


Fig. 97. Foliage and Cone of *Pinus pyrenaica*.

is accepted by all recent botanists. The true *P. pyrenaica* owing to climatic causes is now but rarely if ever seen in this country.

The economic value of *Pinus pyrenaica* is considerable in those districts where it is still abundant as in Cilicia and adjacent parts of Asia Minor. To the inhabitants of this region it supplies the best timber for building and many other constructive purposes, but as the forests are under no kind of supervision or control by the government of the country, the trees are felled in a most reckless manner and with a deplorable waste of material. Still greater destruction is caused by the turpentine collectors who mutilate and render useless every tree they attack.*

Pinus radiata.

A stately tree 80—100 feet high with a trunk 4—5 feet in diameter, covered with thickish bark deeply fissured into broad ridges which are "broken on the surface into thick plate-like scales, and with thick spreading branches which form an open round-topped head." In Great Britain a fast-growing tree of broadly pyramidal outline up to forty or fifty years of age, according to locality and situation, when the leader ceases to ascend and the tree becomes flat-topped by the greater development of the uppermost branches. Branches thick and spreading; branchlets in whorls of three—five, reddish brown marked with the scars of the fallen leaf fascicles. Buds narrowly cylindric, abruptly pointed, 0·25—0·5 inch long, with ovate, acute, chestnut-brown perulæ. Leaves ternate, persistent three—four years, triquetral with slightly scabrous margins, 4—6 inches long, stomatiferous on all sides; basal sheath about one-third of an inch long, loose and scarious. Staminate flowers cylindric, obtuse, 0·5 inch long, spirally arranged in a dense spike, fawn-yellow with a reddish tinge at the apex, and surrounded at the base by fifteen—twenty involucral bracts in two series. Cones in clusters of two—three together or solitary, shortly stalked, deflexed, unsymmetrically ovoid, sub-acute, 3—5 inches long and 2—3 inches broad at the widest part, the scales largely developed and projecting prominently outwards on the upper exposed side, smaller and only slightly convex or nearly flat and mammillate on the under-side. Seed wing three-fourths as long as the scale, oblong, obliquely narrowed at the apex.

Pinus radiata, Don in Trans. Linn. Soc. XVII. 442 (1836). Lambert, Genus Pinus, III. 86. Endlicher, Synops. Conif. 161. Carrière, Traité Conif. ed. I. 337. Sargent, Silva N. Amer. XI. 103, tt. 573, 574.

P. insignis, Loudon, Arb. et Frut. Brit. IV. 2266, with figs. (1838). Forbes, Pinet. Woburn, 51, t. 18. Carrière, Traité Conif. ed. II. 440. Parlatore, D. C. Prodr. XVI. 395. Lawson, Pinet. Brit. I. 37. tt. 1, 5. Gordon, Pinet. ed. II. 270. Engelmann in Brewer and Watson's Bot. Califor. II. 127. Coleman in The Garden XXXVI. (1889), p. 47, with fig. Beissner, Nadelholzk. 271. Masters in Gard. Chron. IX. ser. 3 (1891), p. 337, with fig.; and Journ. R. Hort. Soc. XIV. 230.

Eng. and Amer. Monterey Pine. Germ. Monterey Kiefer.

Pinus radiata inhabits a strip of coast-land in south California extending for about 150 miles from Pescadero to San Simeon Bay, spreading inland only a few miles. "It also grows in a peculiar form on Santa Rosa and Santa Cruz of the Santa Barbara group of islets off the coast of south California, and in Guadalupe off the coast of Lower California. The wood is light, soft and brittle, and is used only for fuel."†

* Walter Siehe in Gartenflora (1897), p. 181, who adds: "Sahe ein deutscher Forstmann diese planlosen, nur auf momentanen Gewinn zielenden Verwüstungen, das Herz würde ihm bluten."

† Silva of North America, XI. 104.

This beautiful Pine is supposed to have been discovered in 1787 during the ill-fated voyage of Lapeyrouse: a cone gathered by Colligon, a gardener who accompanied the expedition, was sent to the Muséum d'Histoire Naturelle at Paris, and twelve plants were raised from the seeds. These plants were described by Loiseleur† in 1812 under the

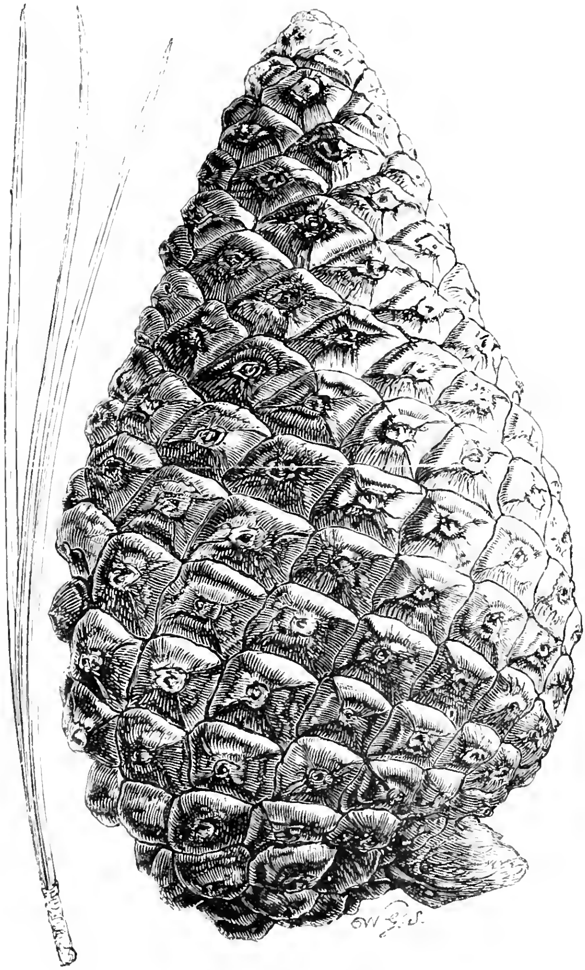


Fig. 98. *Pinus radiata.*

name of *Pinus californica*, which is therefore the oldest name, but as they subsequently disappeared, much doubt is involved in the identification and Loiseleur's name is thence passed over. Douglas re-discovered the Pine during his sojourn at Monterey in 1831–1832, and cones were received from him by the Horticultural Society of

His name is commemorated by the monotypic genus Loiseleuria, founded for the reception of a little alpine and sub-arctic ericaceous shrub, *L. procumbens*, that is also wild in Scotland, but now become extremely rare.

London under the name of *P. insignis*, which remained an herbarium name only till it was taken up by London in his "Arboretum et Fruticetum Britannicum," published in 1838. In the meantime Dr. Thomas Coulter had brought home specimens which were described by David Don as *P. radiata* in a paper read before the Linnean Society in June, 1835, and published in the Transactions of the Society in the following year. Don's name therefore has priority of publication, and it has, moreover, been in use occasionally ever since.

The value of *Pinus radiata* as a subject for British arboriculture is restricted to the area which may be roughly defined to be that part of England south of the Thames and west of the Severn, Ireland generally, and the south-western counties of Scotland. Within this area it is one of the stateliest and most ornamental of all Pines; beyond it, it is liable to be injured by severe frosts, and is often killed by them. Trees from 60 to 70 feet high are not uncommon in Devon and Cornwall and in Ireland, but the "leader" of the older trees has, in most instances, ceased to ascend, and in consequence they are becoming round- or flat-topped, and the lowermost branches are becoming effete or have been cast off altogether.* *P. radiata* is liable to the attacks of the Pine-beetle, *Myelophilus piniperda*, the effects of which are generally counteracted by the luxuriant growth of the tree.

Pinus radiata is much cultivated in Australia and New Zealand, where its growth is still more rapid than in Great Britain. In south California it is planted for fixing the sand dunes.

Pinus resinosa.

A tall tree 60—100 or more feet high, with a trunk 2—2·5 feet in diameter near the base, covered with red bark often split into irregular patches 1—3 inches in diameter. Branches stout, more or less pendulous; in old age confined to the top of the tree, forming a round-topped head. Branchlets stout and glabrous, with pale orange-brown bark. Buds conic, acute, 0·5—0·75 inch long, pale chestnut-brown. Leaves geminate, persistent three years, somewhat close-set, 4·5—5·5 inches long, slender, semi-terete, with slightly scabrous margins, mostly inclined towards the shoot, at first glaucous green, becoming darker with age; basal sheath greyish brown, about an inch long, much shorter, darker and lacerated after the first year. Staminate flowers in short, dense clusters, sub-cylindric, 0·5—0·75 inch long, pale brown tinged with dull rose-purple, and surrounded at the base by about six involucral bracts. Cones ovoid-conic, obtuse, about 2·5 inches long, and 1·25 inch in diameter above the base; scales broadly oblong, 0·75 inch long, with a rather thin rhomboidal apophysis marked with a transverse keel and unarmed central umbo. Seeds small with an oblong wing obliquely rounded at the apex.

* Among the many fine specimens of *Pinus radiata* to be seen within the area mentioned above, mention may be made of those at the Royal residence, Osborne, Isle of Wight; Boconnoc, Carclew and Menabilly in Cornwall; at Bodorgan in Anglesea; at Eastnor Castle, Herefordshire; Monk Coniston, Lancashire; and Bowood Park, Wiltshire. In Ireland at Powerscourt and Charleville, Co. Wicklow; St. Anne's, Clontarf; Hamwood, Co. Meath; Fota Island near Cork; Adare Manor, Limerick, etc.

Pinus resinosa. Solander in Aiton's Hort. Kew. ed. I. Vol. III. 367 (1789). Lambert. Genus Pinus. I. t. 14 (1803). Loudon. Arb. et Frut. Brit. IV. 2210. with figs. Forbes. Pinet. Woburn, 19. t. 6. Link in Linnæa. XV. 501. Endlicher. Synops. Conif. 178. Parlatore. D. C. Prodr. XVI. 388. Gordon. Pinet. ed. II. 256. Hoopes. Evergreens. 102. Beissner. Nadelholzk. 246. Macoun. Cat. Canad. Plants. 165. Masters in Journ. R. Hort. Soc. XIV. 238.

P. rubra. Michaux. Hist. Arb. N. Amer. I. 45. t. 1 (1810). Carrière. Traité Conif. ed. II. 496.

Eng. and Amer. Red Pine. Canadian Pine. Fr. Pin rouge d'Amérique. Germ. Rothkiefer. Harzige Kiefer. Ital. Pino rosso di Canada.

A useful timber tree throughout the region over which it is distributed, which may be defined as a broad zone stretching across the North American continent between the 41st and 48th parallels of north latitude from Newfoundland to the prairie lands of Minnesota, forming scattered groves rarely exceeding a few acres in extent and attaining its greatest development in northern Wisconsin. Many such groves of *Pinus resinosa* have now been cleared or much reduced by lumbermen, or by forest fires along the southern side of the lakes, and its place is being taken by the comparatively worthless *P. Banksiana*. The timber is very durable, the abundant secretions acting like paint in preserving it from decay: the old roots and knobs of this Pine, which are of great weight and completely saturated with resin, burn fiercely, give a brilliant light, and are much used for torches.

Pinus resinosa was introduced into Great Britain about the year 1756 by Hugh, Duke of Northumberland, but it has nowhere adapted itself to the climate of this country, and few, if any, adult trees are now to be seen. In the neighbourhood of the great North American lakes it thrives best in a dry sandy soil, a circumstance suggestive of the places in which a trial of it might be made in England. Botanically the nearest European affinity of the species is *P. Laricio*.

Pinus rigida.

A tree of medium size, with a trunk 40–70 feet high and 2–3 feet in diameter, covered with thick blackish bark deeply fissured into square or oblong plates. Branches of young trees regularly whorled and horizontal, of old trees variable in size and direction, horizontal, deflexed or tortuous. Branchlets at first green, changing with age to dull orange-brown. Buds ovate-conic, acute, 0·5–0·75 inch long, emitting a pleasant lemon fragrance when bruised, the perulæ linear-lanceolate with fringed margins, chestnut-brown, often covered with a film of whitish resin. Leaves ternate, on vigorous shoots sometimes quaternate, persistent three–four years, triquetrous, mucronate with serrulate margins, 2·5–4 inches long, rigid, spreading, grass-green, occasionally glaucous; basal sheath light brown, 0·5 inch long, shorter, darker and corrugated the second year. Staminate flowers in crowded spikes, cylindric, obtuse, 0·75–1 inch long, the anther connective reniform, reddish purple. Cones ovoid-conic, solitary or in clusters of three–four, 2·5–3 inches long, and 1·25–1·75 inch in diameter above the base, light orange-brown:* scales oblong-cuneate, the apophysis rhomboidal with a transverse keel and short pyramidal umbo terminating in a short, sharp prickle.

Pinus rigida, Miller, Dict. ed. VIII. No. 10 (1768). Lambert, Genus Pinus. I. tt. 18, 19 (1803). Michaux, Hist. Arb. Amer. 89, t. 8 (1810). London, Arb. et Frut. Brit. IV. 2239, with figs. Forbes, Pinet. Woburn. 41, t. 13. Link in Linnaea, XV. 504. Carrière, Traité Conif. ed. II. 447. Parlatore, D. C. Prodr. XVI. 394. Hoopes, Evergreens, 119. Sargent, Garden and Forest, IV. 397; and Silva N. Amer. XI. 115, t. 579. Beissner, Nadelholzk. 266, with fig. Masters in Journ. R. Hort. Soc. XIV. 239. And others.

Eng. and Amer. Pitch Pine. Fr. Pin resineux. Germ. Pechkiefer, Steifekiefer.

var.—serotina.

Leaves longer, on strong shoots occasionally in fascicles of four—five: staminate flowers larger, cones more elongated, often remaining closed for several years.

P. rigida serotina, Engelmann, Trans. St. Louis Acad. IV. 183. Hoopes, Evergreens, 120. Beissner, Nadelholzk. 269. P. serotina, Michaux, Hist. Arb. Amer. 86 t. 7. Sargent, Silva N. Amer. XI. 119, t. 580.

Pinus rigida is common along the valley of the river St. John, New Brunswick, to the northern shores of Lake Ontario whence it spreads southwards through the Atlantic States to Georgia and Florida with a westerly extension into West Virginia and Kentucky, growing generally in dry sandy soil, or less frequently in damp cold swamps: it is abundant on the Atlantic coast south of Boston, forming extensive forests in New Jersey and on the Delaware peninsula. As a timber tree *P. rigida* is almost worthless: the wood is coarse-grained, knotty and mostly of small scantling, and is used chiefly for fuel and for the manufacture of charcoal, although formerly much used in New England for building purposes before a cheaper means of transport rendered the more valuable timber of the southern Pines available. Its fuel value is, however, unsurpassed by any tree in the northern forest, and thousands of acres of poor sterile lands in the north-eastern States on which no other tree can exist, have been covered with it at a comparatively trifling cost.†

At least three distinct species of Pinus are called Pitch Pines in North America, the western, *P. ponderosa*, the southern, *P. palustris*, and the northern, *P. rigida*, the subject of the present notice which is also known as the Pitch Pine in Great Britain. In the last named case the vernacular name is misleading; the resinous products of *P. rigida* formerly furnished quantities of turpentine and tar of some commercial importance before the richer and superior supply of the southern Pine Barrens were worked; and the valuable timber used in this country as Pitch Pine is obtained not from *P. rigida* but from *P. palustris*.

* The variability in the size and shape of the cones of *Pinus rigida* is very great. Mr. Thomas Meehan, of Philadelphia, once gathered a series of these cones in the neighbourhood of Hammongton, New Jersey: some were four inches long and almost round, others four inches long and not two inches wide: some were flat at the base and would stand almost upright, others were rounded and would roll over like marbles: some were not more than an inch long and yet bore perfect seeds; some had very narrow scales, others very broad ones.—American Association for the Advancement of Science, 1883.

† Garden and Forest, IV. 397.

The date of the introduction of *Pinus rigida* into Great Britain is not definitely known. According to Aiton* it was introduced prior to 1759 when it was known to be in cultivation at Woburn Abbey. It is now not often met with in the adult state south of the Trent as it is greatly surpassed as an ornamental tree by Pines of subsequent introduction; in the northern counties and in Scotland it is more frequent and better adapted to the climate.

Old trees of *Pinus rigida* attract attention by the numerous small branchlets growing from the trunk and lower part of the primary branches. On the trunk these branchlets are usually produced on the side exposed to the sun; the longest are but a few inches in length and branched, whilst the shortest appear like tufts of leaves issuing from the crevices of the bark; the leaves themselves are shorter and thinner than the normal size. The production of adventitious growths in this manner on *P. rigida* is a common occurrence in North America especially after a forest fire has destroyed all the normal foliage. Carrière records a similar appearance of fascicles of staminate flowers on the trunk of an old Pitch Pine issuing directly from the bark without a trace of foliage.

The variety *serotina* takes the place of the species in the extreme south of its habitat, spreading from Carolina southwards into northern Florida; in this region it is called the Pond Pine from its being always found growing in swampy places or on the banks of streams periodically inundated.

Pinus Sabiniana.

A medium-sized tree 40—50 feet high with the trunk almost always divided at a greater or less distance from the ground into two, three or more secondary trunks, which (in Great Britain) again divide in a similar manner, these secondary divisions usually very irregularly branched towards the summit and forming a rounded head; rarely with a single erect trunk 70—80 feet high and 3—4 feet in diameter. Bark of trunk and primary branches greyish brown fissured into irregular plates, the inner cortex exposed by the fissures, cinnamon-brown. Branchlets stoutish, strongly furrowed and roughened by the scars of the fallen leaves and the cortical ridges decurrent from them. Buds cylindric, abruptly acute, 0·75—1 inch long, the perulæ lanceolate, acuminate, imbricated, pale reddish brown. Leaves ternate, persistent two—three years, produced in loose clusters along the apical half of each year's growth, filiform, pendent, 9—12 inches long, triquetral, compressed, greyish green; basal sheath 1—1·5 inch long, at first pale brown, shortened, corrugated and blackish the second year. Staminate flowers in clusters of fifteen—twenty, cylindric, obtuse, about an inch long, and surrounded at the base by ten—twelve involucral bracts in three series. Cones on stout reflexed peduncles, ovoid-obtuse, 7—9 inches long and 5—6 inches in diameter at the broadest, pale orange-brown when mature, very resinous, and remaining on the tree several years; scales hard, ligneous, 2 inches long and 1·5 inch broad, with a projecting pyramidal apophysis compressed laterally, the umbo elongated into a strong point frequently curved like a hook. Seeds 0·75 inch long and 0·4 inch broad, with an obliquely rounded wing at the apex.

* Hortus Kewensis, ed. II. Vol. V. p. 387.

Pinus Sabiniana, Douglas, MS. ex Comp. Bot. Mag. II. 150 (1836). Lambert, Genus Pinus, ed. II. Vol. II. 146, t. 80. Loudon, Arb. et Frut. Brit. IV. 2246, with figs. Link in Linnaea, XV. 509. Endlicher, Synops. Conif. 159. Forbes, Pinet. Woburn. 63, tt. 23, 24. Van Houtte, Flore des Serres, IX. p. 275, t. 964. Lawson, Pinet. Brit , I. 85, t. 11. Engelmann in Brewer and Watson's Bot. Califor. II. 127. Hoopes, Evergreens. 121. Carrière. Traité Conif. ed. II. 435. Parlatore, D. C. Prodr. XVI. 391. Gordon, Pinet. ed. II. 284. Beissner, Nadelholzk. 256. Masters in Gard. Chron. IV. ser. 3 (1888), p. 14, with fig.; and Journ. R. Hort. Soc. XIV. 239 Sargent, Silva N. Amer. XI. 95, tt. 569, 570.

Eng. Nut Pine. Amer Digger Pine, Bull Pine. Germ. Nusskiefer. Weisskiefer. Ital. Pino noce.

Pinus Sabiniana inhabits the foot-hills of California both of the coast range and of the Sierra Nevada almost throughout the entire length of the State from north to south, ascending in places on the latter to 4,000 feet above the level of the sea, but usually much lower. It is so unlike any other Pine in habit and aspect that even amidst the luxuriant coniferous vegetation of California it forms a distinct feature of the landscape, appearing in the distance more like an Olive tree or a Willow than a Pine; its loose and widely-branched habit and its thin grey pendulous foliage tufted at the ends of its crooked straggling branches render the tree so pervious to light that it affords no shade, but at the same time clothes it with pale colouring so distinct, that in the distance this Pine can be easily recognised amidst the darker surroundings. As it occurs along the torrid foot-hills throughout the coast range, it is one of the first of the true Pines met with by the traveller ascending the mountains from the west: it springs up here and there singly or in groups, never forming forests of itself, usually mixed with an undergrowth of shrubby Oaks (*Quercus Douglasii*) and Ceanothus, but sometimes in sterile, rough rocky places where nothing else grows.*

The economic value of *Pinus Sabiniana* is unimportant; the wood is light, very soft and cross-grained; it soon decays on exposure to the weather, but it is one of the best of firewoods; the tree yields excellent turpentine, but its most useful product is the large seeds of a nutty flavour which are much eaten by the Indians. The seeds, however, are not much relished by the whites, and their economic value as an article of food will doubtless cease with the extinction of the race of red men that now consumes them.

Pinus Sabiniana was discovered by David Douglas during his first exploration in California in 1826, but his specimens were unfortunately lost in crossing a stream on his return northwards. Cones and seeds were received from him in 1832 by the Horticultural Society of London, and plants were subsequently distributed among the Fellows under the name it now bears, which Douglas had given it in compliment to Mr. Joseph Sabine, at that time secretary of the Society and the author of many of the papers published in the earlier Transactions of the Society. In Great Britain this Pine has proved fairly hardy: in the west and south-west of England, where it has in places attained a considerable size, it possesses many of the peculiar

* Muir in Harper's Magazine ex Gardeners' Chronicle. *loc. cit.*

characteristics described above, which render it a decidedly picturesque tree for the park and landscape, and for contrast with other trees it is unrivalled among Pines.*

The present condition of *Pinus Sabiniana* is highly suggestive of its past history and future destiny. Living in a climate singularly favourable for arborescent vegetation, and amidst an environment of lofty coniferous trees from 200 to 300 feet high, it fails, with rare exceptions, to develop a single ascending stem like its congeners: at an early stage in its life its principal axis is forked or divided into three or four ascending stems which seldom attain one-fourth of the height of the species associated with it; its foliage is unusually sparse and lithe, and its large cones are almost of fossil-like consistency. All these characteristics seem to point, on the one hand, to an ancestry that must have originated in times antedating the first appearance of that of most existing Pines, and on the other hand, to a state of decadence foreshadowing its extinction.

Pinus Strobus.

A tall or medium-sized tree according to situation and environment: heights of 80—100 feet attained under favourable circumstances are frequent, 125—150 feet exceptional. In Great Britain trees 75—90 feet high are occasionally seen, but the average height in this country rarely ranges above 60—70 feet. Trunk tapering, 3—4 feet in diameter near the base, covered with greyish bark, smooth on young trees, rugged and fissured on old ones. Branches in pseudo-whorls, the lowermost disappearing as the tree advances in age, so that old trees are usually free of branches for two-thirds or more of their height, and often have a broad, rounded top. Branchlets slender, in whorls of three—five, ash-grey; buds sub-conic, acute, 0·25—0·5 inch long, the perulæ ovate-lanceolate, narrowed into long, slender tips, chestnut-brown. Leaves quinate, persistent two—three years, slender, almost filiform, triquetral with serrulate margins, 3—4 inches long, bluish green at a distance, green on the convex side, marked with silvery stomatiferous lines on the flat sides; basal sheath short and deciduous. Staminate flowers in rather lax spikes more than an inch long, ellipsoid, about 0·4 inch long, yellow stained with pinkish purple, and surrounded at the base by eleven—thirteen involucral bracts in three series. Cones pendulous, shortly pedunculate, cylindric, tapering to an obtuse apex, slightly curved, 5—6 inches long and 1—1·25 inch in diameter; scales obovate-oblong, with a small pointed umbo at the apex, pale brown on the exposed side.

Pinus Strobus, Linnaeus, Sp. Plant. II. 1001 (1753). Miller, Dict. ed. VIII. No. 13 (1768). Lambert, Genus Pinus. I. 31. t. 22 (1803). L. C. Richard, Mém. sur les Conif. 60. Michaux, Hist. Arb. Amer. I. 103. t. 10. Loudon, Arb. et Frut. Brit. IV. 2280, with figs. Hooker, W. Fl. Bor. Amer. II. 161 (exclu. syn. P. monticola). Endlicher, Synops. Conif. 146. Carrière, Traité Conif. ed. II. 398. Parlatore, D. C. Prodr. XVI. 105. Hoopes, Evergreens, 136, with fig. Gordon, Pinet. ed. II. 322. Beissner, Nadelholzk. 288, with fig. Masters in Journ. R. Hort. Soc. XIV. 240. Sargent, Silva N. Amer. XI. 17. tt. 538, 539. And many others.

Eng. Weymouth Pine. Amer. White Pine. Germ. Strobe, Weymouths-Kiefer.

* The largest specimens seen by the author are at Ledbury Park and Eastnor Castle, Herefordshire; Highnam Court and Tortworth Court, Gloucestershire; Pampesford Hall, Cambridge; Orton Hall, Peterborough; and in the Royal Gardens at Kew.

var.—nana.

A small, compact, bushy shrub with short slender branches and numerous branchlets. The leaves are shorter than those of the species, and densely clustered at the extremities of the branchlets.

Other varieties named respectively—*aurea, compacta, fastigiata, nivea, pumila, variegata* and *viridis*, have been in cultivation, but are now rarely, if ever, met with in British gardens.

The greater part of the area of distribution of *Pinus Strobus* on the North American continent lies between the 40th and 50th parallels of north latitude. From Newfoundland, where it is common, it spreads westwards along the northern shore of the St. Lawrence and the great lakes to Lake Nepigon and the River Winnipeg, and through the northern States to Illinois and Iowa. South of the 40th parallel it follows chiefly the trend of the Alleghany mountains through eastern Kentucky and Tennessee into Georgia. It attains its largest size in the valley of the St. Lawrence and adjacent New England States; both at its northern and southern limits it is a smaller tree, less valuable and less abundant.

Pinus Strobus is one of the most important of the North American timber trees, and great numbers are felled every year and sent to Europe under the name of White Pine. It is still abundant in parts of the New England States and Canada, although rapidly diminishing in quantity in consequence of the great demand for its timber; with the view of counteracting the diminishing supply, successful attempts to cultivate it on a large scale have been already made in the northern States, which may lead to further operations of the same kind. So highly is the White Pine held in estimation in New England, that it was made the central figure on the seal and arms of the State of Maine; it is also one of the most valuable trees of Canada and forms an important article of its commerce, and as such finds its way into every carpentering establishment in Great Britain. The wood is light, soft, straight-grained, but not strong, easily worked and susceptible of receiving a beautiful polish.*

The White Pine was first cultivated in Great Britain by the Duchess of Beaufort at Badminton in 1705, and shortly afterwards great numbers were planted by Lord Weymouth on his estate at Longleat in Wiltshire whence this species received the name of Weymouth Pine. The Longleat plantations succeeded so satisfactorily that seeds were subsequently distributed among nurserymen and others throughout the country. The principal use of *Pinus Strobus* in this country is for the decoration of the park and landscape, for mixing with other trees in the formation of belts and screens, and occasionally for forestial purposes; its rate of growth in ordinary soils is from 12 to 15 feet in ten years. The timber of British-grown Weymouth Pine is reported satisfactory but less valuable than that received from America, a circumstance doubtless due to climatic causes.

In the north-eastern States of America *Pinus Strobus* is the best of all Pines for ornamental planting, "impervious to the cold of the Canadian

* Silva of North America, XI. 19.

winter and the burning sun and dry winds of Kansas, the White Pine flourishes also as no other exotic Conifer flourishes in central Europe; and in the gardens of northern Italy it is as beautiful as in the forests of Michigan and Minnesota."*

The specific name *Strobus*, appears to have been taken by Linnaeus from Pliny, who mentions a tree called Strobus, indigenous to Carmania, a province of ancient Persia, where it was sought after for fumigating or incense. It is not known what tree this was.

Pinus sylvestris.

A tree of variable dimensions, according to locality and environment; in favourable situations attaining a height of 80—100 feet with a trunk 2—4 feet in diameter, usually free of branches for two-thirds or more of the height and with a narrowly pyramidal head, but in old age with a rather broad rounded top. Bark of trunk smooth or but slightly roughened, and with a reddish tinge especially along the upper portion, but rugged and irregularly fissured in old age. Branches in pseudo-whorls of three—six, usually horizontal, the lowermost sometimes depressed or even sub-pendulous, whilst those near the top are ascending. Branchlets at first green, changing to reddish brown at the end of the second year. Buds conic-cylindric, acute, 0·25—0·5 inch long, pale chestnut-brown, usually covered with a film of whitish resin; the perulæ lanceolate, acuminate, and minutely ciliolate. Leaves geminate, persistent three—four years, inserted on spirally arranged cortical pulvini, rigid and straight, but often curved or twisted, 1·5 to 3 inches long, semi-terete with a callous tip, at first bluish or glaucous green, changing with age to dull dark green; basal sheath about one-third of an inch long, wrinkled and blackish. Staminate flowers in dense clusters near the end of branchlets of the preceding year, ovoid-cylindric, about 0·25 inch long, sulphur-yellow. Cones ovoid, 2—3 inches long and 1—1·25 inch in diameter above the base; scales narrowly oblong, terminating in a rhomboidal thickening on the dorsal side, with a transverse keel and short pyramidal umbo.†

Pinus sylvestris, Linnaeus, Sp. Plant. II. 1000 (1753). Lambert, Genus Pinus, I. 1, t. 1. (1803). L. C. Richard, Mém. sur les Conif. 55 (1826). Loudon, Arb. et Frut. Brit. IV. 2153, with figs. (1838). Link in Linnaea, XV. 484 (1841). Endlicher, Synops. Conif. 171 (1847). Carrière, Traité Conif. ed. II. 480. Parlatore, D. C. Prodr. 385. Willkomm, Forstl. Fl. ed. II 193. Gordon, Pinet. ed. II. 257. Beissner, Nadelholzk. 225, with figs. Sowerby, Eng. Bot. VI. (1866), p. 264. Hooker fil, Fl. Brit. Isles, ed. III. p. 380. Masters in Journ. R. Hort. Soc. XIV. 240. And many others.

Eng. Scots Pine,‡ Scotch Fir, Wild Pine. Fr. Pin de Genéve, Pin de Riga, Pin silvestre. Germ. Gemeine Kiefer, Föhre, Kienbaum, and others. Span. Pino albar. Probably the πίτυς ἄγρια of Theophrastus.

The varieties of *Pinus sylvestris* are exceedingly numerous; they admit of being arranged into two groups—local or geographical, and those that have originated under cultivation. As scarcely any of these varieties possess any special interest for British forestry and arboriculture, the briefest mention of them in this place must suffice; fuller descriptions of them are given in Willkomm's "Forstliche Flora" and Beissner's "Handbuch der Nadelholzkunde."

* Garden and Forest, X. 160.

† The apophysis of the seed scale of *Pinus sylvestris* is very variable in form in the different regions over which it is spread.

‡ The name used by Sir Walter Scott and since taken up in Scotland generally.

Geographical Varieties.

argentea, a taller tree than the common form, found on the Caucasian mountains and bearing cones with a silver-white tint: *engadensis*, a much-branched small tree, common in Lapland: *erythranthera*, a variety with red staminate flowers occurring in Prussia and Saxony: *nevadensis*, a southern form with broader, shorter and stiffer leaves, inhabiting the Sierra Nevada in Spain: *reflexa*, a smaller tree with an irregular head, growing in marshy valleys among the Swiss Alps and the lowlands of southern Germany: *virgata*, an irregularly-branched tree with twiggy branchlets found on the Oberforst Wandsburg in Prussia, and a few other places.

Garden Varieties.

The most distinct of these have been named *aurea*, *columnaris*, *compacta fastigiata*, *compressa*, *nana*, *pendula*, *pyramidalis*, *variegata*, names sufficiently indicative of their most obvious characteristic. The most useful of these varieties for British gardens is **aurea**, a low tree of dense habit, with the young leaves of a golden yellow colour which changes to the normal green in the second year.

The Scots Pine has a greater geographical distribution than any other Pine, or even of any other species included in the Abietineæ. With the exception of the southern portion of the Balkan peninsula it is spread over the whole of Europe, including the British Islands, and in Asia it occurs throughout nearly the whole of that part of the continent comprised within the Russian dominions. Its western limit is the Sierra Nevada in Spain, whence it ranges eastwards across the continent to the Stanovoi mountains in eastern Siberia, and to the Amur region. It reaches its highest latitude in Europe at about the 70th parallel on the north-west coast of Norway; eastwards of this its northern limit lies near the Arctic Circle, but sinking below the 64th parallel in eastern Siberia: its southern limit in Europe follows very nearly the trend of the mountain systems stretching eastwards from the Sierra Nevada to the Caucasian mountains, and in Asia the mountains of Turkestan and the Altai range to the Amur littoral. Throughout this great region the Scots Pine is very irregularly distributed: as it is a tree of the plain as well as of the mountain, its spread in the lowlands has been greatly influenced by climate and soil, and within historic times by the pressure of population: it forms forests of considerable extent in the flat sandy plains of north-east Germany, also in Finland, Russia and Poland; in Siberia it is more scattered and often mixed with *Picea obovata* and *Abies sibirica*. On the mountains the vertical range of *Pinus sylvestris* varies with the latitude of the localities; in northern Norway it ascends only to about 700 feet above sea-level: on the mountains of central Germany its highest vertical limit is 2,000—2,500 feet on the French Vosges about 4,000 feet, on the Swiss Alps 5,500—6,000 feet, and on the Sierra Nevada of southern Spain 6,500 feet.

The wild Pine of Scotland has been exhaustively studied in its forestial aspect by the Scottish forestry authorities, from whose publications the following interesting particulars have been gleaned:—

Although native, and with evidence that the greater part of Scotland, north of the Grampians, was covered with the wild Pine at no very remote period, forests of indigenous Firs are at the present time few and far between. The chief remaining ones are to be found about the heads of the valleys of the Dee in Aberdeenshire and of the Spey in Inverness-shire; whilst another, equally beautiful but perhaps not so well known, lies on the shores of Loch Rannoch, one of the tributary lochs of the Tay in Perthshire. The latter, from its sombre appearance, is called by the natives the Black Wood. It lies on the south side of Loch Rannoch, and extends along the shores of the loch for about 2½ miles, with an average breadth of about 1 mile; this is about the extent of the dense part of the wood, but including the outlying parts, the length is nearly 7 miles and the greatest breadth 5 miles. In altitude above the sea level the wood lies between 700 and 1,500 feet. There is another remarkable natural forest of Scots Pine at Ballochbuie, on the Braes of Mar, which has now become the property of Her Majesty the Queen, and thus a guarantee is afforded that it will be permanently preserved as a worthy remnant of those magnificent Pine forests with which the Highland glens and mountains were once so widely clothed.

In these forests, specimens of the Scots Pine are to be found which have attained large dimensions. Some of them measure 12 and 13 feet in circumference near the ground, with a height of over 80 feet; many of them are between three and four hundred years old. The trunks are comparatively smooth, and generally straight and free of branches for a considerable part of the height. If in healthy growth, the bark is of a reddish colour on the upper portion of the trunk, and this reddening is usually a sign that the locality is favourable to their development. The quality of the timber of the Scots Pine is very much influenced by the nature of the soil and situation upon which it is grown, as well as by the age at which the tree is cut. The close-grained, highly resinous timber produced upon cold, high-lying districts in the north of Scotland, is found, when of mature age, to be superior to that imported from any part of Europe; whilst that which has been planted in the lowlands of Scotland, as well as in the rather rich soils in many parts of England, is not nearly so good although of the same age.

The technical uses to which the timber of the Scots Pine is applied are almost endless, no sort of wood being so generally used for almost all kinds of purposes to which timber is applied. The wood of young trees felled for thinning is used for cases for dry goods, cooperage, and rough fencing; that of full-grown trees for house building, out-of-door carpentry, railway ties, piles, hydraulic works, street paving, etc.* Among the minor products that were formerly, and are probably still utilised in places are the resinous juices from which tar and pitch are prepared and also turpentine used in house painting. In Lapland and northern Russia the bark is used for covering huts and many other purposes.

The Scots Pine, from its hardy constitution and rapid growth, is

* The Forester, by James Brown, ed. VI, Vol. I. p. 255.

a useful tree for forming screens, and as a nurse for more tender trees. As a tree for planting in poor, dry soils and in exposed situations it is equalled only by the Larch; when planted as a screen for shelter it is best mixed with the common Spruce and the hardier, rapid-growing deciduous trees. Its rate of growth in the climate of London, according to Loudon, is from 20 to 25 feet in ten years, and from 40 to 50 feet in twenty years.

Pinus Tæda.

A tree 80—100 feet high with a cylindric or scarcely tapering trunk about 2 feet in diameter, "in wet ground occasionally 175 feet high with a trunk 5 feet in diameter and free of limbs to nearly half the height." Bark reddish brown irregularly fissured into broad, flat ridges. Branches spreading or ascending, in old trees irregularly developed and forming a wide-spreading or broadly round-topped crown. Branchlets slender, covered with reddish brown bark which, on the younger shoots, is paler and obliquely ridged and furrowed by cortical outgrowths. Buds cylindric-conic, 0·5—0·75 inch long, chestnut-brown, the perulæ lanceolate, acuminate, and fringed with whitish hairs. Leaves ternate, persistent two—three years, trigonal, mucronate with serrulate margins, 3·5—5 inches long, grass-green on the convex side, marked with eight—ten or more whitish stomatiferous lines on the two ventral faces; basal sheath about an inch long, much shorter and lacerated the second year. Staminate flowers crowded in short spikes, cylindric, incurved, about an inch long, surrounded at the base by twelve—fifteen involucral bracts, the anthers with an orbicular connective. Cones usually in pairs or clusters of three, ovoid cylindric, 3—5 inches long and 1—2 inches in diameter; scales narrowly oblong, the apophysis rhomboidal with a transverse keel and small sub-pyramidal umbo armed with a hard, short prickle.

Pinus Tæda. Linnaeus. Sp. Plant. II. 1000 1753 exclu. hab. Canada. Miller. Dict. ed. VIII. No. 11 1768. Lambert, Genus Pinus, I. 23. tt. 16, 17. Michaux, Hist. Arb. Amer. I 97. t. 9. Loudon. Arb. et Frut. Brit. IV. 2237, with figs. Forbes. Pinet. Woburn, 43. t. 14. Endlicher. Synops. Conif. 164 Carrière, Traité Conif. ed. II. 448. Parlatore. D. C. Prodr. XVI. 393. Hoopes. Evergreens, 122. Gordon. Pinet. ed. II. 286. Beissner. Nadelholzk. 265. Masters in Journ. R. Hort. Soc. XIV. 241. Sargent. Silva N. Amer. XI. 111. tt. 577, 578. And many others.

Eng. Torch Pine. Frankincense Pine. Amer. Old Field Pine, Loblolly Pine. Fr. Pin à Encens. Germ. Weihrauch-Kiefer. Ital. Pino a flaccole.

Pinus Tæda is one of the most widely distributed of the Pines inhabiting the Atlantic States of North America. It spreads from Delaware southwards to Florida and through the Gulf States to Texas. Except in the northern portion of its range where it prefers the low lands adjacent to the Atlantic coast, it takes the place of the southern Pitch Pine, *P. palustris*, inland spreading westwards through South Carolina and Georgia to the Mississippi river. West of the great river, the area covered by it is less extensive, but in western Louisiana and eastern Texas it forms considerable forests, and in Arkansas and the Indian territory it is the most important timber tree of the country.

In the warm climate of the south-eastern States, *Pinus Tæda* is a rapid-growing tree: it springs up in abundance on lands exhausted by cultivation whence it has obtained the name of the Old Field Pine, and in a short time affords a supply of timber and wood for fuel. The wood varies much in quality in the different regions in which it is grown; the proportion of sap- to heart-wood is greater than in most Pines, and the latter is for the most part coarse-grained and not durable. The resinous products are inferior to those of *P. palustris*, and are not much worked commercially.

This Pine was introduced by Bishop Compton in 1713. Although it does not refuse to grow in this country, it is of little value for the British Pinetum. Several large trees are mentioned by London that were growing in his time in the Royal Gardens at Kew, at Syon House, Dropmore, and other places: those in the two first-named places have long since perished, more from the deleterious influence of the London smoke than from any other cause. The largest trees in England known to the author are at Bicton and Tortworth Court.

Pinus Thunbergi.

A large tree often attaining a height of 80–90 feet, and in exceptional situations even 120 feet with a trunk 2–3 feet in diameter covered with greyish brown deeply fissured bark and usually with a broad head of stout contorted sub-pendulous branches. Branchlets stoutish, in whorls of three—five with pale reddish brown bark, the younger leafy shoots whitish brown. Buds ovoid-cylindric, suddenly contracted to a sharp point, greyish white, 0·35–0·75 inch long; perulæ linear-lanceolate acuminate, fringed with relatively long silky hairs. Leaves geminate, persistent about three years, rigid, straight, mucronate, 2·75—4 inches long, serrulate at the edges, dull greyish green; basal sheath whitish, 0·5 inch long, contracted and much lacerated the second year. Staminate flowers densely spicate, cylindric, about an inch long, yellowish and often curved; stamens closely imbricated, with short filaments dilated at the apex into an orbicular, irregularly crenulated connective. Cones ovoid-conic, 2 inches long and 1 inch in diameter, pale reddish brown; scales oblong, the apophysis rhomboidal with a transverse keel depressed at the centre.

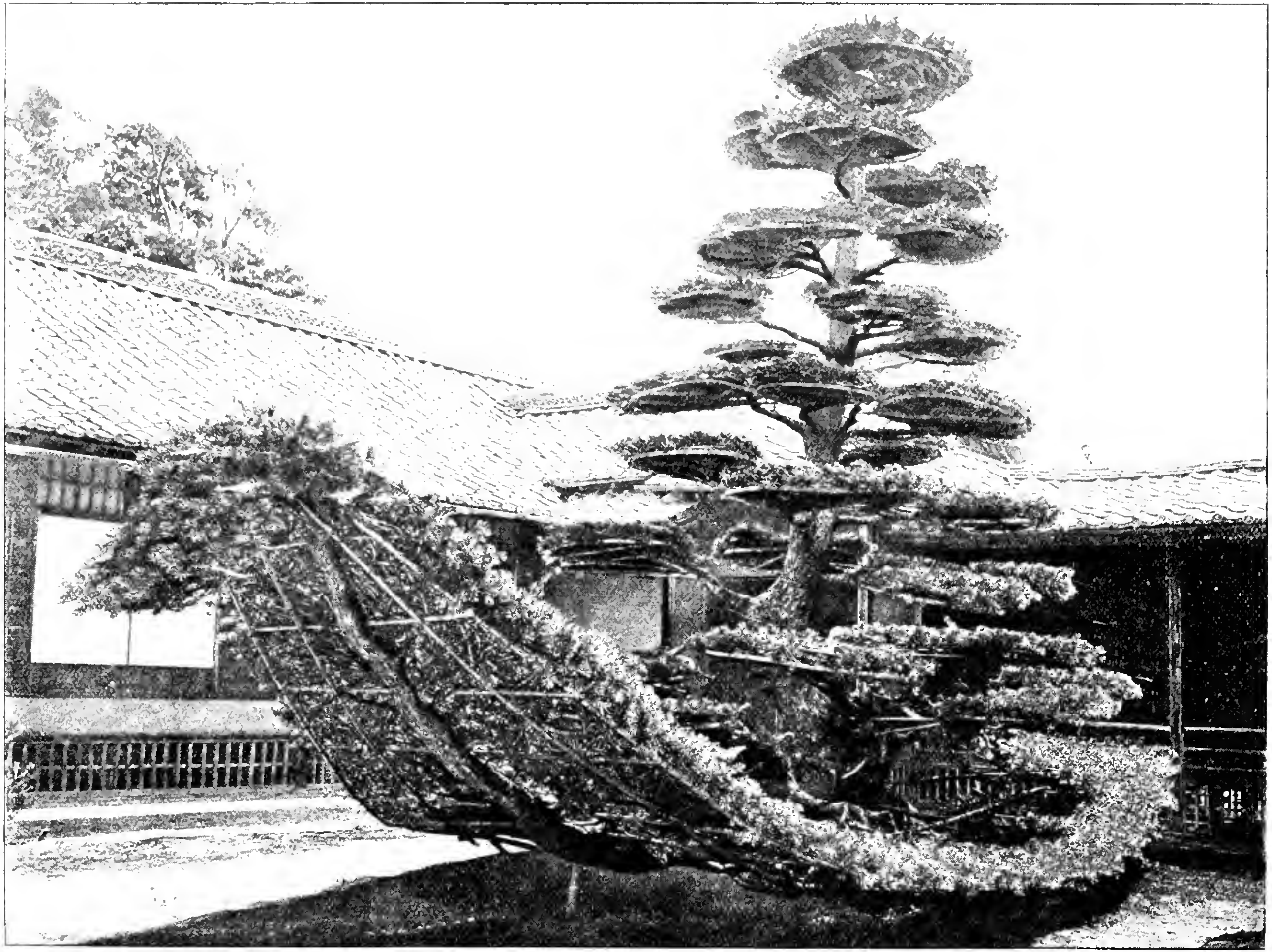
Pinus Thunbergi, Parlatore, D. C. Prodr. XVI. 381 (1868). Franchet et Savetier, Enum. Plant. Jap. I. 461 (1875). Engelmann, Revision Genus Pinus, 22 (1880). Masters in Journ. Linn. Soc. XVIII. 504; and Journ. R. Hort. Soc. XIV. 241. Mayr, Abiet. des Jap. Reiches, 69, t. 5, fig. 16. Beissner, Nadelholzk. 248.

P. Massoniana, Endlicher, Synops. Conif. 174 (1847), not Lambert. Siebold and Zuccarini, Fl. Jap. II. 24, tt. 113, 114. Carrière, Traité Conif. ed. II. 487. Murray, Pines and Firs of Japan, 23, with figs. Gordon, Pinet. ed. II. 241.

P. sylvestris, Thunberg, Fl. Jap. 274 (not Linnæus).

Eng. Japanese Black Pine. Germ. Japanische Schwarzkiefer. Jap. Kuro-matzu.

Although very common throughout Japan except in the northern island of Yeso, no recent botanical traveller in that country has, with certainty, seen *Pinus Thunbergi* growing wild. That it is indigenous to Japan admits of but little doubt, and it may also be assumed to be a native of Corea where it was seen by Mr. James H. Veitch in two or three localities apparently wild; its geographical range may thence be more extensive than was originally supposed.



A trained Pine Tree in the garden of the monastery at Kinkakuja, Japan.

Pinus Thunbergi is planted everywhere throughout Japan and for every conceivable purpose, for it will grow in the poorest as well as in the best soils; it is used as a shelter tree on the sea-coast for the protection of the cultivated lands against the high winds blowing from the ocean; for the fixation of sand dunes in the same way as *P. Pinaster* is used in the French Landes; it is planted in avenues along the public highways for hundreds of miles, often in conjunction with *P. densiflora*; it is also planted on exhausted lands unfit for other crops for the sake of its wood which supplies the fuel of many of the poorer inhabitants. But it is in its relation to horticulture and to the social and religious life of the Japanese that *P. Thunbergi* associated with *P. densiflora* is seen in its most interesting aspects, for it is found in every garden, in every temple enclosure and in every cemetery. As Siebold remarked long ago—"the art of the Japanese gardener has exhausted itself in the cultivation of these Pines; they are clipped and cut in all manner of ways; the branches are spread out like a fan upon horizontal espaliers to give them the form of a flat table. In this artificial cultivation, extremes meet, surprise is equally sought to be gained by specimens of immense extent as by others reduced to the smallest possible dimensions."* During Dr. Siebold's stay at Osaka he went to see the celebrated Pine in front of the Naniwaja Tea-house, of which the branches artificially extended have a circuit of 135 paces. Another remarkable specimen was seen by Mr. Maries in 1878 and fifteen years later by Mr. James H. Veitch in the village of Karasaki about three miles from Lake Biwa-Ko; it is one of the most curious Pines in Japan; the height is about 50 feet, the circumference of the trunk at the base is 20 feet, but at a few feet from the ground owing to trifurcation it is 37 feet; the spread of branches from east to west is 240 feet, and from north to south 288 feet; the principal branches are held up by numerous supports both of wood and stone; old wounds caused by time and decay have been stopped by plaster, and over one particularly bad spot a small roof has been erected.

But more extraordinary still is the Pine trained in the form of a junk, standing in the garden attached to the monastery at Kinkakuja; its present shape is, according to the resident priests, the result of over three centuries of patient labour. The trunk forms the mast, and two opposite branches springing from it at a few inches from the ground have been made the basis on which the structure of the hull has been worked out; this is 35 feet in length and somewhat exceeds the height of the tree. The remaining branches of the trunk are bare from 12 to 18 inches from their base, and the branchlets beyond have been trained in continuous spirals so that the youngest shoots with their foliage now rest upon thick layers of twisted, interlaced, stiffened wood, the accumulated training of a long series of years.†

Pinus Thunbergi was introduced into Europe by Siebold in 1855, and into Great Britain with *P. densiflora* by the late John Gould Veitch in 1861. Unfortunately it was distributed both by Siebold

* Flora Japonica, Vol. II. p. 26.

† Whether this marvellous instance of oriental patience is *Pinus Thunbergi* or *P. densiflora* is somewhat uncertain; the more slender and flexible branchlets of the latter would seem to lend themselves to this kind of training with greater facility than the stouter, stiffer shoots of *P. Thunbergi*.

and from the Veitchian nursery under the name of *P. Massoniana* in the belief that it was the Pine of that name described and figured by Lambert in the "Genus Pinus," which is a different species common on and near the coast of southern China and not sufficiently hardy for the British climate.* In the drier climate of Great Britain *P. Thunbergi* grows somewhat slowly, but it is hardy and sufficiently distinct from the European and American species to be a useful tree for the park and landscape, and for planting near the sea-coast. It commemorates one of the earliest pioneers of botanical explorations in distant lands.

CARL PETER THUNBERG (1743—1828) was the son of a clergyman at Jonköping in Sweden, and in early life a pupil of Linnaeus at the university of Upsal where he graduated in 1770, and won the Kohrean pension for three years which enabled him to visit Paris and the Dutch universities. In 1771 he obtained an appointment as surgeon to one of the Dutch East India Company's vessels, in which he sailed from Amsterdam to the Dutch colonial possessions. He landed at the Cape of Good Hope where he stayed two winters, making several excursions into the interior for the purpose of collecting plants and other objects of natural history, whence his name became associated with the Cape Flora. He then sailed for Java where, including a voyage to Japan, he remained five years collecting a large number of plants previously unknown to European botanists. In Japan he stayed at Jeddo (Tokio) for about two months, and while there and at Nagasaki collected such materials as were within his reach, from which he afterwards compiled a "Flora Japonica" published in 1784. He returned to his native country in 1779, making first a short stay in England, where he became acquainted with Sir Joseph Banks, Dr. Solander and other eminent botanists of that period. During his absence he had been appointed Demonstrator of Botany in the University of Upsal, and in 1784 he succeeded Linnaeus as Professor. Besides the "Flora Japonica," he compiled several other botanical works now become obsolete, but among them some "Observations on the Flora of Japan" published in the second volume of the "Transactions of the Linnean Society of London" will always be regarded with a kindly interest by British botanists.

Pinus tuberculata.

"A tree usually about 20 feet high with a trunk a foot in diameter, but occasionally 80—100 feet with a trunk 2·5 feet in thickness, and frequently divided above the middle into two ascending main stems. Branches comparatively slender, and while the tree is young in regular remote whorls forming a compact or open pyramidal head which, in old age, becomes a round-topped straggling head of sparse, thin foliage."† Branchlets slender, orange-brown; buds ovoid-cylindric, about half-an-inch long, with ovate-lanceolate chestnut-brown perulæ. Leaves ternate, persistent three—four years, slender, 4—6 inches long, triquetral, convex on the dorsal, distinctly keeled on the ventral side, greyish green: basal sheath short and much corrugated. Staminate flowers in elongated spikes, cylindric, 0·5 inch long, with orange-brown anthers, and surrounded at the base by six involucral bracts. Cones in clusters of three—five, elongate-conic, oblique at the base, rounded at the apex, 4—6 inches long and 1·75—2·5 inches in diameter at the broadest: scales more developed on the exposed upper side than beneath, the apophysis with a transverse keel and central umbo

* It has been extensively used for afforesting the bare hills and uplands of Hongkong.
† Silva of North America, XI. 107.

terminating in a strong, sharp prickle; on the under side of the cone much smaller, flat, and with a small prickle in the centre.

Pinus tuberculata, Gordon in Journ. Hort. Soc. Lond. IV. 218, with fig.;* and Pinet. ed. II. 288. Lawson, Pinet. Brit. I. 93, t. 13. Carrière, Traité Conif. ed. II. 441 (in part). Parlatore, D. C. Prodr. XVI. 394 (in part). Engelmann in Brewer and Watson's Bot. Califor. II. 128. Masters in Gard. Chron. XXIV. (1885), p. 786, with fig.; and Journ. R. Hort. Soc. XIV. 241. Beissner, Nadelholzk. 270.

P. attenuata, Lemmon and Sargent. Silva N. Amer. XI. 107. tt. 575, 576.

Amer. Knob-cone Pine. Germ. Hocker-Kiefer.

Pinus tuberculata inhabits the dry southern and western slopes, fully exposed to the sun, of the mountain ranges which, under various names, extend from south-west Oregon, its northern limit, to the San Bernardino mountains in south California. In some places it forms pure forests of considerable extent; in others it is more scattered and mixed with other trees; its vertical range is from 1,000 to 5,000 feet above sea-level. The wood is soft, brittle, and cross-grained, and but little used. It was introduced by the Horticultural Society of London, in 1847, through their collector Hartweg, who was probably the discoverer of it: seeds have since been occasionally received from different parts of its habitat, but its unsuitableness for the British climate has long been apparent, and it is only in dry, sheltered localities, comparatively few in number, that it can be said to have grown satisfactorily.

Pinus tuberculata is singular among Pines in bearing cones when only a few feet high, and which remain on the tree for thirty to forty years, often becoming imbedded in the bark, and not opening till the tree dies from local causes or is destroyed by a forest fire. *P. tuberculata* also has the peculiarity of producing its cones on the main trunk as well as on the branches, giving it a singular appearance, as they are arranged around the stem in almost a circle, usually five though often seven cones composing the circle. Sometimes two or three circles of these cones are closely crowded together, overlapping each other as they hang down; they are very compact, and covered with a resinous coating which insures them against cracking, a good provision for the preservation of the seed which is never shed till the tree has been felled. In forests where this Pine is abundant it has been noticed that the trees are all of the same age, which can only be accounted for by the simultaneous shedding of the seed.

LARIX.

Salisbury in Trans. Linn. Soc. VIII. 313 (1805). Regel in Gartenfl. XX. 91 (1871). Bentham and Hooker, Gen. Plant. III. 442 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 75. (1887). Masters in Journ. Linn. Soc. XXX. 31 (1893).

If we regard the Larches in respect of their foliage only, they form a very natural genus. The deciduous leaves of herbaceous texture and of a soft pleasing green when first developed, clearly

* Parlatore quotes Don (Trans. Linn. Soc. XVII. 442) as the author of the species. Don gives a description of a cone only, which is not that of *P. tuberculata* but *P. radiata* apparently somewhat abnormal.

distinguish them from all other coniferous trees, and on this ground chiefly the genus Larix has been adopted by most recent authors. Every other character, except the anatomical structure of the wood, is possessed in a greater or less degree in common with one or other of the genera included in the Abietineæ. In the crowded fascicles of leaves produced on short arrested branchlets, the Larches agree with the Cedars; the cones of Larix combine the persistent scales of those of a Picea with the erect or assurgent position of those of an Abies; and the staminate flowers conform very nearly to those of a Tsuga.

The essential characters of Larix in respect of the reproductive organs may be thus formulated:—

> Flowers monœcious. Staminate flowers sessile along branchlets of the preceding year, and surrounded at the base by numerous reflexed involucral bracts, globose or ovoid, composed of numerous stamens with short footstalks spirally arranged around a central axis. Anthers two-celled, with a sharply pointed connective; dehiscence longitudinal.
>
> Ovuliferous flowers sub-globose on the ends of very short lateral branchlets (sub-sessile), and consisting of numerous suborbicular scales bearing nearly at the base of the ventral face two inverted ovules, and attached to the highly-coloured dorsal face, a linear bract, often much longer than the scale and at first separable from it.
>
> Cones ovoid, rarely cylindric, obtuse; scales loosely imbricated, persistent, and bearing on the inner face two winged seeds. Seeds triangular, rounded on the sides.

The technical distinction of the species is attended with considerable difficulty, in some cases arising chiefly from their extensive distribution, so that local or geographical divergences from what is regarded as the common type are not infrequent. These divergences are for the most part intermediate between two types to which they are geographically adjacent, and thence form a connecting link between them. Instances of such forms have been observed by Regel, Willkomm and others, connecting *Larix europæa* with *L. sibirica*, *L. sibirica* with *L. dahurica*, and even *L. dahurica* with *L. leptolepis*. These Larches thence constitute a series which must have had a common origin.

The Larches are northern and even sub-arctic trees, spreading to the limits of arborescent vegetation in both hemispheres, and both in North America and in northern Asia covering immense areas, either forming pure forests or mixed with species of Picea. They also inhabit most of the mountain ranges north of the 45th parallel of north latitude, on which they ascend to the highest vertical limit of arborescent growth. *Larix Griffithii* is an outlying species that occurs only on the central and eastern Himalaya. Nearly all the Larches afford valuable timber.

Larix americana.

A slender tree 50—70 or more feet high with a trunk 2—3 feet in diameter near the base, oftener much less, and at its northern limit a low tree or bush not higher than a man. Bark ash-brown, at first smooth or slightly rugose, much and irregularly fissured in old age. Branches relatively stout; in old age often large, irregularly developed, and sometimes much contorted. Branchlets with light yellowish brown bark, mostly pendulous. Leaves in tufts of twenty—forty, narrowly linear, 0·5—1 inch long, obscurely mucronate, with a sunk median line above and keeled beneath, light grass-green, sometimes with a bluish tint. Staminate flowers globose, cream-white, scarcely 0·25 inch in diameter. Ovuliferous flowers 0·5 inch long; scales crimson with a narrow green bract. Cones the smallest in the genus, globose-cylindric, 0·75 inch long; scales suborbicular with a short thickened claw; bract one-third as long as the scale.

Larix americana, Michaux, Hist. Arb. Amer. III. 37, t. 4 (1813). Loudon, Arb. et Frut. Brit. IV. 2399. Hoopes, Evergreens, 247. Regel in Gartenfl. XX. 105. Macoun, Cat. Canad. Plants, 475. Beissner, Nadelholzk. 329. Sargent, Silva N. Amer. XII. 7, t. 593.

L. microcarpa, Forbes, Pinet. Woburn, 139, t. 47 (1839). Link in Linnæa, XV. 536. Carrière, Traité Conif. ed. II. 355. Gordon, Pinet. ed. II. 175. Kent in Veitch's Manual, ed. I. 130.

L. pendula, Salisbury in Trans. Linn. Soc. VIII. 313 (1805). Gordon, Pinet. ed. II. 177. Masters in Journ. R. Hort. Soc. XIV. 218.

L. tenuifolia, Salisbury in Trans. Linn. Soc. VIII. 314 (1805).

L. laricina, Koch, Dendr. II. 263 (1873).

Pinus laricina, Duroi, Observ. bot. 49 (1771).

P. pendula, Lambert, Genus Pinus, I. t. 36. Endlicher, Synops. Conif. 132. Parlatore, D. C. Prodr. XVI. 409.

P. microcarpa, Lambert, Genus Pinus, I. t. 37 (1803). Endlicher, Synops. Conif. 132.

Abies microcarpa, Lamarck, Dict. VI. 514 (1804). Lindley, Penny Cycl. I. 33, (1833). And many others.*

Eng. American Larch, Red Larch. Amer. Tamarack, Hackmatack, Black Larch. Fr. Mélèze d'Amérique, Epinette rouge. Germ. Kleinzapfige Lärche. Ital. Larice nero, Larice americano.

The American Larch is essentially a northern tree, widely dispersed over an immense region which may be roughly described as extending from Yukon and the valley of the Mackenzie river eastwards to the shores of Labrador and including Newfoundland; and from the Arctic Circle southwards to about the 40th parallel of north latitude. In the Canadian provinces and the northern States it mostly occurs in cold swampy ground associated with *Abies balsamea*, *Picea nigra* and *Thuia occidentalis*, in places forming pure forests. The wood is heavy, hard, very strong, rather coarse-grained, and durable in contact

* This Larch has been excessively overburdened with names. One of the oldest is the *Pinus Larix americana* of Munchhausen, published in 1770; this was not, however, taken up by Lambert who figured it in the "Genus Pinus" as two species under the names of *P. pendula* and *P. microcarpa*. Salisbury also described it as two species, but substituted *tenuifolia* for Lambert's *microcarpa*. Michaux recognised but one species in Canada and the eastern United States, since abundantly confirmed, and named it *Larix americana* in contradistinction to *L. europæa*. By adopting Michaux' name, the ambiguity attending the older names of Lambert and Salisbury is got rid of.

with the soil; it is used in ship-building, fence-posts, telegraph poles, railway ties, etc.*

According to Aiton, the American Larch was introduced into Great Britain by Peter Collinson some time prior to 1739. In this country it is an inattractive tree assuming no particular shape; its branches are often irregularly developed and grow in different directions, some ascending at an acute angle to the trunk, others horizontal, and others again quite pendulous.† It is worthless for forestry purposes on the drier land, but it would seem to be a suitable subject for trial on unproductive bogs and marsh ground. It is far better adapted to the German than the British climate, and it is accordingly more used for park and landscape planting in Germany than in England.

Larix dahurica.

A medium-sized tree, at its northern limit and highest vertical range a stunted, straggling shrub: in its arborescent form with a straight slender trunk and tapering loosely-branched crown, often with several leaders and sparsely and irregularly branched, but in the Botanic gardens of northern Europe sometimes 60 feet high with a regular pyramidal crown. Branches and branchlets slender and more or less pendulous. Leaves in fascicles somewhat distantly placed, narrowly linear, about an inch long, pale green. Staminate flowers small, hemispheric, compressed, about one-sixth of an inch in diameter: anthers sub-sessile, papilla- or teat-like, pale green. Ovuliferous flowers cylindric, obtuse, a little less than 0·5 inch long, surrounded at the base by numerous crumpled, involucral bracts, and composed of broadly ovate-oblong scales that are at first rose-pink but change with age to dark purple, and after fertilisation to dull brown. Cones ovoid or sub-globose, 0·75–1 inch long, composed of four—six series of rounded or slightly truncate scales faintly striated on the back.‡

Larix dahurica, Turczaninow in Bull, Soc. Nat. Mosc. 1838, p. 101. Carrière, Traité Conif. ed. II. 351. Regel in Gartenfl. XX. 104. Gordon, Pinet. ed. II. 168. Willkomm, Forstl. Fl. ed. II. 155. Beissner, Nadelholzk. 328, with fig. Masters in Journ. R. Hort. Soc. XIV. 216.

L. kurilensis, Mayr, Abiet. Jap. Reiches, 66, t. 5, fig. 15 (1890).

L. europaea dahurica, Loudon, Arb. et Frut. Brit. IV. 2352.

Pinus dahurica, Endlicher, Synops. Conif. 121. Parlatore, D. C. Prodr. XVI. 410.

Larix dahurica is a sub-arctic species which has its home in the coldest region of the northern hemisphere in which arborescent vegetation is known to exist. It is spread over north-east Siberia as far as the Tundras, and it is even scattered over parts of these in the form of a stunted bush but a few inches high; it attains its polar limit on the Boganida river at about latitude 72° N.: it forms forests of considerable extent around Iakoutsk, in Kamtschatka and in Saghalien where it is often mixed with *Picea ajanensis*, and

* Silva of North America, XII. 9.

† The best specimen known to the author is standing in the grounds of Dalkeith Palace, from which materials for description were communicated by the late Malcolm Dunn.

‡ Abridged from Willkomm.

finds its eastern limit in the Kurile Islands. On the mountains of Dahuria it ascends higher than the Siberian Larch, forming, as a stunted shrub, the highest zone of arborescent vegetation.*

A tree that exists and perpetuates itself in a region in which there is an annual range of temperature of over 100° Fahr. including 40° below zero, is unable to live long under the stimulus of the more equable climate of Great Britain. According to Loudon *Larix dahurica* was first introduced into this country in 1827; it is still represented by young trees in the Royal Gardens at Kew, and is occasionally procurable in nursery gardens.

Larix europæa.

A lofty tree attaining in favourable situations a height of 120 feet, but more commonly the height of adult trees ranges from 80 to 100 feet, and at the highest vertical limit of the species much less. Trunk straight, gradually tapering upwards, 2—4 feet in diameter near the base, and covered with greyish brown bark fissured into irregular thin plates. Branches in pseudo-whorls, spreading, more or less upturned at the end, on adult trees nearly of equal length,† the lowermost usually cast off before the tree attains its full height. Branchlets with smooth, pale, yellowish bark, pendulous on adult trees, often spreading on vigorous young trees. Leaves in fascicles of thirty—forty or more on arrested branchlets or "spurs," scattered on the leader and terminal shoots: narrowly linear, obtuse, obscurely keeled on the under side, soft light green. Staminate flowers at first ovoid-globose, afterwards sub-cylindric, 0·25—0·75 inch long, pale yellow. Ovuliferous flowers shortly pedunculate, sub-cylindric; reddish purple before fertilisation. Cones ovoid-cylindric, variable in size: in Great Britain 1—1·5 inch long, composed of six—nine series of imbricated, suborbicular, pale brown scales with entire margins, and striated on the exposed side; bracts oval at the base, prolonged at the apex into a short point. Seed wings obliquely-ovate, nearly as long as the scale.

Larix europæa. De Candolle, Flore Française, III. 277 (1805). Loudon. Arb. et Frut. Brit. IV. 2350, with figs. (1838). Link in Linnæa, XV. 534 (1841). Carrière, Traité Conif. ed. II. 357. Hoopes. Evergreens, 249, with fig. Gordon, Pinet. ed. II. 169. Willkomm, Forstl. Fl. ed. II. 140. Beissner, Nadelholzk. 321, with fig. Masters in Journ. R. Hort. Soc. XIV. 217.

L. decidua,‡ Miller, Dict. ed. VIII. (1768). Koch, Dendrol. II. 258. Regel in Gartenfl. XX. 101 (1871).

Pinus Larix, Linnæus, Sp. Plant. II. 1001 (1753). Lambert, Genus Pinus. I. 53, t. 35. Endlicher, Synops. Conif. 133. Christ. Uebersicht. der Europ. Abietin. 8. Parlatore. D. C. Prodr. XVI. 411.

Abies Larix. L. C. Richard, Mém. sur les Conif. 65 (1826). Lindley and Gordon in Journ. Hort. Soc. Lond. V. 213.

And many others.

Eng. European Larch, Common Larch. Fr. Mélèze de l'Europe. Germ. Gemeine Lärche. Ital. Larice ordinario. Span. Pino Alerce.

* Dr. Regel distinguished three forms of *Larix dahurica*: 1 *typica*; 2, *prostrata*; 3, *japonica*: the last named probably the *L. kurilensis* of Mayr. Gartenflora, *loc. cit. supra*.

† The length and persistency of the lower branches of the Larch varies greatly. When standing alone in open spaces the branches sometimes attain a length of 25 to 30 feet.

‡ This specific name is thence older than De Candolle's *europæa*, but it was not taken up by any subsequent authors except the late Professor Koch of Berlin, and Dr. Regel of St. Petersburg.

var.—pendula.

This is recognised in two forms:—In one the trunk is short and divided near the top into several secondary stems that are bent downwards, as are the branches and their appendages.* In the other, the branches are spreading and even ascending at the distal end, whilst the branchlets, usually very slender and much elongated, are quite pendulous.

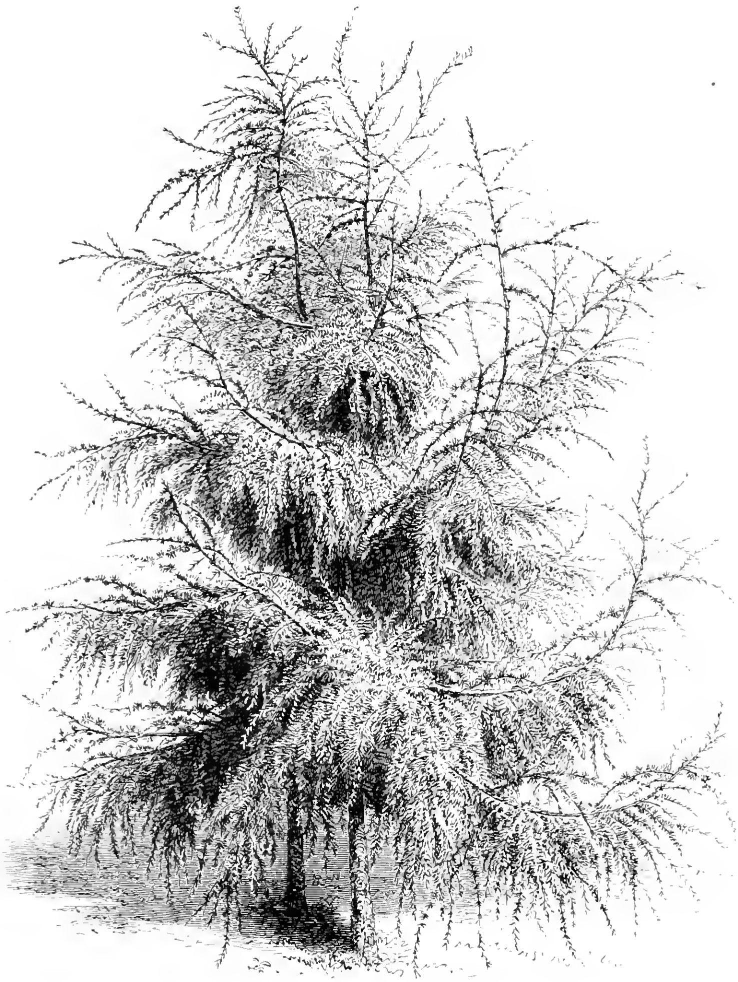


Fig. 99. *Larix europæa pendula.*
(From the *Gardeners' Chronicle.*)

L. europæa pendula, Loudon, Arb. et Frut. Brit. IV. 2351. L. decidua pendula, Regel in Gartenfl. XX. 101 (1871).

* One of the most remarkable specimens of this form of the pendulous Larch is at Henham Hall, Suffolk, the seat of the Earl of Stradbroke; in this tree the branches are excessively developed at the expense of the trunk, and cover a space 100 feet long and 63 feet wide.

The natural geographical limits of the European Larch are now difficult to determine, as so much has been done for its artificial distribution. It is, however, essentially an alpine tree, and is found wild on the Alps from Dauphiné to the Tyrol, on the Carpathians, and on the mountains of Bohemia and Moravia. In some places it forms pure forests, of which the most extensive are on the Alps of Dauphiné; in others it is often mixed with the Spruce Fir, the Silver Fir, or the Cembra Pine, and at its highest vertical limit, with the dwarf Mountain Pine, *Pinus montana*. Its vertical range varies with the latitude of the locality; on the central Alps of Switzerland it ascends to 6,000—7,000 feet above the level of the sea; on the Carpathian and Bohemian mountains it reaches the highest limit of arborescent vegetation, the altitude of which is considerably less than that reached by the Larch on the Alps.

The common Larch was introduced into Great Britain at an early date. According to Loudon the earliest mention is made of it in Parkinson's "Paradisus" published in 1629, but at that period it was quite rare; a century later Miller states in the first edition of his "Dictionary of Gardening" (1737) that it was common in most English gardens. During the latter half of the eighteenth century its value as a timber tree became known, and public attention was called to it by the Society of Arts by offering, in 1788, three gold medals for the planting of Larch and the making known the most useful properties of its timber. From that epoch the Larch became the subject more for forestry and economic planting than for arboriculture in its decorative aspect. Into the forestial management and uses of the Larch it is not our province to enter, but mention must be made of those remarkable plantations around Dunkeld and on other portions of the Atholl estate on account of the historical interest attached to them, and the beneficial influence they have exercised on the extension and practice of forestry in Great Britain.*

The Larch plantations at Dunkeld originated with James, second Duke of Atholl, who planted three hundred and fifty Larches between 1740 and 1750, which were probably intended as a trial. Nine years later a still larger number was planted on the face of a rocky hill unsuited for agricultural operations, and this plantation throve in so satisfactory a manner that his son, the third Duke, was induced to continue the trials, and at the time of his death four hundred and ten acres, previously given up to unproductive broom furze and juniper, were covered with thriving Larch trees. In 1774, John the fourth Duke surnamed "The Planter" succeeded to the title and estates, and under his direction the Atholl Larch plantations became the most famous in the country. During his tenure of the estate, Duke John caused over fifteen thousand acres of practically waste land to be planted principally with Larch trees, of which over twenty-seven millions of plants were used.†

Thousands of these trees have since been felled for profitable use, but thousands still remain to attest the forethought and wisdom of the

* The author had the privilege of inspecting a portion of these magnificent plantations in the summer of 1896 through the kindness and under the guidance of Mr. David Keir, Forester to the Duke of Atholl.

† Hunter, Woods, Forests and Estates of Perthshire, p. 45.

Dukes of Atholl under whose direction they were planted, and noteworthy among them are two great trees standing near one of the entrance gates to Dunkeld House. These trees are the survivors of five planted by Duke James in 1738; two were felled in 1809 and one had been cut down twenty years before; their height in 1888 was somewhat over 102 feet, their girth at three feet from the ground about 17 feet, and it was estimated that they contained over 530 cubic feet of timber without the bark. For the illustration we are indebted to the courtesy of the author

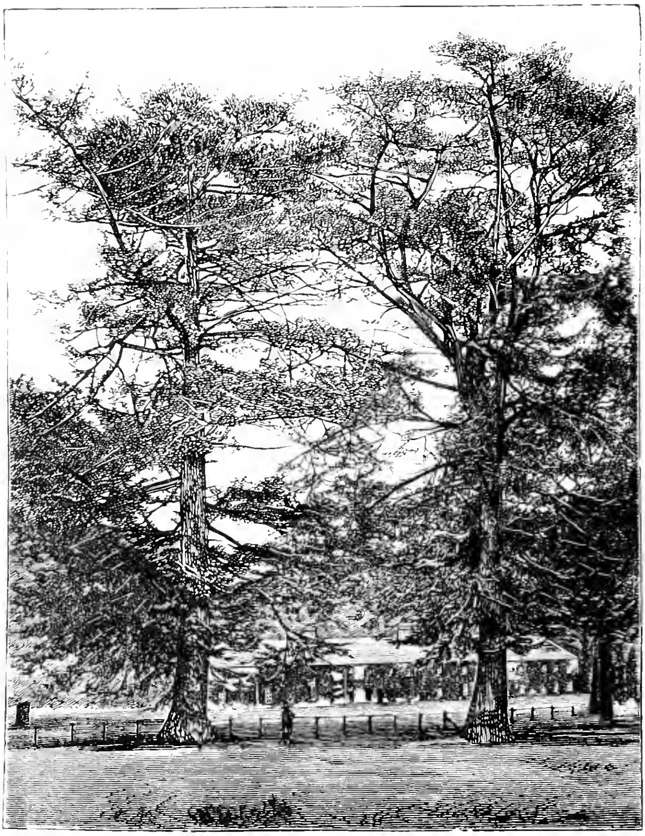


Fig. 100. The Parent Larches at Dunkeld.

of "Woods, Forests and Estates of Perthshire" and editor of the "Perthshire Constitutional."

The great value of Larch timber consists chiefly in its durability, strength, the facility with which it may be worked, and the rapidity with which it is produced: the trees with red heart-wood are most in request. Larch timber is used for all purposes of rural industry, in mining operations, for railway ties, telegraph posts, scaffold poles and wherever durability under exposure to the weather is required. On the continent of Europe, besides the ordinary uses of its timber, Venetian turpentine is procured from trees growing on the southern slopes of the Alps: and in places where the Oak is scarce, Larch bark is used in tanning leather. As a tree for the park and landscape, the common Larch has always held a prominent place as a graceful tree, distinct in all its most obvious characters from every other deciduous tree, particularly in Spring when the young leaves have just burst into life, and which at that season have a peculiar soft yellowish green tint possessed by no other tree of our forests. It is also highly appreciated in the eastern States of North America, both as a timber and ornamental tree.

Larix Griffithii.

A slender tree 40—60 feet high in the valleys of the inner Himalaya, much smaller on the higher slopes. Bark of trunk pale reddish brown, rugged and much fissured into irregular plates. Branches spreading or ascending, often long in proportion to height of trunk. Branchlets quite pendulous, covered with pale brown bark, fluted and grooved by cortical outgrowths obliquely decurrent from the "spurs." Buds broadly conic with light chestnut-brown perulæ. Leaves in fascicles of thirty—fifty, linear-acicular, about an inch long, light soft green. Staminate flowers globose, 0·25 inch in diameter; anthers numerous with a sub-quadrate, pale brown connective. Ovuliferous flowers cylindric, composed of numerous small suborbicular scales subtended by lanceolate, acuminate bracts three times as long as themselves, bright crimson with a green median line. Cones shortly stalked, cylindric, 2—3 inches long; scales subquadrate-cuneate with retuse apical margin; bracts exserted, lanceolate, cuspidate, reflexed at the tip. Seeds with an oblong wing.

Larix Griffithii, Hooker fil. Illust. Him. Plants, t. 21 (excl. figs. A. 1—4), 1855; Fl. Brit. Ind. V. 655; and Gard. Chron. XXV. (1886), p. 718, with fig. Carrière, Traité Conif. ed. II. 359 (Griffithiana). Brandis, Forest Fl. N.W. India, 531. Gordon, Pinet. ed. II. 171. Masters in Gard. Chron. XXVI. (1886), p. 464, with fig; and Journ. R. Hort. Soc. XIV. 217. Beissner, Nadelholzk. 316.

Pinus Griffithii, Parlatore, D. C. Prodr. XVI. 411 (1868).

Eng. Himalayan Larch. Fr. Mélèze de l'Himalaya. Germ. Griffiths-Larche. Ital. Larice del Sikkim.

Larix Griffithii has a restricted range in eastern Nepal, Sikkim and western Bhotan at 8,000—12,000 feet elevation. The wood is of no great economic value; it is white, soft but durable and splits well; the planks are, however, of small scantling.

The Himalayan Larch is chiefly distinguished from the other species by its larger cones with exserted reflexed bracts; in aspect it closely resembles the pendulous variety of the European species. As seen on the slopes of the inner Himalaya, it is a graceful tree of slender habit and sparse foliage; its long pensile branchlets are set in motion by the slightest breeze, and in a heavy gale are so completely blown on one side that the tree appears lop-sided. It was discovered in western Bhotan in 1837 by William Griffith whose enormous collection of herbarium specimens lay buried for many years in the cellars of the old East India House in Leadenhall Street, so that this Larch remained unknown to science till it was rediscovered by Sir Joseph Hooker in Sikkim in 1848, and who sent seeds to the Royal Gardens at Kew, which germinated freely and the seedlings were widely distributed but nearly all ultimately succumbed either to climate or disease. Repeated importations of seeds since, have met with no better fate. One survivor of the first batch of seedlings supposed to have been presented to the late Mr. Wentworth Buller, is growing in the grounds of Mr. H. M. Imbert Terry, at Strete Ralegh near

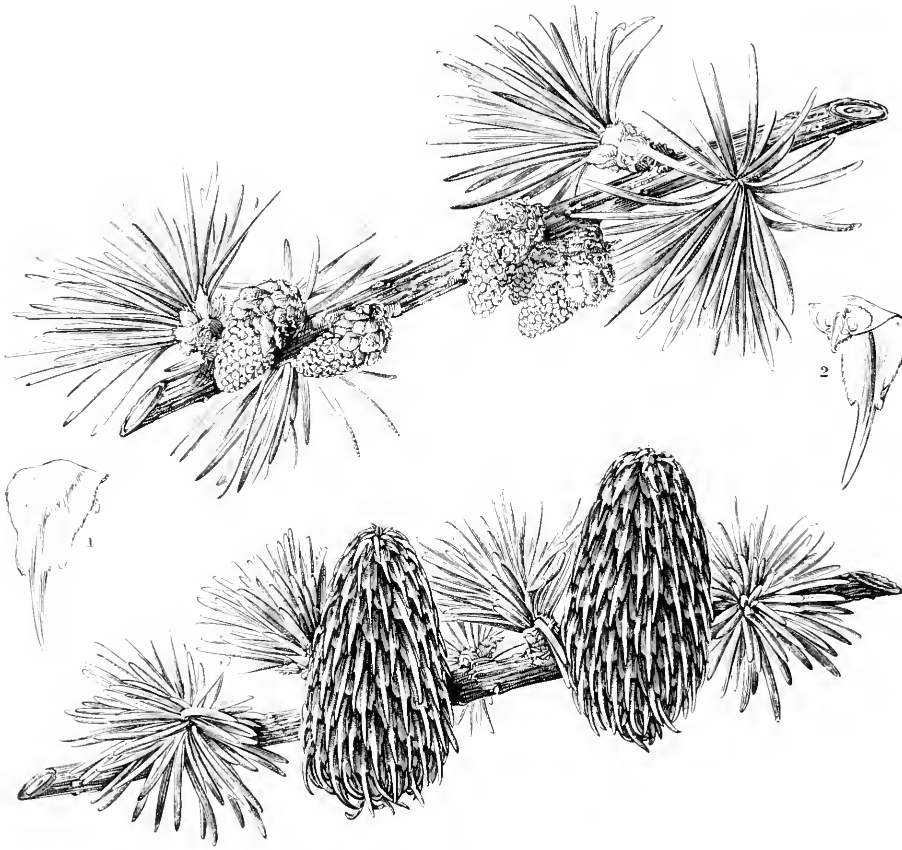


Fig. 101. *Larix Griffithii.* A, branchlet with staminate—B, with ovuliferous flowers. Ovuliferous scale 1, dorsal—2, ventral side.

Exeter, which is now upwards of 40 feet high and attracts attention by its marked unlikeness to any of the surrounding trees. Another tree 50 feet high of which a branch with cones is figured in the "Gardeners' Chronicle" of October 9th, 1896, is (or was) standing in the grounds of Major-General Jago-Trelawny at Coldrenick in Cornwall.

The species perpetuates the name of one of the most indefatigable of the earlier botanical explorers of India, who unfortunately succumbed to the climate at a comparatively early age.

William Griffith (1810—1845) completed his education at University College, London, where he distinguished himself in the medical classes, especially that of Botany, of which Dr. Lindley was the Professor. He went to India in 1832 as assistant surgeon on the Madras establishment, and was shortly afterwards appointed by the Government to investigate the forests of Tenasserim. In 1835 he accompanied Doctors Wallich and McClelland into Assam for the purpose of reporting on the growth of the Tea-plant, exploring also the Khasia and Naga Hills: from the latter he passed through the Hookung valley down the Irrawadi to Rangoon. Having been appointed surgeon to the Embassy to Bhotan, he explored part of that country and also part of Sikkim; he was afterwards attached to the army of the Indus for the purpose of examining the vegetation of the Indus, and after the subjugation of Cabul he penetrated to Khorassan. No botanist ever made such extensive explorations nor collected so many specimens as Griffith did during the brief thirteen years of his Indian career. Wherever he travelled he made sketches of the most striking features in the scenery, and his itinerary diaries are full of information not only on the botany, but also on the zoology, geology, physical geography, etc., of the countries through which he passed. Among the plants discovered by him were *Vanda cærulea*, *V. cærulescens*, *Cymbidium eburneum*, *Cyperorchis Mastersii* and other Orchids that will long retain a place in British gardens. In 1841 he was appointed to the superintendence of the Botanic Garden at Calcutta during the absence of Dr. Wallich who had been invalided home; but on the return of the latter, he resumed his medical duties at Malacca where he contracted a disease of the liver, which terminated his life at the age of thirty-five.

Larix leptolepis.

A slender tree resembling the European Larch with a trunk 60—80 or more feet high and 1·5—2·5 feet in diameter covered with reddish bark; reduced to a small shrub or stunted bush at the limits of arborescent vegetation on Fuji-yama. Branches spreading, with lateral ramification at the distal end. Branchlets more rigid than in the European species, with light brown bark fluted with oblique longitudinal cortical outgrowths. Leaves in tufts of thirty—fifty, narrowly linear, flat, 0·5—1·25 inch long, pale green above with two stomatiferous lines beneath. Staminate flowers globose-conic, 0·35 inch in diameter, light yellow-brown. Ovuliferous flowers sessile, rose-pink; bracts large in proportion to the scale, broadly lanceolate, cuspidate, reflexed at the apex. Cones globose-conic, 1·25 inch long and 1 inch broad; scales subquadrate, rounded and reflexed at the apical margin; bracts enclosed, half as long as the scale.

Larix leptolepis, Gordon, Pinet. ed. I. 128 (1858); and ed. II. 173 (1875). Murray, Pines and Firs of Japan, 89 (1863), with figs. Regel in Gartenfl. XX. 102 (1871). Hoopes, Evergreens, 254. Masters in Journ. Linn. Soc. XVIII. 522; Gard. Chron. XIX. (1883), p. 88, with fig.; and Journ. R. Hort. Soc. XIV. 41. Beissner, Nadelholzk. 318, with fig. Mayr, Abiet. Jap. Reiches, 63, t. 5, fig. 11.

L. japonica, Carrière, Traité Conif. ed. I. 272 (1855); and ed. II. 353. Murray, Pines and Firs of Japan, 9, with figs.

Abies leptolepis, Siebold and Zuccarini, Fl. Jap. II. 12, t. 105 (1842).

Pinus leptolepis, Endlicher, Synops. Conif. 130 (1847). Parlatore, D. C. Prodr. XVI. 410.

P. Larix, Thunberg, Fl. Jap. 275 (not Linnaeus and exclu. syns.).

Eng. Japanese Larch. Fr. Mélèze du Japon. Germ. Japanische Lärche. Ital. Larice giapponese. Jap. Toga, Kara-matzu, Fuji-matzu.

The Japanese Larch first became known to science through Kaempfer, who mentions it in his "Amœnitates Exoticæ," published in 1712.* The only other European botanists who saw it prior to

* There can be no doubt that *Larix leptolepis* was the Larch seen by Kaempfer, and not the Chinese tree that bears his name. Kaempfer was never in China, nor is the Chinese Larch wild or cultivated in Japan.

the opening of the ports to foreigners in 1859 was Thunberg, who included it in his "Flora Japonica" under the Linnaean name of *Pinus Larix* in the belief that it was the European species; and Siebold, who figured and described it as *Abies leptolepis.* All of these had seen trees in cultivation only: it was first detected wild by the late John Gould Veitch during his ascent of Fuji-yama in 1860, and by whom it was introduced in the following year.* *Larix leptolepis* has, at the present time, a somewhat restricted range on the central mountains of Japan, where it is not uncommon at 5,000 — 6,000 feet elevation between 35°30' and 38° north latitude. The wood is hard, heavy and strong, but not much used on account of the inaccessibility of the trees.

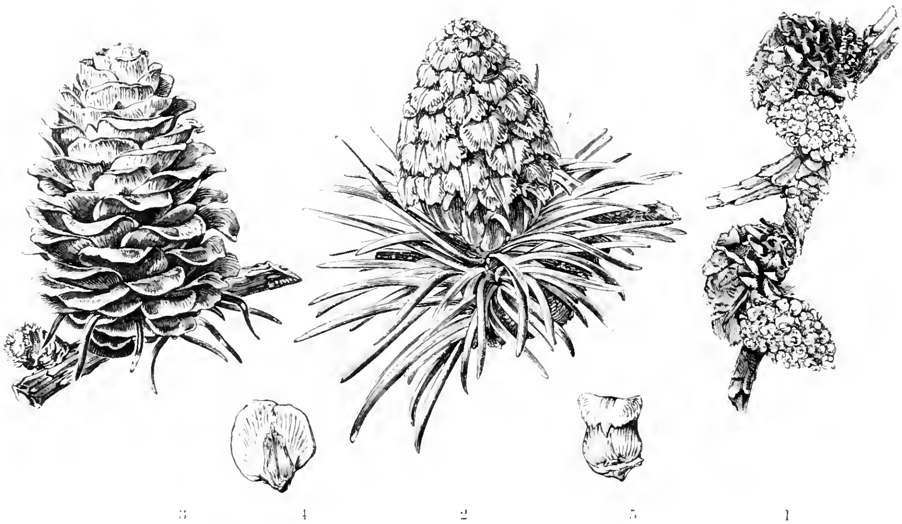


Fig. 102. *Larix leptolepis.* 1, Staminate,—2, Ovuliferous flowers. 3, Mature Cone. 4 and 5, front and back view of ovuliferous scale. Nat. size.

In Great Britain the best specimens of *Larix leptolepis* are medium-sized trees from 30 to 35 or more feet high with a broadly conical head when standing alone, and for the most part of pleasing aspect. When in a thriving condition it is fully equal to the common Larch as an ornamental tree; the foliage is lighter in colour, of a softer shade of green, contrasting more strongly with that of the surrounding trees, and in autumn it dies off with a richer golden hue. The tree is of slower growth than the common Larch, and should not be planted in dry sandy soils.

* The late Andrew Murray described a second Japanese Larch under the name of *Larix japonica* (Pines and Firs of Japan, p. 94) from herbarium specimens gathered by John Gould Veitch on Fuji-yama, near the upper limit of arborescent vegetation. It differs from *L. leptolepis* in little else than in being reduced by wind and cold to a small scrubby bush, and presents much the same aspect as *L. dahurica* under similar circumstances.

Larix Lyalli.

A tree usually 40—50 and occasionally 70 feet high with a trunk 18—20 inches but sometimes 3—4 feet in diameter, and remote, elongated, pinnately-divided branches that are sometimes decidedly pendulous, sometimes abruptly ascending at the extremities. Bark of old trees dark brown, 0·75—1 inch thick, divided by shallow fissures into irregularly-shaped plates. Buds conspicuous from the long white matted hairs which fringe the margin of their scales. Branchlets short, coated with thick hoary

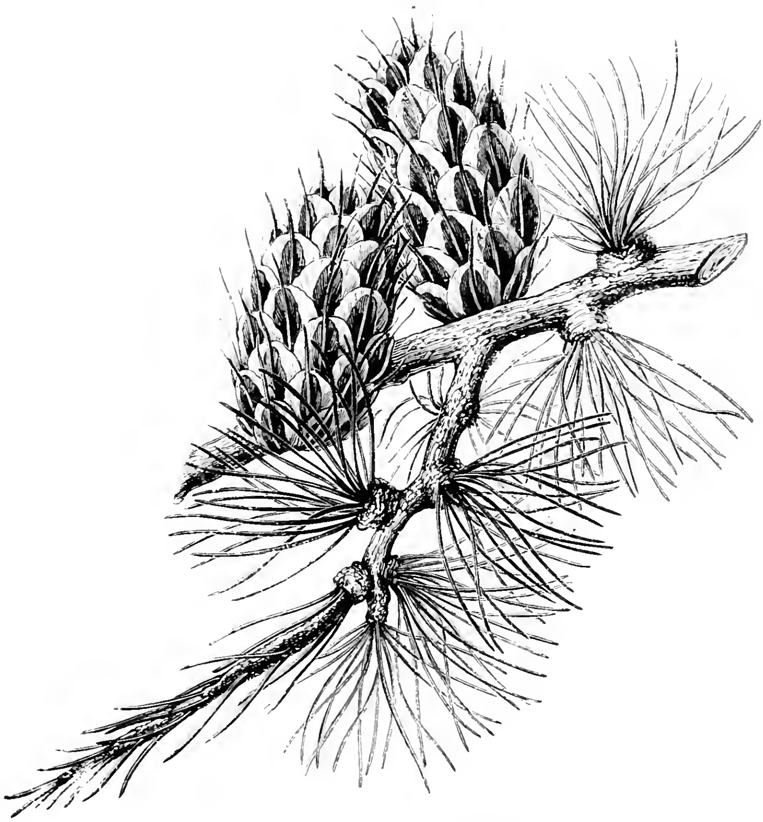


Fig. 103. Fertile branchlet of *Larix Lyalli*.
(From the *Gardeners' Chronicle*.)

tomentum which does not disappear till after the second winter. Leaves tetragonal, rigid, pale blue-green, 1—1·5 inch long. Staminate flowers cylindric, about an eighth of an inch long, with pale yellow anthers. Cones ovoid, 1·5—2 inches long, sub-sessile; bracts dark purple, exserted, with slender tips, much larger than the oblong-obovate thick scales which are erose at the margin and fringed with white hairs that are also scattered over their lower surface. Seeds with a light red wing broadest near the base.—Sargent, *Silva of North America*, XII. 15, t. 595.

Larix Lyalli, Parlatore in Gard. Chron. 1863, p. 916. Hoopes, Evergreens, 256. Regel in Gartenfl. XX 103. t 685. Carrière, Traité Conif. ed. II. 361. Gordon, Pinet. ed. II. 175. Sargent in Gard. Chron. XXV. (1886), p. 652, with fig.; and Silva N. Amer. *loc. cit. supra.* Beissner. Nadelholzk. 316, with fig. Macoun. Cat. Canad. Plants. 476. Masters in Journ. R. Hort. Soc. XIV. 218.

Pinus Lyalli, Parlatore, D. C. Prodr. XVI. 412 (1868).

Larix Lyalli is an alpine tree which grows only near the timber line on mountain slopes from 4,500 to 8,000 feet elevation in southern Alberta, British Columbia and northern Washington, in places associated with *Pinus albicaulis*, *Abies lasiocarpa* and *Tsuga Mertensiana.* It was discovered on the Cascade mountains in 1860 by Dr. David Lyall, surgeon and naturalist of the British Commission which marked the boundary of the United States west of the Rocky Mountains. It has not yet been introduced in Great Britain.

Larix Lyalli comes so very close to the more widely-distributed Larch of the plains and lowlands of the same region that it is not improbable forms may come to light which will unite them. It is distinguished from *L. occidentalis* "by its shorter quadrangular leaves, its stouter spurs, by the dense white tomentum which covers the young shoots and leaf buds, and by its larger sessile cones." The wood is reddish brown, heavy, hard and close-grained.

David Lyall (1817—1895) was born at Auchinblae in Kincardineshire. He received a medical education at Aberdeen University where he took his M.D. degree. Shortly afterwards he undertook a voyage to Greenland as surgeon to a whaling ship, and on his return he entered the Royal Navy and was soon afterwards appointed Assistant-Surgeon to H.M. ship "Terror," one of the vessels fitted out for a scientific expedition to the Antarctic regions under Sir James Ross. During his stay in the antarctic regions he made a collection of Algæ which formed an important addition to antarctic botany. After his return in 1842 he was appointed to the Mediterranean service, and in 1847 he was selected as surgeon and naturalist to accompany H.M. ship "Acheron" on the survey of the coast of New Zealand. Here, besides devoting himself to the collection of the lower orders of plants, he made many discoveries in the phanerogamic flora of the islands, including the gigantic white-flowered buttercup, *Ranunculus Lyalli.* In 1852 he was appointed to H.M. ship "Assistance," one of the squadron sent to the Arctic regions under the command of Sir Edward Belcher in search of Sir John Franklin; during this expedition he collected the largest herbarium ever formed in the American Polar islands. In 1858 he accompanied the Land Boundary Commission on the survey of the boundary line between the United States and British Columbia. From this expedition he brought home a magnificent herbarium which was followed by a valuable contribution to the Journal of the Linnean Society containing a botanical account of the region traversed from the sea inland to 8,000 feet altitude of the Rocky Mountains, and in which the various zones of vegetation in British Columbia were for the first time portrayed. He continued in the service of the Government till 1873 when he retired and afterwards removed to Cheltenham where he resided till his death. His name is botanically commemorated by the genus Lyallia founded by Sir J. D. Hooker on a curious cariophyllaceous plant discovered during the Antarctic expedition in Kerguelen's Land as well as by the specific names of several plants of which he was the discoverer, including the Larch described above.—*Journal of Botany*, Vol. XXXIII. p. 209.

Larix occidentalis.

A lofty tree, attaining at its greatest development a height of 250 feet with a trunk 6—8 feet in diameter, but more usually about 100 feet high and 2—3 feet in diameter, the trunk covered with dark brown bark which in old trees is very thick and fissured into irregular plates. Lowermost branches horizontal, elongated and remote, dying off at an early age of the tree and leaving a short pyramidal head of short branches clothed with a scanty foliage. Branchlets stoutish, at first pubescent, with reddish brown bark changing to grey-brown with leaves trigonous, keeled on the lower side, rigid, acute, 1—1·5 inch long, pale green. Staminate flowers shortly stipitate, globose-cylindric with pale yellow anthers. Cones ovoid-cylindric, obtuse, 1—1·5 inch long and nearly an inch in diameter: scales suborbicular, entire or slightly erose; bracts produced into elongated, exserted bristle-like tips as long again as the scale.

Larix occidentalis. Nuttall, Sylva, III. 143, t. 120 (1849). Hoopes. Evergreens, 253. Regel in Gartenfl. XX. 103. with fig. Gordon. Pinet. ed. II. 176. Sargent in Gard. Chron. XXV. (1886), p. 652. with fig.; and Silva. N. Amer. XII. 11, t. 594. Macoun. Cat. Canad. Plants. 475. Beissner. Nadelholzk. 314, with fig. Masters in Journ. R. Hort. Soc. XIV. 218.

L. americana brevifolia. Carrière. Traité Conif. ed. II. 357.

Pinus Nuttalli. Parlatore. D. C. Prodr. XVI. 412.

Eng. Western Larch. Amer. Tamarack. Germ. Westamerikanische Lärche.

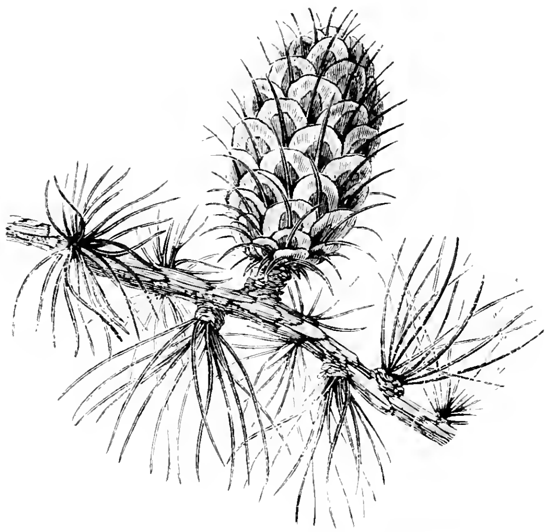


Fig. 104. Fertile branchlet of *Larix occidentalis*.
(From the *Gardeners' Chronicle*.)

The habitat of the Western Larch is for the most part restricted to the basin of the upper Columbia river and its tributaries in the States of Oregon, Washington, northern Montana and Idaho, crossing into southern British Columbia to the mountains east of Lake Shuswap, and finding its northern limit at about lat. 51° N. It nowhere forms pure forests of any extent, but is scattered over the region mixed with Hemlock, Spruce and Douglas Firs and other trees in the valleys and lowlands, and growing mostly in the deep alluvial soil of river sides it only occasionally ascends the drier mountain sides at elevations of 2,500 to 5,000 feet. It attains its largest size along the streams which flow into Flathead Lake.

Larix occidentalis, the largest of all Larches and one of the most useful timber trees of North America, was seen for the first time by Lewis and Clark during their adventurous journey across the American continent in 1805—1806; it was next detected by David Douglas in 1827, who mistook it for the European species, and seven years later by Thomas Nuttall who first specifically distinguished it, but a long series of years elapsed before it was brought into cultivation. Growing in the midst of some of the most gigantic coniferous trees in the world, it is not surprising that *Larix occidentalis* should simulate their lofty stature: nevertheless the tree grows slowly, which the author of the "Silva of North America" ascribes to "the smallness of the leaf surface in comparison with the height and thickness of stem, and there is certainly no other instance among the trees of the northern hemisphere where such massive trunks support such small, short branches and sparse foliage.* The wood surpasses that of all other American Conifers in hardness and strength; it is durable, beautifully coloured, free of knots, and is adapted to all sorts of construction, and for household furniture; it is, however, but little used in the sparsely settled and remote region in which it abounds. The thickness of the bark of this Larch enables it to resist the heat of the forest fires, which are fast destroying the noble coniferous trees in the Columbia basin; "and in the struggle for supremacy between the different inhabitants of the Columbian forests under the changed conditions which have followed the white man's occupation of the country *Larix occidentalis* seems destined to hold its own, and probably even to extend its sway." †

The Western Larch was introduced through the Arnold Arboretum in 1881, but it is still extremely rare in Great Britain, and no definite conclusion can yet be arrived at respecting its suitableness for the British climate and its use for British arboriculture.

Larix sibirica.

A slender tree with an elongated spiry crown of which the lower branches are more or less pendulous. Leaves 1—1·5 inch long, in much crowded fascicles. Staminate flowers hemispheric, compressed; anthers shorter than in *Larix europæa*, with a short oblique, obtuse connective. Ovuliferous flowers 0·5 inch long, and nearly as broad, composed of pale green downy scales and surrounded at the base by numerous obovate involucral bracts, strongly keeled on the back and terminating in a short mucro, and which arch over and almost enclose the flower. Cones ovoid-cylindric, about 1·5 inch long: scales in five—six series, ovate-orbicular, striated on the dorsal face; seed-wings scarcely broader than the seed.

Larix sibirica, Ledebour, Fl. Alt. IV. 204 (1833). Willkomm, Forstl. Fl ed. II. 153. Link in Linnæa, XV. 535.

L. Ledebouri, Gordon, Pinet. ed. II. 173.

L. europæa var. sibirica, London, Arb. et Frut. Brit. IV. 2352. Beissner, Nadelholzk. 324, with fig.

Pinus Ledebouri, Endlicher, Synops. Conif. 131 (1847). Parlatore, D. C. Prodr. XVI. 410.

* Vol. XII. p. 11. † *Idem.* p. 13.

The Siberian Larch covers large areas in northern Russia as far as the 67th parallel of north latitude and spreads eastwards through Siberia to the Yenesei river and probably beyond it; it also follows the trend of the Altai mountains as far as Lake Baikal, ascending in places to 5,000 feet above sea level. It is one of the most widely distributed trees in Siberia, and one of the most useful to the inhabitants of the region.

According to Willkomm, the Siberian differs from the European Larch in its longer and more crowded leaves: in its pale green ovuliferous flowers surrounded at the base by numerous involucral bracts which almost enclose them; in its reflexed ovuliferous scales which are at first clothed with down, and in its usually larger cones. It was introduced from Archangel by the Duke of Atholl in 1806, and a trial was made of it in the plantations at Dunkeld which proved a failure.* Transported from a climate in which the seasons are arctic and sub-tropical by turns, the trees dwindle and ultimately perish under the stimulus of the more equable climate of this country.

LARICOPSIS.

Pseudolarix,† Gordon, Pinet. ed I. 298 (1858). Eichler in Engler and Prantl, Nat. Pfl. Fam. 77 (1887). Masters in Journ. Linn. Soc. XXX. 32 (1893). Larix, Bentham and Hooker, Gen. Plant. III. 442 (in part).

In 1853 the late Robert Fortune discovered a Larch, or properly a Larch-like tree, in eastern China, of which he sent herbarium specimens to Dr. Lindley. The cones differ in several respects from those of the common Larch especially in the scales which instead of being persistent "are so deciduous that it is scarcely possible to hold them together." Dr. Lindley accordingly referred the tree to Abies although the foliage was known to be tufted and deciduous like that of the Larch; but Gordon in the first edition of his "Pinetum" gave it separate generic rank as Pseudolarix, an ill-phrased name unsuited for scientific nomenclature. The staminate flowers remained unknown to science until 1884 when a tree in the nursery of Messrs. Rovelli, at Pallanza in Italy, produced them, which, as the illustration shows, differ morphologically from those of every other Larch in their umbellate disposition.‡ These differences in the cones and staminate flowers are now recognised as sufficient for establishing a distinct genus for the reception of the Chinese Larch.

* Loudon, Arboretum et Fruticetum Britannicum, *loc. cit. supra.*

† This is a negative name that connotes nothing definitely. Granted that the prefix "pseudo" may be conveniently combined with technical terms in the sense of "apparently but not really," it is manifestly objectionable in the generic names, and scarcely less so in the specific names of plants. "Nature produces nothing false," certainly not in the Greek sense of ψεῦδος.

‡ It is a singular fact that nearly all the monotypic Coniferae of China and Japan have the umbellate disposition of their staminate flowers: Ginkgo, Sciadopitys, Cunninghamia and Laricopsis. It is also a characteristic of Abietia (Keteleeria) Fortunei.

Laricopsis Kæmpferi.

"A tree 120—130 feet high, symmetrically branched and having the aspect of something between the Cedar and the Larch, but more covered with foliage in consequence of the large size and breadth of the leaves." In Great Britain, a slow-growing tree of broadly pyramidal outline, the branches often increasing in length almost at the same rate as the trunk. Bark of trunk dark ash-brown, much fissured into irregular plates, the broader fissures exposing a light reddish brown inner cortex. Branches sparsely ramified, the branchlets for the

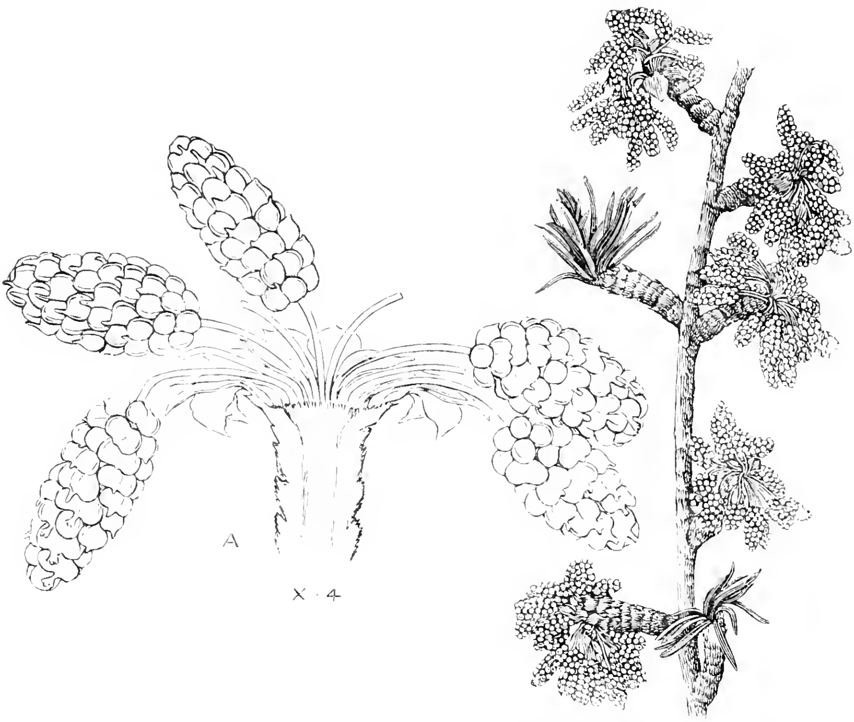


Fig. 105. Staminate flowers of *Laricopsis Kæmpferi*.
(From the *Gardeners' Chronicle*.)

most part produced laterally only. Leaves deciduous; on the older branchlets in tufts on short "spurs"; on the youngest terminal shoots scattered or spirally arranged, linear-lanceolate, acute, 1·5—3 inches long, soft light green changing to rich golden yellow before they fall. Staminate flowers in umbels at the apex of short "spurs" and surrounded by membraneous involucral bracts, each member of the umbel stalked, sub-pendulous or arching, cylindric, about 0·75 inch long; anthers sub-globose, the lower ones almost sessile, the upper ones prolonged into a long appendage, three-lobed at the apex. Cones ovoid, about 3 inches long and 2·5 inches in diameter at the broadest, with deciduous scales diverging at the apex much like those of the common artichoke. Scales ovate-oblong, sub-acute, about 1·25 inch long, with a small bract of nearly the same shape on the under side, not more than one-fourth as long as the scale and bearing two seeds near the base on the ventral side. Seed wings tapering to a rounded point, nearly as long as the scale.

Laricopsis Kæmpferi, *supra*.

Pseudolarix Kæmpferi, Gordon, Pinet. ed. I. *loc. cit.*; and ed. II. 360. Carrière. Traité Conif ed. II. 363. Masters in Gard. Chron XXI. (1884), p. 584, with figs; Journ. Linn. Soc. XXII. 208, with fig.; and Journ. R. Hort. Soc. XIV. 244. Beissner. Nadelholzk. 310, with fig.

Larix Kæmpferi, Carrière in Flore des Serres. XI. 97 (1856). Kent in Veitch's Manual, ed. I. 129.

Abies Kæmpferi. Lindley in Gard. Chron. (1854). p. 255, with fig. Murray. Pines and Firs of Japan, 100, with figs.

Pinus Kæmpferi, Parlatore, D. C. Prodr. XVI. 412.

Eng Golden Larch, Chinese Larch. Fr. Melèze de Chine. Germ. Chinesische-Goldlärche.

Fig. 106. Cone of *Laricopsis Kæmpferi*.

Nothing is known respecting the geographical distribution of *Laricopsis Kæmpferi*. Fortune, its discoverer, first became acquainted with it as a pot plant in a dwarfed state, but he did not meet with adult trees till the autumn of 1853, when he came upon some fine specimens growing near a monastery at Tsant-sing in the province of Che-kiang at 1,000 to 1,500 feet above sea-level, and subsequently he saw others on a sloping hill at Quanting, twenty miles distant, localities not found on modern maps. As the trees in both places appeared to him to have been planted, the origin of the species remains in uncertainty.

The Chinese Larch was for a long time very rare in British gardens. Only about a dozen plants were raised from the seeds collected by Fortune, and propagation by layering from such of these as were available for the purpose was the only means of increasing the number till the recent coning of the tree at Pallanza, whence seeds and seedlings have since been distributed. It has proved hardy wherever it has been planted, and is a beautiful and interesting tree, especially in autumn when the leaves before falling take on a golden yellow of exceptional richness. It has also proved hardy in the New England States of North America where the winters are much colder and the summers hotter and drier than ours, a circumstance which seems to indicate that the tree is of northern origin. Among the finest specimens in this country are those at Panjerrick, near Falmouth; Scorrier, near Truro; Carclew, Tortworth Court and Penrhyn Castle.

The species was named by Lindley after Kaempfer, the first European naturalist who visited Japan, under the erroneous impression that it was the Larch mentioned by him in the narrative of his travels, but as already stated under *Larix leptolepis*, the tree is not known in Japan, and Lindley's name is thence wrongly applied; that of its discoverer would be more appropriate, as proposed by Mayr.*

ENGELBERT KAEMPFER (1651—1716) was a native of the principality of Lippe-Detmold in Germany. After passing through several schools, he studied at the University of Cracow and afterwards at Königsburg. From Prussia he went to Sweden where he obtained the secretaryship to an embassy which was then being sent to Persia. The embassy arrived at Ispahan in 1684, and returned to Europe in the following year; the information which Kaempfer collected during this mission and his subsequent travels was afterwards embodied in a work which he entitled "Amœnitates Exoticæ," and published in 1712. After his return from Persia he entered the service of the Dutch East India Company as a surgeon, and served many years at Batavia in Java, where he occupied himself chiefly with the natural history of the island. From Batavia he went to Japan with the embassy which the Dutch East India Company sent annually to that country. He resided at Nagasaki from September, 1690, to November, 1692, and during the interval he visited Yeddo (Tokio) the capital, and compiled a history of Japan which was never published; but a translation made from a copy in the possession of Sir Hans Sloane was published in England after his death. Kaempfer returned to Europe in 1694, and shortly afterwards took the degree of Doctor of Medicine in the University of Leyden, and subsequently obtained the appointment of physician to the Prince of Detmold which he retained till his death.

CEDRUS.

Loudon, Arb. et Frut. Brit. IV. 2402 (1838). Bentham and Hooker, Gen. Plant. III. 439 (1881). Eichler in Engler and Prantl. Nat. Pfl. Fam. 74 (1887). Masters in Journ. Linn. Soc. XXX. 30 (1893).

The Cedars have long been recognised as being among the most stately of trees for the parks and gardens of Great Britain;† but apart from their striking aspect as decorative trees, they are of the highest interest on account of their botanical relationship, their remarkable geographical distribution, and the historic and sacred associations of the type, or longest known of them. There are three easily distinguishable forms, conventionally recognised as species but scarcely so in a strictly scientific sense, respectively known as the Cedar of Lebanon, the Deodar or Indian Cedar, and the African or Mount Atlas Cedar.

The typical form which inhabits the slopes of Mount Lebanon and the Cilician Taurus, has been known as *The Cedar* from remote antiquity; the existence of a second Cedar forming extensive forests in the north-west Himalaya was not known to science till the commencement of the nineteenth century; whilst the presence of a third on the Atlas mountains of Algeria was not suspected till its discovery after the occupation of the country by the French in 1831. The Lebanon type was thence the only Cedar known to Linnæus which he, in common

* Abietineen des Japanischen Reiches, p. 99. Kaempfer's name is commemorated by the Seitamineous genus Kæmpferia (Linnæus).

† In the New England States of North America, the Cedars do not grow satisfactorily. *Cedrus atlantica* and *C. Libani* are somewhat more successful further south, but *C. Deodara* thrives only (for a time, perhaps) in some of the southern States and California.—Garden and Forest, X. 500.

with nine other species of the Abietineæ, included in Pinus in the "Species Plantarum," published in 1753,* and for nearly a century afterwards generic rank was denied to these noble trees. Loudon was, in a technical sense, the first to recognise their claim to this rank, which has since been generally admitted. When the reproductive organs alone are considered, it is not easy to find in the Cedars, characters that shall clearly separate them from Abies. The structure of the cones almost conforms to that of the cones of the Silver Firs; the scales, seeds and their wings corresponding in shape, texture and arrangement; but whilst the cones of the Silver Firs usually fall off the first year, with the exception of the central axis which remains some time longer, the cones of the Cedars persist from two to three years. Moreover the staminate flowers in Abies are axillary and often clustered; in the Cedars they are solitary and terminal on short arrested branchlets or "spurs," a character which also distinguishes Cedars from Tsuga, Picea and Pinus. In the arrangement of the leaves in pseudo-fascicles or tufts on the "spurs" the Cedars agree with the Larches, but the leaves themselves come much nearer in form, texture and consistency to those of the Spruce Firs.

The generic characters of Cedrus may thence be formulated thus:—

Staminate flowers terminal on short arrested branchlets, surrounded at the base by numerous small involucral bracts. Anthers very numerous, sub-sessile, spirally crowded around an erect staminal column; anther cells 2, dehiscing longitudinally.

Ovuliferous flowers sub-globose, composed of spirally arranged, closely imbricated scales with a small appressed bract on the under (dorsal) side, and bearing two inverted ovules on the upper (ventral) side near the base.

Cones maturing the second year, ovoid, cylindric, obtuse, variable in size. Scales closely imbricated and enclosing the bract which disappears before the cone ripens, the outer exposed margin slightly rounded or almost truncate, contracted on the basal side to a short cuneate claw, and persistent for some time after the fall of the seeds.

Seeds angular, with a hard ligneous testa and large membraneous wings.

Whilst the relationship of the Cedars to the other members of the Abietineæ can be distinctly formulated, their relationship, *inter se*, is so close that characters sufficiently definite to separate them specifically are almost wanting. This relationship was critically investigated by Sir J. D. Hooker many years ago, after making an excursion to Mount Lebanon with the object of ascertaining the condition of the celebrated Cedar grove in the Kedisha valley; the result of the mission and the investigation that followed were communicated in a memorable paper published in the "Natural History Review" for January, 1862.

After describing the condition of the Cedars in the Kedisha valley and their geographical position in respect to those on Mount Atlas

* Lambert followed Linnæus in including the Cedar of Lebanon in Pinus, and also at a later period Endlicher and Parlatore, joining with it the Indian and African forms, but distinguishing them sectionally. By L. C. Richard the Cedar of Lebanon was included in Abies, in which he was followed by Lindley. By the pre-Linnean botanist, Tournefort, it was included in Larix, also by Miller in the early editions of his Dictionary, and later by Salisbury.

and the north-west Himalaya, the various parts of the three Cedars are compared, the bark, wood, leaves, staminate flowers, cones, etc., and the conclusion arrived at is:—"that as species the three Cedars cannot be distinguished, and that they must all have been derived from one common stock; * nevertheless they may be regarded as three well-marked forms, which are usually very distinct but which often graduate into one another."

That they are necessarily regarded as distinct by the arboriculturist and landscape gardener will be evident enough from a comparison of the habit, aspect and colour of the foliage of the three Cedars as seen growing in the parks and gardens of Great Britain. As thus viewed the following points of difference are quite obvious:—

In *Cedrus Libani* the primary branches are frequently long in proportion to height of trunk, often of timber-like size, usually horizontal, but sometimes bent downwards by the weight of their appendages, regularly tabuliform, and the terminal growths more or less pendulous. The leaves are shorter than in *C. Deodara* and longer than in *C. atlantica*, and grass-green in colour.

In *Cedrus Deodara* (up to forty—fifty years) the primary branches are usually shorter in proportion to height of trunk than in *C. Libani* or *C. atlantica*, of nearly equal length in each pseudo-whorl, gradually shorter upwards and giving the tree a more strictly pyramidal outline than is observable in the other two; the terminal growths are more slender, more elongated with paler bark, and quite pendulous. The leaves are longer and of a paler green.

In *Cedrus atlantica* the primary branches are horizontal, often of unequal length in the same pseudo-whorl, giving the tree a less formal outline than in *C. Deodara*; less formally tabuliform than in *C. Libani* and with the terminal growths mostly rigid. The leaves are shorter, glaucous, sometimes of a silvery whiteness, and the cones are smaller than in the other two.

The geographical distribution of the Cedars is remarkable; they are confined to three separate regions in the great mountain systems that cross the eastern continent between the 28th and 38th parallels of north latitude with but little interruption from the Atlantic Ocean to the China Sea. The three species, here recognised as such for practical convenience, occupy positions nearly equidistant, *Cedrus Libani* (Syria and Cilicia) being in the middle with *C. Deodara* (Afghanistan and north-west India) and *C. atlantica* (Algeria) east and west of it respectively and separated from it by an interval of 1,200 to 1,400 miles.† Their habitat is thus restricted to a mountainous region with a vertical range of from 4,000 to 6,000 feet elevation for the middle

* This view of the relationship of the three Cedars was strengthened by the discovery, some years after the publication of Sir J. D. Hooker's paper, of a Cedar growing spontaneously in the island of Cyprus, with characters well-nigh intermediate between those of the Lebanon and Mount Atlas forms.

† The presence of an intermediate form between *C. Libani* and *C. atlantica* on the island of Cyprus scarcely affects the general statement in the text; the proximity of the island to the Syrian coast almost brings it within the given range.

and western forms whilst the Deodar ascends to 12,000 feet on the Hindu Koosh.

The Cedars are of geological antiquity and it is interesting to find that remote ancestors of the present race formerly inhabited Great Britain, fossil evidences of them having been met with in the lower Greensand of Maidstone, Shanklin and Folkestone.*

Cedrus from κέδρος, but more often applied by the Greeks to the pungent-leaved species of Juniper common throughout the Mediterranean region, as *Juniperus Oxycedrus*, than to the noble Syrian tree, just as Cedar is often applied at the present time to trees included in the Cupressineæ, as the Red Cedar, *Juniperus virginiana*; White Cedar, *Cupressus thyoides* and *Thuia occidentalis*; Canoe Cedar, *T. gigantea* and others.

Cedrus atlantica.

A stately tree attaining a height of 80—100 feet with a trunk 5 feet in diameter at the base. Trunk tapering, rarely forked or divided as in *Cedrus Libani*. Branches horizontal and much ramified, scarcely so formally tabuliform as in the Lebanon type. Branchlets distichous, opposite, but oftener alternate and of unequal lengths, the terminal growths usually rigid and horizontal like the older parts. Buds globose conic, about 0·25 inch long, with numerous small imbricated perulæ. Leaves persistent four—five or more years, four-angled, mucronate, about 0·5 inch long, dark green and more or less glaucous; distant and scattered on the terminal shoots; in dense tufts of forty—seventy, the number varying with the age of the arrested branchlet or "spurs" on which they are produced. Staminate flowers and cones identical in structure with those of *C. Libani*, the latter being almost invariably smaller.

Cedrus atlantica, Manetti, Cat. Hort. Madoet. Suppl. 9 (1844). Carrière, Traité Conif. ed. II. 374. Gordon, Pinet. ed. II. 60. Lawson, Pinet. Brit. III. 217, t. 38, and figs. Willkomm. Forstl. Fl. ed. II. 160. Beissner, Nadelholzk. 392, with fig. Masters in Gard. Chron. X. ser. 3 (1891), p. 423, with fig.; and Journ. R. Hort. Soc. XIV. 200.
C. Libani var. atlantica, Hooker fil in Nat. Hist. Rev. 1862.
C. africana, Gordon and Hort.
Pinus atlantica, Endlicher, Synops. Conif. 137.
P. Cedrus var. atlantica, Parlatore, D. C. Prodr. XVI. 408.

vars.—argentea and aurea.

In the first named the foliage is highly glaucescent, sometimes of a silvery whiteness, the glaucescence frequently becoming heightened with the age of the tree. In the last named the young foliage is of rich golden which changes to the normal green of the species in the second year.

C. atlantica argentea, Hort. C. atlantica aurea, Hort.

The botanical history of the Mount Atlas Cedar dates from an epoch within the memory of many botanists and horticulturists still living, the first published mention of it being made by the Italian botanist Manetti, in a Catalogue of Plants cultivated in the Imperial Garden at Modicea or Monza, near Milan, and issued in 1844.

* J. Starkie Gardner, British Eocene Flora, p. 11.

Carrière gives this year as the date of its introduction into Europe, but there are trees in Great Britain whose age must apparently be greater than the date of Manetti's catalogue would account for, and which must have been raised from seeds previously gathered in Algeria and sent to this country under the name of *Cedrus Libani.* Since the establishment of a Forestry Department in Algeria by the French Government, definite information respecting the habitat and distribution of *C. atlantica* has been obtained, and it is now known to inhabit the Atlas mountains from the meridian of Greenwich to long. 8° E.: its western limit has not yet been determined; its vertical range is from 4,000 to 6,000 feet above sea level. It does not spread continuously throughout this range but occurs at intervals in forests that in places cover a considerable area; this is especially the case on Aurès, near Batna; at Ben Thaleb, in Babor and Ta Babort where it is associated with *Abies numidica,* all in the province of Constantine; whilst in Algiers proper it is found on the Djurdjurah range, on the hills above Blida and at Teniet-el-Ahd, in places mixed with Yew and Juniper.

As a tree for the park and landscape in Great Britain, *Cedrus atlantica* is unquestionably the best of the three Cedars taken in all its bearings, among which especial stress should be laid upon its hardiness, its adaptability to many soils and situations, its rapid growth, its pyramidal but not too formal outline, and lastly its glaucous foliage which when heightened to a silvery whiteness, affords a picture unsurpassed by any other coniferous tree in cultivation whether standing alone or in contrast with the greenery of other trees. Remarkable instances of this picturesque effect may be seen at Eastnor Castle and Madresfield Court. The trees at the first-named place were raised from seeds gathered by the late Earl Somers at Teniet-el-Ahd, and it is a curious fact that all, or nearly all, the trees raised from these seeds are of the *argentea* variety, and being in considerable numbers and distributed generally over the grounds they form a marked feature of the place; the whiteness of the trees seems to be intensified with age, so that many of them are, at the present time, of striking beauty. At Madresfield Court, the seat of Earl Beauchamp, an avenue has been formed of *Cedrus atlantica* at a right angle to another avenue of *Abies nobilis,* of which an illustration is given under that species. All the trees in the Cedar avenue have highly glaucous foliage and have grown with considerable uniformity as to height of trunk and length of branches. The vista formed by them compares favourably with the sombre gloom of an avenue of old Cedars of Lebanon.*

The timber of the Mount Atlas Cedar almost equals in quality and value that of its Himalayan congener, and is consequently much in

* Among the finest specimens of *Cedrus atlantica* in Great Britain are those at High Elms, Beckenham; The Royal Gardens, Kew; Hardwicke House, Bury St. Edmunds; Mulgrave Castle, Yorkshire; Orton Hall, Peterborough; Penrhyn Castle, Bangor; Bretby Park, Derbyshire; Adhurst St. Mary, Petersfield. In Scotland at Whittinghame, East Lothian; Cultoquhey, Murthly Castle, and Scone Palace in Perthshire. In Ireland at Fota Island, Cork; Carton, Co. Kildare; Charleville and Powerscourt, Co. Wicklow; Hamwood, Co. Meath; Curraghmore, Co. Waterford; Baron's Court, Co. Tyrone.

request in Algeria and adjacent countries. The heart-wood is used for railway ties which last from eight to ten years: it has also been used with good results for street paving; the outer portion is prepared for carpentry and especially for cabinet making and decorative purposes on account of its beautiful veining.*

Cedrus Deodara.

A lofty robust tree 200—250 feet high, the girth of the trunk near the base 15—20 feet, very gradually diminishing upwards, at 80 feet being about one-third less than at the base. Bark of old trees 1—1·5 inch thick, dark grey, often tinged with brown or purple and fissured by longitudinal dark furrows and short transverse cracks into long irregular plates.† Branches mostly horizontal, the lower ones often depressed by the weight of their appendages. Branchlets distichous, opposite or alternate, decurved or sub-pendulous at the distal end, the axial terminal shoots quite pendulous in young and vigorous-growing trees, and covered with whitish brown bark. Leaves persistent three—four years, fascicled on short "spurs," each tuft consisting of thirty—sixty leaves; on the terminal shoots solitary and scattered, 0·75—1 inch long, sub-triquetral or obscurely four-angled, light green, becoming much darker with age. Staminate flowers as in *Cedrus Libani*. Cones sessile or sub-sessile, erect, ovoid or ovoid-cylindric, 3—5 inches long and 2—3 inches in diameter; scales flabellately triangular, 2—2·5 inches broad, with the outer edge rounded. Seed wings triangular with rounded sides.

Cedrus Deodara, Loudon, Arb. et Frut. Brit. IV. 2428. with figs. (1838). Forbes, Pinet. Woburn, 149, tt. 48, 49. Link in Linnæa, XV. 538. Carrière, Traité Conif. ed. II. 367. Brandis, Forest Fl. N.W. India, 516. Gordon, Pinet. ed. II. 61. Lawson, Pinet. Brit. III 225, tt. 39—43, with figs. Aitchison in Journ. Linn. Soc XVIII. 98. Beissner, Nadelholzk. 305, with fig. Masters in Journ. R. Hort. Soc. XIV. 200.

C. Libani var. Deodara, Hooker fil, Fl. Brit. Ind. V. 653.

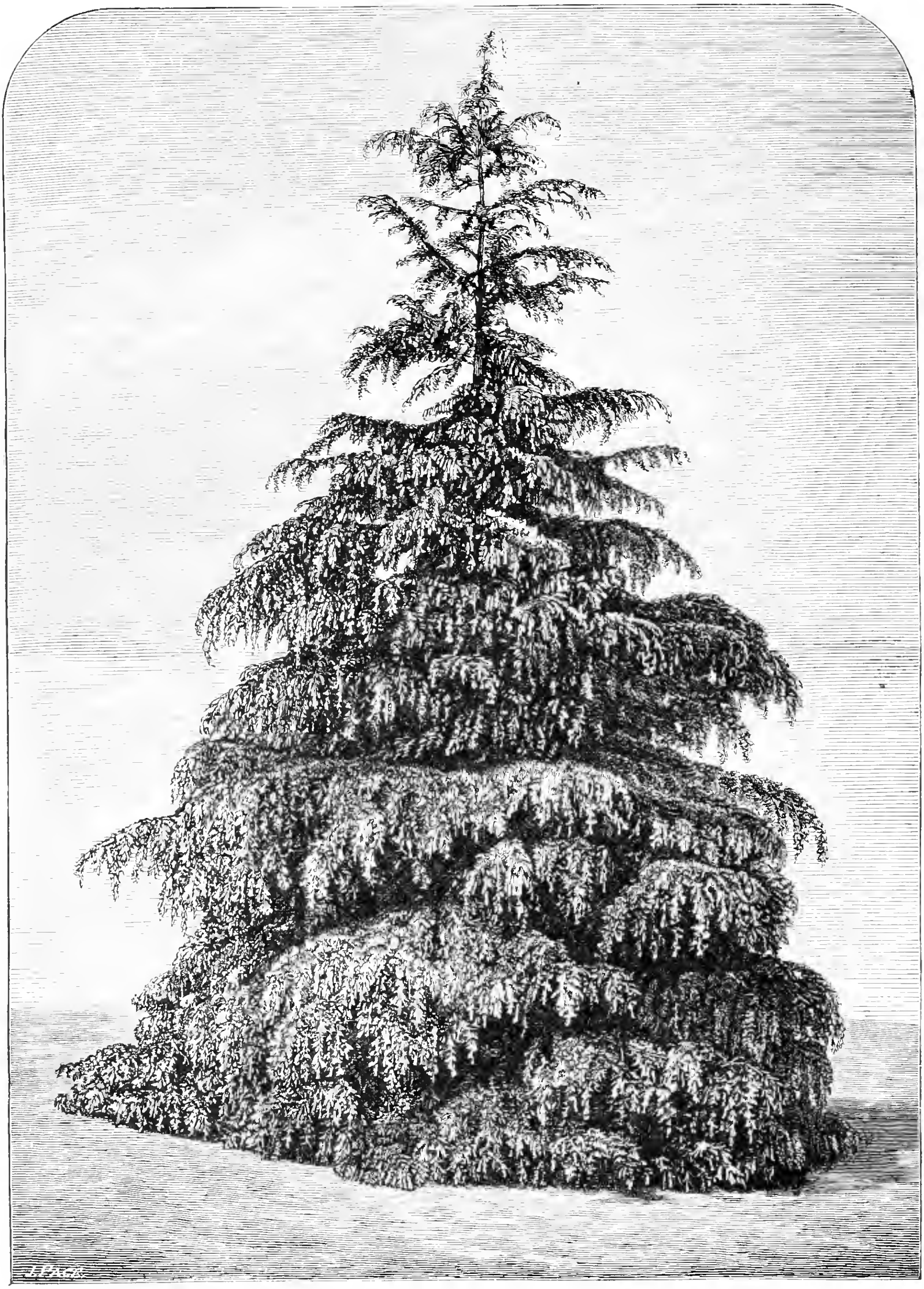
Pinus Deodara, Lambert, Genus Pinus, II. t. 3. Endlicher. Synops. Conif. 135. Parlatore. D. C. Prodr. XVI. 408.

Eng Deodar, Indian Cedar. Fr. Cedre de l'Himalaya. Germ. Himalaya Ceder. Ital. Cedro indiano.

Since its introduction, varieties of the Deodar have originated in British and Continental nurseries, which have been named respectively:— **argentea,** in which the glaucescence of the foliage is heightened to almost silvery whiteness; **aurea,** the young foliage of a decided yellow tint which changes with age to the normal green of the species; **crassifolia,** the leaves thicker and shorter; **robusta,** the branches and their appendages larger and stouter; **verticillata glauca,** the leaves of the young shoots whorled instead of scattered and quite glaucous; **viridis,** the foliage of a deeper green than in the ordinary type.

The Deodar Cedar is distributed over a limited area in north-west India. It forms forests on the mountains of Afghanistan, north Baluchistan, and the north-west Himalaya, where its eastern limit is below the Niti Pass on the Dauli river. Its vertical range is from 6,000 to 10,000 feet, descending in some places to 3,500 feet and ascending

* Journal of the Society of Arts, September, 1895.
† Brandis. Forest Flora of North-west India, p. 185.



Cedrus Deodara thirty-five to forty years old in Great Britain.

in others to 12,000 feet. It also forms forests in the basin of the main tributaries of the Indus: in these forests it covers large areas either unmixed or associated with *Pinus excelsa* and *Picea Smithiana*; less commonly with *Abies Webbiana* and with Oaks.

In their native forests young Deodars bear a good deal of shade; the terminal shoots like the extremities of the branches are soft and drooping, but will pierce with great vigour through thickets of other trees, and it is not a rare occurrence to see the proportion of Deodars in an Oak forest increase by self-sown seedlings which come up under the shelter of the Oaks and make their way through its foliage. When isolated, young trees are branched to the ground, and have the pyramidal outline as seen in Great Britain: old isolated trees have flat tabular tops in a very marked manner, and attain large girths. The data available show clearly that the rate of growth of the Deodar is much influenced by the greater or less moisture of the climate:—thus, in the forest at the head waters of the Bhagïrati river in a dry climate, the tree requires upwards of two hundred years to attain a girth of six feet, whereas in the Jaunsar forest on the outer hills with a heavy rainfall, seventy years suffice to attain this size. As compared with other Abietineæ the Deodar has a great power of reproduction, and its branches often show a tendency to form straight leading shoots. In many places the trees near villages are lopped of their branches to a considerable height; the naked stems reclothe themselves with side branches in a short time. Trees are often found with the main trunk, instead of growing up straight, divided into numerous branches, each forming a separate leader; this division sometimes takes place near the ground, sometimes at a height of ten feet or more; these leaders form well-shaped tops, so that at a distance the forest has a deceptive appearance; the trees appear tall and well-formed, but on approach they are found to be worthless for timber. The heart-wood is light brown, fragrant, compact, even-grained, does not readily warp or split, and is exceedingly durable, so much so that in the climate of Cashmir and the Punjab it is almost imperishable by the ordinary agents of Nature except fire.*

The Deodar Cedar was introduced into Great Britain in 1831 by the Hon. W. Leslie Melville; one of the first seedlings raised was planted in the garden of the Horticultural Society of London at Chiswick. For some time afterwards it was quite scarce, young plants in the London nurseries being sold at two guineas each. In 1841, the authorities at the head of the Board of Works fearing an insufficient supply of oak-timber in future years for the purposes of the Navy, and believing that the Deodar was as hardy, strong and durable as the Oak with the advantage of growing much more rapidly, obtained from the Directors of the East India Company a large supply of seeds which were distributed among the Royal Forests and the principal nurseries of Great Britain. This supply was supplemented a few years afterwards by a still larger one from the Company's experimental garden at Saharunpore,

* Brandis, Forest Flora of North-west India, pp. 519—521. Some remarkable instances of the durability of Deodar timber are given in page 88.

from whence seeds were sent gratuitously to every one who would pay the cost of the carriage.

This abundant and cheap supply of seed resulted in Deodar seedlings becoming for a time as plentiful as Larch and Scots Fir, and high expectations were formed respecting their ultimate value as timber trees. In less than twenty years afterwards the faith in the qualities of the Deodar as a tree for economic planting in Great Britain began to be challenged by experienced foresters, but their warning was disregarded for a time. Another twenty years' experience of it, however, fully justified the warning, and proved without need of further trial the unsuitableness of the tree for British forestry. However flourishing the young plants appear for a time, an enormous proportion of them perish before they reach even a fractional part of the age and size attained by their gigantic progenitors in their native forests. Nor is this surprising: the Deodars in Great Britain are placed under climatic conditions very different from those under which their progenitors live for centuries, high up on the slopes of the Himalaya, where for nearly half of the year they are enveloped in snow, and where from the middle of March to the middle of June there is considerable dryness in most of the localities covered by Deodar forests; and from the middle of June to the end of September there is a cloudy atmosphere and almost continual rain. These variations in the season recur with tolerable constancy year after year; whereas in Great Britain in no two consecutive years are the seasons precisely alike; often they are very different.

Nevertheless the Deodar should not be disparaged as an ornamental tree for the park and lawn, especially in those localities where good specimens are to be seen retaining a healthy aspect, or at least showing no signs of decay, of which many such are growing in various parts of England, in Wales, and in Ireland generally. Even in the colder climate of Scotland, Dunn's Census in the Conifer Conference Report of the Royal Horticultural Society shows that, although of slower growth, the Deodar thrives more or less satisfactorily in many places, especially in the more humid climate of Perthshire and the south-western counties. To secure good park and lawn specimens, spots sheltered from the east and north-east winds should be selected, and ample space should be allowed for the expansion of the lowermost branches; these in some of the oldest trees in England have attained a length of 25 to 30 feet, but are usually less in fast-growing trees. The rate of growth of the leader shoot in Great Britain ranges in different localities from 12 to 21 inches.

There is a beautiful avenue of Deodars in the grounds of Lord Poltimore, near Exeter, which was planted in 1851 or 1852; this avenue is 180 yards in length, and consists of twenty trees on each side, their average height being at the present time (1900) nearly 70 feet. There is another fine avenue of somewhat greater extent at Killerton, the seat of Sir C. T. Dyke-Acland, of which the variability in habit of some of the trees composing it is a remarkable feature.

At Charleville in Co. Wicklow, the residence of Viscount Monck, is a fine avenue of Deodars called the "Cedar Walk," planted in 1851 to commemorate the great International Exhibition held in London in that year; the avenue is 328 yards in length; the trees average about 60 feet in height and are in faultless condition.* The specific name, Deodara or Devadara, is a native word indicative of the connection of the tree with sacred objects and worship; it is said to be derived from two Sanscrit words, *deva* (a deity) and *darra* or *daru* (wood).

Cedrus Libani.

A majestic tree 50—80 or more feet high, of variable habit according to situation and environment but always with spreading tabuliform branches from which it receives the peculiar aspect that distinguishes it from every other tree. When standing alone the principal branches frequently attain a great length, and the tree has a broadly pyramidal outline with a rounded or flattened top, the diameter of the spread of branches sometimes exceeding the height of the tree; when surrounded by or in contact with other trees, the trunk usually ascends higher and the length of the branches is much contracted. In very many of the largest trees in Great Britain, the trunk is not only forked at a short distance from the ground but often divides into several ascending stems. Bark of trunk thick, rough, and deeply and irregularly fissured into larger or smaller plates. Branches in pseudo-whorls or tiers often unequally developed, the largest of timber-like size, spreading horizontally, the lowermost decumbent and frequently sweeping the ground; the ramification mostly confined to the distal end, lateral and in the same plane. Branchlets opposite or alternate, covered with light brown smooth bark that peels off in thin scales. Buds sub-cylindric, obtuse, about 0·25 inch long with ten—twelve broadly ovate pale brown perulæ. Leaves persistent three—five years, acicular, obscurely four-angled, spine-tipped, 0·75—1·25 inch long, dark lustrous green, produced on short arrested branchlets usually erect on the axial growths, close-set and spirally arranged around them in tufts of thirty—fifty, but often many more on strong healthy trees; on the terminal growths scattered and inserted on small cortical outgrowths (pulvini). Staminate flowers terminal on arrested branchlets five—seven years old, cylindric, 1—1·75 inch long, surrounded at the base by ovate-lanceolate bracts in two series; stamens numerous, spirally crowded around the central axis, yellowish brown. Ovuliferous flowers terminal, broadly ovoid, purplish before pollination. Cones erect, mature at the end of the second season, ovoid-cylindric or sub-cylindric, variable in size, 3—4·5 inches long and 1·75—2·5 inches in diameter at the broadest part; scales sub-quadrate, closely imbricated and attached to the axis by a short cuneate claw. Seeds angular with a cuneate oblong membraneous wing.

* Good specimens of the Deodar over 50 feet high are (or were till quite recently) growing at Howick Hall, Northumberland; Armathwate Hall, Cumberland; Revesby Abbey, Lincolnshire; Thoresby Park, Notts; Hewell Grange, Worcestershire; Penrhyn Castle, Bangor; Linton Park, Maidstone; Carclew, Cornwall; Bicton, Devonshire; Tortworth Court and Highnam Court, Gloucestershire; Eastnor Castle, Ledbury. In Scotland at Abercairny, Dunkeld, Dupplin Castle, Murthly Castle and Rossie Priory in Perthshire. In Ireland at Fota Island, Cork; Courtown, Wexford, Woodstock, Kilkenny, Hamwood, Co. Meath; and Castlewellan, Co. Down.

Cedrus Libani, London, Arb. et Frut. Brit. IV. 2402, with figs. (1838). Hooker fil in Nat. Hist. Rev. (1862), p. 1. Carrière, Traité Conif. ed. II. 370. Gordon, Pinet. ed. II. 65 Willkomm, Forstl. Fl. ed. II. 159. Lawson, Pinet. Brit. III. tt. 42, 44, 45, and figs. Boissier, Fl. orient. V. 699. Beissner, Nadelholzk. 297, with figs. Masters in Journ. R. Hort. Soc. XIV. 201.

Pinus Cedrus, Linnæus, Sp. Plant. II. 1001 (1753). Lambert, Genus Pinus, I. t. 38. Endlicher, Synops. Conif. 136. Parlatore, D. C. Prodr. XVI. 407.

Larix Cedrus, Salisbury in Trans. Linn. Soc. VIII. 314 (1807).

Abies Cedrus, L. C. Richard, Mém. sur les Conif. 62 (1826).

Eng. Cedar of Lebanon. Fr. Cédre du Liban. Germ. Libanon Ceder. Ital. Il Cedro del Libano.

var.—brevifolia.

A geographical form with shorter leaves and smaller cones, discovered in 1879 growing on Mount Troodas near Khrysokus in the island of Cyprus, where it is found only in one secluded spot, and the trees are relatively few in number.

C. Libani brevifolia, Hooker fil in Journ. Linn. Soc. XVII. 517. Beissner, Nadelholzk. 300, with fig.

var.—glauca (syn. *argentea*).

Differs from the common form only in its glaucous foliage which is sometimes heightened to a silvery whiteness. The glaucescence is rarely if ever observed in young trees, but it occurs in old trees both wild (Mount Taurus) and cultivated.

C. (Pinus) Libani glauca, Parlatore, D. C. Prodr. XVI. 408. C. Libani argentea, Kent in Veitch's Manual, ed. I. 137.

Varieties that have originated under cultivation have been named *decidua*,* *denudata*, *nana*, *pendula*, *stricta*, *viridis*, but it is uncertain whether any of them are to be met with in British gardens.

The specific name *Libani* refers to the ancient mountain with which the tree has been associated from remote antiquity and especially in the Sacred Writings: the Cedars on Mount Lebanon have thence acquired a separate and special interest throughout the Christian World. They were, for several centuries, believed to be confined to a small grove in the Kedisha valley at 6,000 feet elevation, about fifteen miles from the Syrian port of Beyroot (Bêirût) and not far from the high road to Baalbek (Heliopolis). That this valley should have been for so long a time the only locality on the ancient Lebanon the Cedars were known to inhabit, will not be surprising when the circumstances of time and place are considered; it was the nearest accessible spot, and there was nothing to tempt, but much to deter travellers from diverging from the common route. Since the era of the Reformation the Cedars of the Kedisha valley have been visited from time to time by travellers from western Europe, many of whom have left some account of the trees they found

* Known only from a single tree in France observed many years ago by the late M. Carrière. A similar instance of *Cedrus atlantica* growing near Chichester was recently brought under the notice of the author by Captain Norman, R.N., of Berwick-on-Tweed. These deciduous forms, although abnormal states, show unmistakably the close affinity of the Cedars and Larches.

One of the largest of the Cedars on Mount Lebanon.

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standing at the time of their visit. These accounts agree as to their majestic proportion and venerable aspect; they also show that the number of trees in the grove has been gradually diminishing since they were observed by the first visitors in the fifteenth century, till those remaining can be easily counted and their position mapped down; and moreover, that no young trees or seedlings of a second year's growth are to be found, hence leading to the conclusion that the Cedars in the grove will continue to diminish till the grove itself becomes extinct. However interesting the reports of travellers to Mount Lebanon may have been in their day, it was long felt that a scientific investigation alone could satisfy the very natural desire to know the actual state of the trees forming the grove. This investigation was undertaken by Sir J. D. Hooker in the autumn of 1860, and the results were published in the Natural History Review for 1862; the report may still be read with almost undiminished interest.

At the date of Sir Joseph Hooker's visit to the Kedisha valley, at least one other locality on Mount Lebanon was known to be inhabited by the Cedar, and since that time others have been discovered; and although our information may still be imperfect, the Cedars are now known to occur in great numbers on Mount Lebanon, chiefly on the western slopes between latitudes 33° 30′ and 34° 30′ N., not forming a continuous forest, but in stretches or groves, some of them comprising several thousands of trees. Besides these, there are vast forests of Cedars covering the higher slopes of Mounts Taurus and Anti-Taurus in Cilicia, with a vertical range of from 3,000 to 6,000 feet elevation, intermixed at the lower limit with *Abies cilicia*.

> On the Cilician Taurus the Cedar occupies the higher slopes where the snow lies several feet deep for nearly five months of the year. Here it forms forests of impressive grandeur whose stillness is only occasionally interrupted by the cry of the yellow-beaked alpine crow, or by the crash of a boulder set in motion from the rocks above by the bound of the wild goat. In the valleys may occasionally be seen the variety *glauca*, its foliage in places heightened to a silvery whiteness. The wood of the Cedar is highly valued in this region; it is strong, and does not warp when exposed to the weather; it is also very fragrant and free from the attacks of insects; it is used for the interior woodwork of the Greek churches and places of worship, and for the best kinds of household furniture.*

Perhaps no tree in the British Pinetum is looked upon with greater interest than the Cedar of Lebanon. Its majestic aspect, the enormous dimensions it attains under favourable circumstances, the great age it is supposed to reach, and especially its sacred and

* Walter Siehe in Gartenflora, 1897. p. 205.

historic associations, have all combined to attract towards it a kind of regard that is not felt for any other coniferous tree. As a tree for the landscape and park, the Cedar of Lebanon may be said to be almost indispensable, for it imparts a feature so peculiarly its own that not even its near congeners, the Himalayan and the Mount Atlas Cedars, should be substituted for it. It is perfectly hardy; it has passed through the severest winters on record unscathed, except a very few trees that were unfavourably located; it thrives in many kinds of soils, even in dry sandy ground usually considered poor; it is almost indifferent to situation and environment: proximity to water does not seem to affect it where the drainage is free, as the roots do not penetrate deep into the soil but range over a large area near the surface.

If exposed to high winds the great bulk often attained by the Cedar of Lebanon offers a resistance to their force greater than the root-hold of the tree can withstand, and many large and noble specimens have been overthrown and consequently destroyed by more than usually violent gales.* When the period of decadence has set in, accidents by wind become frequent, occurring even in places not more than ordinarily exposed; many Cedars, famous in their time, have disappeared from this cause.† Large trees with long spreading branches occasionally suffer breakage by heavy falls of snow. In the drier climate of England, except the counties of Devon and Cornwall, the branches generally increase in length at almost the same rate as the trunk gains in height; but in the more humid climate of Ireland,‡ Wales, parts of Scotland, Devon and Cornwall; and also in places where the trees have been planted in groups, or in close proximity to each other, or to other trees, the leader usually ascends faster than the branches increase in length; the trees have then the elongated pyramidal outline of the Deodar and Mount Atlas Cedars.§ Under most circumstances the rate of growth of the Cedar of Lebanon in Great Britain compared with that of the Abietineæ generally may be considered slow. The increase in height during the first fifty years scarcely exceeds a foot annually taking one year with another, and this rate of growth diminishes with the increase of age till the leader or leaders—for plurality, or at least more than one, is the rule rather

* Several grand specimens at Orton Hall, near Peterborough, were overthrown by a disastrous gale which occurred on March 24th, 1895. On March 3rd, 1897, eleven fine Cedars, some of them almost equal in size to that figured, were uprooted in Goodwood Park by a fierce gale which for several hours swept along the south coast as far as Cornwall, and which overturned many others standing in proximity to the sea in Hants, Dorset and Devon.

† The great Cedar at Hendon, one of the first that was planted in this country, was blown down in 1779; its height was 70 feet, and the diameter of umbrage 100 feet.

‡ At Carton in Co. Kildare, the seat of the Duke of Leinster, are some of the finest Cedars in Ireland; most of them have straight undivided trunks, and the tallest exceed 70 feet in height. These Cedars are a conspicuous feature of the domain.

§ There is an imposing group of Cedars at Strathfieldsaye, in North Hants, "twelve in number, the largest of which towers to a height of 120 feet; their tall cylindrical stems are denuded of branches to a height of about 70 feet, and present more the appearance of well-grown Larch stems than that of ordinary Cedars. - Gardeners' Chronicle, XIX. ser. 3 (1896), p. 8.

than the exception—cease to ascend and the tree then becomes flat or rounded at the top.

Many are the renowned Cedars in Great Britain placed on record in works on Arboriculture and in the horticultural press, and many are the incidents in relation to their history that have been noted.* So interesting a record is, without doubt, worthy of reproduction, but even the briefest recapitulation would occupy more space than can be well spared; special notice in this place must therefore be restricted to two trees which stand forth prominently among the existing noble specimens of the Cedar of Lebanon; viz., the Enfield Cedar and the subject of the illustration.

The Enfield Cedar is one of the oldest, if not *the* oldest in England; it was planted by Dr. Uvedale, Master of the Enfield Grammar School, some time between 1662 and 1670. This venerable tree stands on the south side of the old Elizabethan palace, and is somewhat over 50 feet high; the trunk is undivided, 24 feet in girth near the base, and free of branches to about fifteen feet of the height; the principal branches are most developed on the south side, and have a spread of 30 to 35 feet; on the opposite side the tree has suffered breakage from north-east winds and snow. The yearly increasing volume of smoke consequent on the rapid spread of London northwards, and which is so deleterious to coniferous trees, is doing its work slowly but surely, so that the fate of this old Cedar will not remain long in suspense.† It is the parent of the fine Cedars at Bayfordbury, near Hertford.

The Great Cedar at Goodwood is one of a large number dispersed through the park and grounds that were planted for the Duke of Richmond under the direction of Peter Collinson;‡ it stands in a level glade of the park on the south-east side of the mansion. As seen from a distance the outline presented by the tree is more than usually regular for a Cedar of Lebanon, but its immense size is not fully apparent till the tree is closely approached, when it is seen that the massive bole, which is over 25 feet in girth, is entire only to about six feet from the ground, when it divides into ten stems which have grown straight upwards to a height of nearly 90 feet, and from which have sprung the horizontal branches that gradually diminish in length from below upwards; the twelve lowermost of these have originated from their base at the top of the undivided trunk, the three largest spread in different directions at an angle of about 120° between each two, and measure respectively 69, 66 and 62 feet in length; the diameter of umbrage is therefore over 130 feet. §

The date of the introduction of the Cedar of Lebanon into Great Britain cannot be fixed with certainty; it is not mentioned in Evelyn's "Silva," published in 1664, but there is evidence to show

* Loudon, Arboretum et Fruticetum Britannicum, Vol. IV.; Lawson's Pinetum Britannicum, Vol. III.; Hunter's Woods, Forests and Estates of Perthshire; The Transactions of the Royal Scottish Arboricultural Society; The Gardeners' Chronicle *passim*, etc. etc.

† And such, we fear, must be said of the fine old Cedars in the Royal Gardens at Kew, at Syon House, Chiswick, Gunnersbury Park and other places in the vicinity of the metropolis.

‡ Loudon, Arboretum et Fruticetum Britannicum, IV. 2414.

§ Communicated by Mr. R. Parker, Gardener to the Duke of Richmond.

that it was introduced shortly afterwards. The Enfield Cedar, already adverted to, was planted some time between 1662 and 1670; and an old Cedar at Bretby Park, Derbyshire, is known to have been planted in 1676.* There are also some very old Cedars at

The Great Cedar of Lebanon in Goodwood Park.

Woburn Abbey, Syon House, Warwick Castle; Eden Hall, Cumberland; Wilton House, near Salisbury; and High Clere in Berkshire, that are presumably of seventeenth century origin. Judging from the present

* This old Cedar is still healthy and vigorous; it is over 80 feet high; the trunk is undivided to fifteen feet, it then divides into three main stems which rise perpendicularly and nearly parallel to each other.

condition of most of these trees, it may be roughly estimated that the life of the Cedar in this country is not likely to be prolonged beyond four hundred years: the probability is even very great that the age generally will not much exceed three hundred years. This estimate falls far short of the supposed age of the patriarchal trees on Mount Lebanon; but in England the Cedar is an exotic, living under conditions as regards climate, altitude and environment very different from those under which it has braved the storms of centuries on the mountains of Syria and Cilicia.*

The economic value of the Cedar of Lebanon in modern times, otherwise than for ornamental planting, is inconsiderable; the timber of trees felled in Britain is inferior; "the wood is light, soft, brittle, apt to warp, and by no means durable." † There are, however, grounds for believing that the Cedars growing under very different circumstances of climate in proximity to the snows of Lebanon and Taurus yield timber of the finest quality. In the expedition to Mount Lebanon, undertaken by Sir J. D. Hooker, Captain Washington, R.N., and other gentlemen in the autumn of 1860, "a section of the lower limb of one of the older trees (which lay dead on the ground) was procured, which gave a totally different idea of the hardness of Cedar-wood from what English specimens do."

The secretions of the Cedar of Lebanon are not abundant, but they appear to possess very remarkable properties, some of which were known in very ancient times; the Egyptians are said to have used its whitish resin in embalming their dead; they also rubbed it over the leaves of papyrus and other objects to preserve them from the attacks of insects. The most recent notice of these properties appears in Mr. Smee's entertaining book, "My Garden," p. 429: "The wood of the Cedar contains a volatile essential oil, which has the curious property of unsettling printer's ink and making it run. Some years ago a Bank of England note was offered to the cashier with its printing disturbed. Inquiry was set on foot, and it was traced to several individuals who satisfactorily explained its custody and possession. It was then brought to me, when I suggested that the detectives should inquire whether it had been kept in a Cedar box; it was then discovered that the last possessor had kept it in a new Cedar box which she had recently bought, and thus the mystery was solved."

PICEA.

Link, Abhandl. Akad. Berlin, 179 (1827). Bentham and Hooker, Gen. Plant. III. 439 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 77 (1887). Masters in Journ. Linn. Soc. XXX. 28 (1893).

The Spruce Firs by an overwhelming weight of authority are now brought under Picea. The genus as at present circumscribed is a

* Among the many fine Cedars scattered over the country mention may also be made of those on the Royal domain at Windsor, at Langley Park near Slough, one of the finest in the country; others at Dropmore, Linton Park, Bayfordbury, Elvaston Castle, Blenheim Palace, Cobham Park. In Scotland at Dalkeith Palace, Murthly Castle, Methven Castle. In Ireland at Powerscourt, Woodstock, Adare Manor, Whitefield Lodge, Phœnix Park; the Royal Botanic Gardens, Glasnevin, etc.

† Loudon, Arboretum et Fruticetum Britannicum, IV. 2417.

fairly natural one and includes about seventeen species, but some of them are not distinguished by very definite characters, and may hereafter be reduced to varieties of more common types.*

The essential characters of the genus may be thus formulated:—

Flowers monœcious in the axils of leaves of shoots of the preceding year; the ovuliferous flowers occasionally terminal.

Staminate flowers stipitate, ovoid or cylindric, the stipes (stalk) surrounded by numerous involucral bracts in two—three series. Anthers spirally arranged around an axis, with a crimson or yellow connective dilated into a rounded crest and opening longitudinally.

Ovuliferous flowers shortly stipitate, cylindric, composed of numerous scales usually broader than long, spirally imbricated in many ranks, and bearing on the ventral (inner) face, near the base, two anatropous (inverted) ovules.

Cones cylindric, or some slight modification of that form, rarely ovoid, at first erect but ultimately pendulous, attaining maturity the first

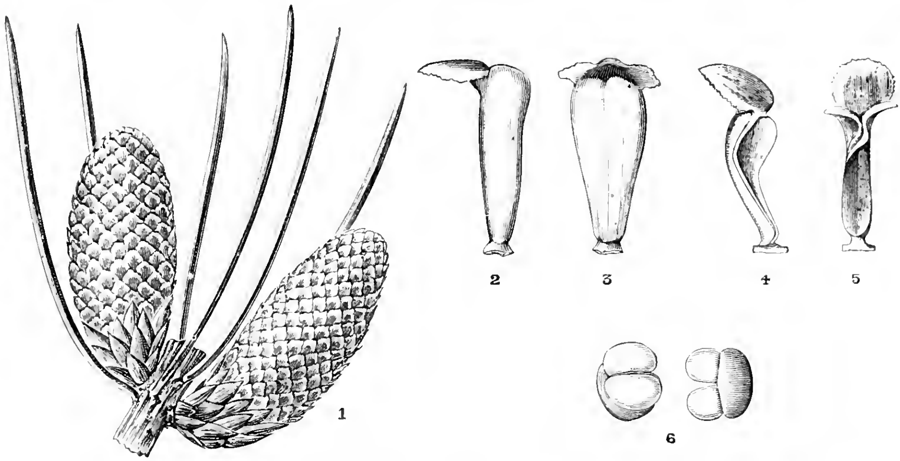


Fig. 107. 1, Staminate flowers of *Picea Smithiana*, nat. size. 2 and 3, side and front view of anther before dehiscence. 4 and 5, after dehiscence, enlarged five diameters. 6, Pollen grains, enlarged 120 diameters.

season and falling off after the dispersion of the seeds in the following winter, or persistent longer. Scales entire, denticulate or erose, gradually decreasing in size towards the two ends of the cone, always longer than the bract and bearing on the inner face two winged seeds.†

The Spruce Firs are evergreen trees, in their best aspect of conical or pyramidal outline. The trunk is tall and tapering, clothed with relatively thin bark, sometimes strongly buttressed at the base and regularly feathered with branches so long as it continues to increase in height; in old age usually denuded of branches for the greater part of

* E.g., *Picea excelsa* and *P. obovata*; *P. Glehnii* and *P. Alcockiana*; *P. alba* and *P. Engelmanni*; *P. nigra* and *P. rubra*.

† The most important botanical characters by which Picea is distinguished from Abies are:—The leaves are stomatiferous on the upper surface; the dehiscence of the anthers is longitudinal (not transverse); the scales of the cone are always longer than the bract, and persist after the dispersion of the seeds. Very obvious differences are also observable in the pendulous (not erect) cones with differently shaped scales; in the four-angled spine-tipped leaves of the greater number, and in the general habit of most of the species.

the height and furnished with a spire-like, sometimes rounded top. The primary branches are whorled (more correctly pseudo-whorled), often slender, elongated, twice—thrice ramified; the branchlets distichous and mostly opposite. The leaves are spirally arranged around the branchlets and more or less appressed to, or turned towards them, but occasionally apparently two-ranked and spreading on the lower side by a twist of the short petiole; they spring from a distinct outgrowth (pulvinus), and are either four-sided or flattened—characters which mark out the species into two sections, thus:—

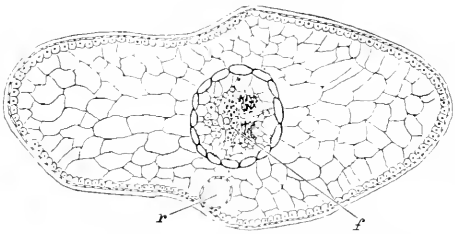


Fig. 108. Transverse section of leaf of *Picea excelsa.*

EUPICEA.—Leaves tetragonal, stomatiferous on all sides; resin canals one—two.

OMORICA.—Leaves flattened, stomatiferous only on the upper side; resin canals two.

This section includes only *ajanensis*, *Breweriana*, *Omorica* and *sitchensis*.

The Piceas form immense forests in the plains of Siberia, northern Russia and the British Dominion of North America, either pure or mixed with Larix; also on the slopes of the Alps, Ural, Altai, Rocky and other mountain ranges; in other regions they are less aggregated and frequently intermixed with other trees. Inhabiting generally the northern portion of the temperate zone, they are among the hardiest and in many respects among the most useful of trees; less striking in appearance than many of the Silver Firs, and therefore, with two or three exceptions, held in lower estimation as ornamental trees, they are of far greater economic value both on account of the quality of their timber and for the many purposes of utility for which some of the species are planted.

The Spruce Firs are of geological antiquity, although the strata which contain fossil evidence of their first appearance are relatively modern compared with those that bear witness to the first appearance of the Gingko, the Yew, the Araucarias and Sequoias The earliest vestiges of them occur in the Miocene (Middle Tertiary) Age; they seem to have increased in number until Pliocene times, when the common Spruce formed an ingredient of the British Flora, but subsequently disappeared under the extreme cold of the Glacial period. Picea is generally but not universally accepted as the classical name of the European Spruce Fir, some maintaining that Abies is the correct name; the weight of evidence, however, leans greatly in favour of Picea.*

* Perhaps the following lines from Virgil may help to solve the difficulty:—

"Instar montis equum, divina Palladis arte
Ædificant, sectaque intexunt *abiete* costas."—*Æneid*, II. 15.

The locality to which these lines refer is Troy, which stood near the foot of Mount Ida, now called Kas Dagh. On this mountain no Spruce Fir is known to grow, but the Silver Fir (Abies) is still abundant; differing somewhat from the European type it has been felicitously named var. Equi Trojani by Boissier.

Picea ajanensis.

A lofty tree attaining a height of 120 feet, occasionally upwards of 150 feet, the trunk covered with greyish brown bark fissured into small scale-like plates, and except when standing alone, free of branches for more than half the height. In Great Britain, a much-branched tree of broadly pyramidal outline, with the primary branches more or less ascending but sometimes horizontal. Branchlets distichous and opposite, with many short adventitious shoots on the upper side of the axial growth, the bark whitish or pale orange, with projecting rounded ridges running obliquely from the pulvini of the leaves. Buds small, broadly and obtusely conic, with ovate reddish brown perulæ. Leaves persistent seven nine years, spirally crowded, flattened, mucronate or obtuse, 0·5—0·75 inch long, the shorter ones on the upper side appressed and imbricated; the longer ones on the under side, pseudo-distichous or spreading; with a silvery white stomatiferous band on each side of the thickened midrib on the ventral side, bright green with a raised median line on the dorsal side. Staminate flowers solitary or in clusters of two—five near the distal end of lateral branchlets of the preceding year, cylindric-conic, 0·5—0·75 inch long, pale yellow. Ovuliferous flowers cylindric, erect, about an inch long, carmine-crimson before fertilisation. Cones cylindric, 1—2 inches long and 0·75—1 inch in diameter; scales oval-oblong, undulated, erose on the free edge. Seed-wings obovate-oblong, more than half as long as the scales.

Picea ajanensis, Fisher. Fl. Ochot in Middendorf. Reise. 87. tt. 22—24 (1856). Maximowicz. Prim. Fl. Amur. 1859. Masters in Gard. Chron. XIII. (1880), p. 115 XIV. p. 127. with figs.; Journ. Linn. Soc. XVIII. 508, with figs.; and Journ. R. Hort. Soc. XIV. 220. Hooker fil. Bot. Mag. t. 6743.
P. microsperma. Carrière. Traité Conif. ed. II. 339 (1867).
P. jezoensis, Carrière. Traité Conif. ed. II. 345 (in part).
P. Hondoensis. Mayr. Abiet. Jap. Reiches. 51. Tafel IV. fig. 9 (1890).
Abies ajanensis, Kent in Veitch's Manual. ed. I. 66 (1881).
A. microsperma. Lindley in Gard. Chron. (1861), p. 22. Murray. Pines and Firs of Japan, p. 69.
A. jezoensis, Siebold and Zuccarini. Fl. Jap. II. 19. t. 110 (1842), in part. Murray, Pines and Firs of Japan, 72. with figs. Gordon. Pinet. ed. II. 11 (Jessoensis).
Pinus Menziesii. Parlatore. D. C. Prodr. XVI. 418 (in part).
Eng. Yesso Fir. Germ. Ajan Fichte. Jap. Eso-matsu. Kuro-matsu.

Picea ajanensis is a northern tree attaining its greatest development in the Japanese Island of Yeso, where it is abundant, forming pure forests in the cold, swampy plains near the west coast, and much mixed with *Abies sachalinense* and *Picea Glehnii* on the central mountains. Northwards it spreads through Saghalien to the Kurile Islands, and on the Continent through the coast district of Amurland; southwards it occurs wild only on the central mountains of Hondo as far as the 35th parallel of north latitude.*

* Dr. Mayr considers the Hondo form of *Picea ajanensis* to be specifically distinct from the Yeso type, and has described and figured it as such under the name of *P. Hondoensis*. Abietineen des Japanischen Reiches, *loc. cit. supra.*; but neither the description nor the figures appear to justify the separation. The specific name, *microsperma*, was given by Lindley to a Spruce Fir brought from Hakodate by the late John Gould Veitch. which proved to be a weakly plant unsuitable for the climate of this country.

Picea ajanensis at Ochtertyre, Perthshire.

The wood is very light and soft, and much used in Yeso for all kinds of carpentry.

Picea ajanensis was introduced in 1861 by the late John Gould Veitch, and was subsequently distributed under the name of *Abies Alcoquiana* from the unfortunate circumstance that the seeds of both species brought home by him had been collected by natives and were mixed together, which may be accounted for by the custom then prevalent in Japan of applying the same name to different species having a superficial resemblance to each other.* It was not till several years afterwards, when the seedling plants growing side by side had attained a size sufficient to render the difference obvious, that the error could be rectified. As an ornamental tree in this country *Picea ajanensis* takes a high rank; its growth is slow during the first four or five years from the seed, during which period it frequently shows a tendency to produce rival leaders which should be reduced to one when observed; but when once established, especially in retentive soils, its growth is more rapid, the leader shoot increasing in height from 6 to 9 inches annually. It flowers at an early age, and in May, when loaded with its young crimson cones, it is one of the most beautiful objects in the Pinetum.†

Picea alba.

A tree varying greatly in height and dimensions in different parts of the great area in North America over which it is distributed; the maximum height east of the Rocky Mountains ranges from 60 to 70 feet with an average trunk diameter of 2 feet; at its northern limit it is reduced to a low shrub. Bark of trunk thin, greyish brown, fissured into irregular small plates. Branches relatively thick and long; in Great Britain rather close-set, rigid, and spreading horizontally. Branchlets opposite or alternate, the bark whitish brown with prominent rounded cortical outgrowths obliquely decurrent from the pulvini of the leaves. Buds broadly conic, about 0·25 inch long, with ovate, acute, keeled perulæ that are chestnut-brown. Leaves persistent four—five years, spirally crowded, four-angled, mucronate, mostly upturned from the twisting of the petiole of those on the under side of the shoot, 0·5—1 inch long, at first pale green, becoming darker with age, often with a bluish glaucous tint, and emitting a strong fetid odour when bruised. Staminate flowers cylindric, 0·5—0·75 inch long, pale red or yellow, suspended on slender peduncles. Cones sessile, sub-cylindric, obtuse, 1·5—2 inches long and 0·5—0·75 inch in diameter; scales loosely imbricated when mature, suborbicular, shortly clawed, minutely crenulate at the margin, pale brown with faint longitudinal striations on the exposed side.‡

* The same thing happened with *Tsuga diversifolia* and *T. Sieboldii*, and with *Pinus parviflora* and *P. pentaphylla*. As in the case of the Piceas, the cones of each pair of species were mixed together.

† Very beautiful specimens of *Picea ajanensis* are growing at Ochtertyre, Perthshire, the subject of our illustration; at Scone Palace and Murthly Castle in the same county; at Menabilly and Penearrow in Cornwall; at Warnham Court, Horsham; and in Ireland Kilmacurragh, Co. Wicklow; Hamwood, Co. Meath; and Fota Island, near Cork.

‡ I am indebted to the Director of the Arnold Arboretum, Harvard University, Mass. U.S.A., for American-grown branchlets and cones of *Picea alba*.

Picea alba, Link in Linnæa, XV. 519 (1841). Carrière, Traité Conif. ed. II. 319 (1867). Van Houtte, Flore des Serres, XXI. 157, t. 2251. Engelmann in Gard. Chron. XI. (1879) p. 334. Sargent, Forest Trees N. Amer. 10th Census, U.S.A. IX 204. Macoun. Cat Canad. Plants, 169. Beissner, Nadelholzk. 340, with fig. Masters in Journ. R. Hort. Soc. XIV. 220.

P. canadensis Sargent. Silva N. Amer. XII. 37. t. 598 (1898).

Abies alba. Michaux, Hist. Arb. Amer. I. 133, t. 12 (1810). Loudon, Arb. et Frut. Brit. IV. 2310, with figs. Forbes, Pinet Woburn, 95, t. 33. Nuttall, Sylva, III. 129. Hoopes, Evergreens. 157, with fig. Gordon, Pinet. ed. II. 3.

A. canadensis, Miller. Dict. ed. VIII. (1768).*

Pinus alba, Lambert, Genus Pinus, I. t. 26 (1803). Endlicher. Synops. Conif. 112. Parlatore. D. C. Prodr. XVI. 414.

Eng. and Amer. White Spruce. Fr. Sapinette blanche. Germ Weissfichte. Ital. Abete bianco.

The geographical distribution of *Picea alba* extends over the whole of British North America as far as the northern limit of arborescent vegetation; it also spreads through Alaska to Behrings Strait. South of the Dominion boundary it extends along the Atlantic coast of Maine, where it is constantly bathed in the spray of the ocean; also into the northern parts of the New England States; and westward it fringes the international boundary from northern Michigan to northern Montana. Throughout this enormous area it inhabits chiefly the alluvial soil on the banks of streams where it attains its greatest size and affords the best timber of the region. It is the most valuable tree in Newfoundland, in the inhospitable countries around Hudson's Bay, in the Yukon valley, and in the Klondyke around Dawson City. The wood is light, soft and straight-grained, with a satiny surface but not strong. The long tough flexible roots are used by the Indians of the north to fasten together the sheets of birch-bark of which they make their canoes, and to weave water-tight baskets, etc.†

According to Aiton, the White Spruce was introduced into Great Britain a little earlier than the year 1700, at which date it was in cultivation in Bishop Compton's garden at Fulham. It was formerly much more extensively planted than at present, when it had fewer competitors for favour among the Coniferæ; in the milder climate of this country it is comparatively short-lived, and soon loses the ornamental properties which render it so attractive an object in the rigorous climate of Canada and the north-west provinces of the Dominion. It is, however, still propagated in nursery gardens, and may occasionally be seen in road-side and other plantation belts associated with the commoner Conifers. The common form being of such little value as an ornamental tree, not much can be expected from any of the varieties, of which Beissner describes ten;‡ of these the best is doubtless that named *cærulea*, the Blue Spruce of our predecessors, of which a good specimen 45 feet high is growing in a light loam at Dolphinton in Lanarkshire.§

* This is the oldest published name of the White Spruce; left in abeyance or unnoticed by most subsequent authors, it has recently been revived by American botanists.

† Silva of North America, XII. 40.

‡ Nadelholzkunde, 350. The White Spruce is better adapted to the climate of Germany than of Great Britain.

§ The late Malcolm Dunn *in lit.*

Picea Alcockiana.

A medium-sized tree with the habit and aspect of the common Spruce, and of which the average height is estimated at 60—75 feet; in old age free of branches for about two-thirds of the height and with an irregular crown, the trunk covered with greyish brown bark fissured into scale-like plates. Branches stoutish with distichous ramification, depressed or horizontal. Branchlets mostly opposite, the bark pale yellow-brown marked with rounded ridges running obliquely downwards from the pulvini of the leaves, the youngest shoots pubescent. Buds ovoid, with broadly ovate, obtuse, closely imbricated perulæ. Leaves persistent five—seven years, spirally crowded around the branchlets, linear, mucronate, four-angled (rhomboidal) in transverse section, 0·5—0·75 inch long, with a white stomatiferous band on the two dorsal faces, bright green on the ventral sides; those on the upper side of the shoot more or less appressed to it, those on the under side turned away from it at an angle of 45°. Cones ovoid-cylindric, 2—3 inches long and 1—1·5 inch in diameter near the base; scales broadly obovate-cuneate, with slightly erose apical margin, and faintly striated on the exposed side; seed wings obovate-oblong, two thirds as long as the scale.

Picea Alcockiana, Carrière, Traité Conif. ed. II. 343 (1867). Masters in Gard. Chron. XIII. (1880), p. 212, with fig.; Journ. Linn. Soc. XVIII, 508, with figs.; and Journ. R. Hort. Soc. XIV. 221. Beissner. Nadelholzk. 377. with fig.

Abies Alcockiana, Lindley in Gard. Chron. 1861, p. 22 (Alcoquiana). Murray. Pines and Firs of Japan, 66, with figs. Gordon, Pinet. ed. II. 4.

Pinus Alcoquiana, Parlatore, D. C. Prodr. XVI. 417.

Picea bicolor, Mayr, Abiet. Jap. Reiches, 49, Tafel III. fig. 8 (1890).

Abies bicolor, Maximowicz in Bull. Acad. St. Petersb. X. 487 (1866). A. acicularis, Hort.

Eng. Sir Rutherford Alcock's Fir. Germ. Buntfichte. Jap. Ira-momi, Shira-momi. And others.

Picea Alcockiana is a rare and local species found only at high elevations scattered through the Oak and Beech forests, presenting in its home a wretched and forlorn appearance;* it is confined to the mountains of central Japan between the thirty-fifth and thirty-eighth parallels of north latitude. On Fuji-yama it occupies the central zone of forest vegetation at an altitude of 6,000 to 7,500 feet, mixed with *Abies Veitchii*, *Picea ajanensis* and *Larix leptolepis* at its lowest vertical limit. Here the younger trees have a more regular outline and bear much resemblance to the common Spruce. On account of its scarcity, the wood is not much used. *P. Alcockiana* was discovered by the late John Gould Veitch during an ascent of Fuji-yama in September, 1860, in company with Sir Rutherford Alcock, at that time British Minister at Tokio and whose name it commemorates.

As already stated under *Picea ajanensis*, seeds of that species and *P. Alcockiana* were brought home mixed together, and the seedlings were subsequently distributed under the latter name; but the seedlings

* Garden and Forest, VI. 494.

of *P. ajanensis* far outnumbered those of *P. Alcockiana*, whence large specimens of the latter are extremely rare in British Pineta. One of the best known to the author is at Blackford Park, near Edinburgh; it is a tree of remarkably handsome shape and healthy appearance, growing in a situation exposed to the full force of the westerly gales that sweep along the Pentland Hills, and where few other Conifers can thrive.*

Picea Breweriana.

A tree 80—100 feet high with a trunk 2—3 feet in diameter and furnished to the ground with crowded branches; at the top of the tree these are short with comparatively short pendulous lateral branches; below they are horizontal and clothed with slender, flexible, whip-like branchlets, often 7—8 feet in length, and not more than a quarter of an inch in thickness, and are furnished with numerous laterals of the same character and habit. Leaves abruptly narrowed and obtuse at the apex, straight or slightly incurved, rounded or obscurely ridged, and dark green on the lower surface; flattened and marked with rows of small stomata on each side of the midrib on the opposite surface, 0·75—1·125 inch in length. Staminate flowers oblong, 0·625 inch long, dark reddish purple with conspicuously toothed anther crests. Cones oblong, gradually narrowed from the middle to both ends, acute at the apex, 2·5—5 inches long, and 0·75—1 inch in thickness; when fully grown, dark purple or green, more or less tinged with purple, at maturity light orange-brown; scales broadly obovate, slightly thickened on the entire margin.—Sargent, *Silva of North America*, XII. 51, t. 601.

Picea Breweriana, Watson, Proc. Amer. Acad. XX. 378 (1885). Sargent in Gard. Chron. XXV. (1886), p. 498, with fig. Garden and Forest, III. (1890), p. 63, with figs.; and Silva N. Amer. *loc. cit.* Beissner, Nadelholzk. 350.

The following account of *Picea Breweriana* is derived almost solely from the great work from which the description was taken:—

"It is the most local and least known of all the American Piceas; it is scattered in small groves through an area of a few hundred acres of dry mountain ridges near the timber line on the northern slope of the Siskiyou mountains at an elevation of about 7,000 feet, just south of the northern boundary of California. There is a grove a few miles south of this, and it also covers a mile square on a high peak west of Marble Mountain, and it occurs again in three or four localities on the mountains of southern Oregon. It was discovered in 1884 in the first-named locality by Mr. Thomas Howell, a botanist of Oregon, and is named in compliment to Professor W. H. Brewer, who, more than any one in his generation, has brought to light by explorations in the forest the character and distribution of the Pacific coast Conifers."

Curiously enough, *Picea Breweriana* most resembles in leaf structure and in the form of its cone-scales the flat-leaved *P. Omorica* of the Balkan peninsula, the least known of European Conifers; in its weeping habit it approaches the *P. Smithiana* of the Himalaya mountains, and on that account alone it would be a most desirable tree for British

* Communicated by the late Malcolm Dunn.

parks and gardens, but little hope can be entertained of acquiring it. "Fires which are increasing every year in frequency and destructiveness are prevalent in all the dry mountain regions which form the boundary between north-western California and south-eastern Oregon, probably the only home of *P. Breweriana*, and it seems hopeless to expect that the relatively few isolated trees of this species can long escape their ravages." Moreover, attempts to raise seedlings on a large scale have signally failed, both at Waukegan in Illinois and in the Arnold Arboretum in Massachusetts; it is, nevertheless, most desirable that a trial should be made in the more equable climate of Great Britain, but the difficulties of obtaining seeds are apparently insurmountable.

Picea Engelmanni.

A lofty tree, at its greatest development 100—150 feet high with a trunk 4—5 feet in diameter covered with brown bark that is much furrowed in old trees. Branches in regular tiers at short intervals, the lower ones usually cast off as the tree advances in age, leaving the trunk bare for the greater part of its height. Branchlets slender, with light brown smooth bark which on the youngest shoots is whitish and pubescent. Buds conic, obtuse, about an eighth of an inch long, with loosely imbricated pale reddish brown perulæ. Leaves with a peculiar fetid odour when bruised, resembling that emitted by the bruised leaves of *Picea alba*, persistent four—five years, four-angled, pungent, 0·5—1 inch long, in close-set spirals and pointing forwards, those on the upper side of the axis nearly parallel with it, at first glaucescent, but at the end of the first season dark green. "Staminate flowers oblong-cylindric, about five-eighths of an inch long, with purple anthers, and raised on slender footstalks when fully grown." Cones ovoid-cylindric, variable in size, 1·75—2·5 inches long and 0·75—1 inch in diameter; scales thin, obovate-rhombic with a more or less erose-dentate margin.

Picea Engelmanni, Engelmann in Trans. St. Louis Acad. II. 212 (1863); and Gard. Chron. 1863, p. 1035. Carrière. Traité Conif. ed. II. 348 (1867). Beissner. Nadelholzk. 343, with fig. Masters in Journ. R. Hort. Soc. XIV. 221. Sargent. Silva N. Amer. XII. 43, t. 599.

P. columbiana, Lemmon in Garden and Forest, X. (1897). p. 183.

Abies Engelmanni, Parry in Trans. St. Louis Acad. II. 122 (1863). Hoopes. Evergreens, 177, with fig.

Abies commutata, Gordon. Pinet. ed. II. 5.

Pinus commutata, Parlatore. D. C. Prodr. XVI. 417 (1868).

Eng. and Amer. Engelmann's Spruce, Rocky Mountains Spruce.

Picea Engelmanni inhabits the Rocky Mountains from Alberta southwards to Arizona and New Mexico, forming in places extensive pure forests, especially in that part of its range which lies within the Canadian Dominion and in the States of Montana and Wyoming. Its vertical range varies to some extent with the latitude of the locality, reaching from 3,000 feet towards its northern to 11,500 feet towards its southern limit, often, in places, fringing the limits of arborescent vegetation where it is reduced to a stunted bush. *P. Engelmanni* also occurs west of the Rocky Mountains on the mountain ranges of Washington and Oregon, on the high mountains of eastern Nevada, and on Mounts Francisco and Graham in Arizona. The wood is light, soft, close and straight-grained, but not strong; where accessible it is used for all kinds of constructive work especially in Colorado and Utah. The bark is locally used for tanning.*

Picea Engelmanni was first specifically distinguished by Dr. C. C. Parry, who discovered it on Pike's Peak in Colorado in 1862; it was introduced into Great Britain shortly afterwards, probably in 1865. Apparently, seedlings have been raised in numbers so restricted that this Fir is still but seldom seen in this country. The variety described in the former edition as *P. Engelmanni glauca* does not belong to this species but to *P. pungens*: seedlings of *P. Engelmanni* with a highly glaucous foliage occasionally appear in the seed beds, but they may be distinguished from *P. pungens* by their softer, less rigid and far less pungent leaves, which emit an unpleasant odour when bruised.

The nearest affinity of *Picea Engelmanni* is *P. alba*; the former is essentially a tree of the mountains, the latter inhabits the woods and sand-hills of the plains. Distinct as they appear when growing side by side in a British nursery, it is not easy to formulate the characters by which they are specifically separated: the most obvious differences are seen in the cones and their scales. So closely do they sometimes resemble each other that, according to Professor Macoun, in northern Columbia the one merges into the other, the two being indistinguishable.† *P. Engelmanni* commemorates one of the ablest and most respected American botanists of his time.

George Engelmann (1809—1884) was born at Frankfort-on-the-Maine, where his father was a clergyman and master of a school. He entered the University of Heidelburg in 1827, but in the following year removed to Berlin University where he took the degree of Doctor of Medicine in 1831. He soon afterwards went to America and established himself at St. Louis, where he resided during the remainder of his life, being chiefly engaged in the practice of medicine, but devoting much of his spare time to botany. He helped forward in divers ways the botany of his adopted land: in the Coniferæ, the Oaks, Agaves and other genera, he became looked up to as the leading authority. At a time of life when most people would have preferred to remain at home, he visited the great forests of the West in company with three other eminent scientists, where fifty years previously Douglas had collected so many Conifers for the Horticultural Society of London. Much remained to be cleared up respecting these trees: their nomenclature and synonomy were under constant discussion with constantly varying results. Engelmann was enabled to gather many of the Conifers in the very localities indicated by Douglas, and to study their distribution and modifications as they diverged in one direction or another, or occupied different stations from the coast to the slopes of the mountains. He occasionally visited this country where his aid was sought in settling questions of nomenclature, as may be seen from the notes and memoranda with which he enriched the national herbarium at Kew.—*Gardeners' Chronicle*, XXI. (1884), p 321.

Picea excelsa.

A lofty tree, in places attaining a height of 125—150 feet, with a trunk 3—5 feet in diameter; the average height of full-grown trees in Great Britain ranges from 60 to 100 feet, according to locality and environment. In early age the bark is thin, smooth and of a reddish brown colour; later it becomes fissured into thin scales that are eventually cast off. Branches slender, in regular pseudo-whorls from

* Silva of North America, XII. 45.

† Catalogue of Canadian Plants, 470.

the base to the summit when the trees are standing alone and in the prime of life, the lowermost gently decurved and upturned at the tip, those higher up spreading horizontally, the uppermost slightly ascending; when the trees are crowded and in old age, the trunk is denuded of branches for a greater or less portion of the height and they have a thin spire-like crown. Branchlets distichous and mostly opposite, covered with corrugated orange-brown bark. Buds sub-conic, acute, about 0·25 inch long, with oval-oblong, reddish brown perular scales. Leaves persistent five—seven years, spirally crowded around the branchlets, those on the upper side pointing forwards at a small angle to the axis, those on the under side pseudo-distichous in two—three ranks, four-angled, compressed, mucronate, 0·25—0·75 inch long, lustrous grass-green. Staminate flowers solitary or two and three together near the distal end of branchlets of the preceding year, sub-cylindric, slightly tapering at each end, about 0·75 inch long, pinkish yellow, and surrounded at the base by numerous involucral scales. Cones pendulous, sub-cylindric or cylindric-conic, 4—6 inches long and 1—2 inches in diameter, scales sub-rhomboidal, truncate and toothed at the apex, light brown, striated; seed-wings oval, semi-transparent, pale brown.

Picea excelsa, Link in Linnæa, XV. 517 (1841). Carrière, Traité Conif. ed. II. 327. Willkomm, Forstl. Fl. ed. II. 67. Beissner. Nadelholzk. 351, with figs. Brown, James, The Forester, ed. VI. Vol. I. 328, with fig. Masters in Journ. R. Hort. Soc. XIV. 221.

Abies excelsa, De Candolle, Flore Franc. III. 275 (1805). Richard, L. C. Mém. sur les Conif. 69 (1826). Loudon. Arb. et Frut. Brit. IV. 2293, with figs. Forbes, Pinet. Woburn, 87. Gordon, Pinet. ed. II. 6. Lawson. Pinet. Brit. II. 135, tt. 19—20.

Pinus Picea, Duroi. Observ. Bot. 37 (1771). Endlicher. Synops. Conif. 116. Parlatore. D. C. Prodr. XVI. 415.

P. Abies, Linnæus, Sp. Plant. 1002 (1753). Lambert, Genus Pinus I. t. 25 (1803).

Eng. Spruce Fir, Norway Spruce, Common Spruce. Fr. Pesse, Epicea. Germ. Fichte, Rothtanne, Pechtanne. Ital. Abete rosso, Pezzo.

var.—Clanbrasiliana.

A low, dense, globose or rounded bush seldom seen higher than 5—6 feet; the branches, branchlets and leaves all much shortened and close-set. A supposed sterile variety. **Clanbrasiliana elegans** of larger dimensions and less dense in habit than *Clanbrasiliana*.

P. excelsa Clanbrasiliana, Carrière, Traité Conif. ed. II. 334. Abies excelsa Clanbrasiliana, Loudon, Arb. et. Frut. Brit. IV. 2294.

var.—dumosa.

A dwarf variety which fails to form an ascending trunk, and in which the branches are quite prostrate and furnished with numerous slender branchlets clothed with rather distant short mucronate leaves. Two other forms of similar habit and aspect have been named *procumbens* and *tabuliformis*.

P. excelsa dumosa, Carrière, Traité Conif. ed. II. 332. Beissner, Nadelholzk. 365.

var.—eremita.

A robust variety in which the branches are turned obliquely upwards at a small angle to the trunk, the branchlets stouter, shorter, and with larger winter buds than in the common form. Leaves distant, short, thick, spine-tipped and sometimes sub-distichous. **Remontii** is a dwarf modification of this.

P. excelsa eremita, Carrière, Traité Conif. ed. II. 330. Beissner, Nadelholzk. 362. Spitzfichte of German foresters.

var.—Finedonensis.

This shows an unusual change of colour in the young shoots and foliage which, when first developed, are pale yellow, afterwards gradually changing to yellowish brown and finally assuming the normal green of the species.

P. excelsa Finedonensis, Beissner Nadelholzk. 367. Abies excelsa Finedonensis, Gordon, Pinet. ed. II. 9. A. Finedonensis, Hort.

var.—Gregoryana.

A diminutive variety seldom growing more than 1—2 feet high, with numerous small spreading branches and branchlets thickly clothed with short stiff leaves spreading obliquely from all sides.

P excelsa Gregoryana, Beissner, Nadelholzk. 364. Abies excelsa Gregoryana, Gordon, Pinet. ed. II. 9.

var.—inverta.

A pendulous variety in which the lateral branchlets droop like those of *Picea Smithiana*, and which are clothed with larger, longer leaves of a lighter green than those of the common Spruce.*

P. excelsa inverta, Beissner, Nadelholzk. 361. Abies excelsa inverta, Gordon, Pinet. ed. II. 9.

var.—monstrosa.

A remarkable variety in which the energy of the plant appears to be expended in the formation of the principal branches at the expense of the lateral branchlets. The branches are long and straggling, almost without laterals, and clothed with bristly leaves usually longer and stouter than those of the common form.

P (Abies) excelsa monstrosa, London, Arb. et Frut. Brit. IV. 2295. P. excelsa denudata, Carrière, Rev. Hort. (1854). p. 102, with fig. P. excelsa viminalis, Caspary ex Masters in Journ. Linn. Soc. XXVII. 282. Gartenflora (1887). p. 521. Abbild. 128 Schlangenfichte of German gardens.

var.—mutabilis.

This is a modification of var. *Finedonensis*. The young shoots are at first light yellow which soon changes to golden yellow, and this again to the normal green of the species by the end of the first season. Other coloured forms have been named **aurea, argentea, variegata.**

P. excelsa mutabilis, P. excelsa aurea, etc. Hort. ; and Beissner, Nadelholzk. 367.

var.—pendula.

As distinguished from *inverta*, the primary branches are produced at irregular intervals, and with their appendages hang downwards at a greater or less distance from the trunk.

P. (Abies) excelsa pendula, London. Arb et Frut. Brit. IV. 2294 Beissner, Nadelholzk. 360. Weeping Spruce Fir.

var.—pumila.

A dwarf variety of conical habit, with much shortened branches and branchlets clothed with dark green glaucescent foliage; the leaves spread from all sides of the branchlets.

P. excelsa pumila, Hort. Abies pumila glauca, Hort. A. pumila nigra, Hort.

* This curious deviation from the type was first detected by Mr. R. Smith Carrington in a plantation near Kinlet Hall, Shropshire.—The Garden, XXV. (1884). p. 229.

var.—pygmæa.

A diminutive dense bush in which the branches are excessively shortened and all their parts similarly diminished. Leaves small, pungent, and very close set. **var. echinoformis** is a slight modification of this.

P. Abies excelsa pygmæa, Loudon, Arb. et Frut. Brit. IV. 2295. P. excelsa echinoformis, Beissner, Nadelholzk. 364. P. excelsa minima, Hort.

The common Spruce Fir is one of the most widely distributed of the European Coniferae. The region over which it is spread may be broadly expressed as extending west to east from the Pyrenees to the Ural mountains, and north to south from Lapland to the Alps of northern Italy; it does not, however, occur wild in Great Britain, Denmark and Holland. Its geographical limits have been carefully investigated by Professor Willkomm who gives the following interesting facts, among many others, respecting its distribution.

Its north-western limit occurs on the Norwegian coast about lat. 67° N. and in east Finmark its extreme northern point is reached in 69° 30′ N. From this point eastwards, its northern range sinks gradually till it reaches the Ural mountains in lat. 63° N. where it meets the Siberian Spruce, *Picea obovata*, with which it is often intermixed along its eastern limit; its farthest point in this direction is placed near the confluence of the Wjalka (Viatka) and Kama rivers in lat. 55° where its southern limit commences; this trends in a south-western direction across Russia to the Carpathian mountains which it follows southwards and along the connecting ranges to Mount Kopaonik in Servia about lat. 43° N. Westwards from this locality it follows the slopes of the mountains through Croatia, Styria and the Alps along their whole extent to Nice; it then crosses the Cevennes and reaches the central Pyrenees on which it occurs but sparingly. The western limits of the common Spruce Fir have a very irregular outline extending from the Pyrenees through central France to the Vosges and thence along the mountains of south-west and central Germany through Saxony to Silesia and Pomerania. The altitude to which it ascends on the mountains varies inversely with the latitude of the locality: in Norway its highest vertical limit is from 2,500 to 2,900 feet above the level of the ocean; on the Harz mountains 3,000 feet; on the Bavarian Alps 4,500 feet; on the Tyrolese and Swiss Alps 6,500 feet; but although the vertical limit is gradually higher in proceeding from north to south, there are instances in which this limit is lowered, chiefly in the south-west, the cause of which is ascribed to the lower hygrometric condition of the atmosphere. In the northern and central parts of its range, the Spruce Fir descends into the plains and in places covers considerable areas; in the southern parts it is essentially a mountain tree, more scattered and forming but small stretches of pure forest.

The German Forestry authorities distinguish two principal forms (Hauptformen) of the Spruce Fir, the red-coned *erythrocarpa* and the green-coned *chlorocarpa*; this difference in the colour of the cones is always accompanied by a difference in the habit of the tree and in the quality and texture of the wood. Besides these Hauptformen, several geographical or climatic varieties are also recognised, which although closely resembling each other in many respects, are designated by names for the most part indicative of the region in which they are found; the most noteworthy of these are:—*alpestris*, common in parts of the Swiss Alps; *carpatica* which has been introduced into Great Britain from the Carpathian mountains; *hyrcinica* found on the Harz mountains; and *medioxima*,* common in north Scandinavia, Finland and Russia. These geographical forms are distinguished from the common type chiefly by their smaller dimensions, denser habit, shorter leaves and smaller cones. They are botanically interesting as intermediate states between *Picea excelsa* and *P. obovata* and between *P. excelsa* and *P. orientalis*, but for British arboriculture they are relatively worthless.

It is, however, under cultivation and in the seed beds that the surprising variability of the common Spruce Fir is most manifest; but although deviations from the ordinary type are extremely numerous, they take place in comparatively few directions and thence admit of a loose kind of grouping under four heads which may be designated: 1, dwarf, 2, snake-branched, 3, pendulous, and 4, coloured. The most distinct and the most useful of the forms in each group for garden decoration in this country are those described in the preceding pages, but many others, closely resembling or intermediate forms have also received distinguishing names.†

The Spruce Fir in Great Britain, in its normal form, is of more concern to the forester than the horticulturist; nevertheless, under conditions favourable for its development, it is one of the most picturesque of coniferous trees for the park and landscape when standing singly and feathered with branches from the base to the summit. The rate of growth of the leader shoot after the first three or four years from the seed, ranges from one to three feet annually, according to situation, up to twenty-five—thirty years, when it very gradually diminishes till the tree attains its maturity, which takes from seventy to one hundred and twenty years, according to locality. It is also highly appreciated as an ornamental tree in the northern and middle States of North America, but it is comparatively short-lived; it grows with vigour and rapidity for thirty to forty years, but healthy trees of more than fifty years old are uncommon, so that it is not suited for economic planting in North America.‡ On account of its hardiness and its power of resisting the force of high winds the Spruce Fir is one of the best of trees for the formation of protective screens for the more tender Coniferæ in their young state; but the

* This is described and figured as a species by Andrew Murray in Lawson's Pinetum Britannicum, Vol. II. p. 159, t. 23.

† Beissner, Nadelholzkunde, pp. 355—367, has described upwards of sixty varieties of the common Spruce Fir including the Hauptformen and geographical varieties. Some of the closely resembling forms have originated in different countries, as *monstrosa*, England; *viminalis*, Sweden; *virgata*, Norway; *denudata*, France.

‡ Garden and Forest, Vol. X. p. 481.

limits of temperature under which it can thrive is not less than 10° C. (50° F.) for the average July temperature, nor can it exist with an average January temperature below—12° C. (about 10° F.): although it can endure an average July temperature of 18·75 C. (67° F.) it languishes when the average is above this.*

The wood is light, even in grain, easy to work and durable, but the quality of Spruce timber is influenced by the soil and situation upon which it is produced. It is used for all kinds of building and constructive purposes; it is sawn into boards for flooring, and planks for roofing and fencing; poles, ladders, telegraph posts and railway ties are made of it; toys for children and sounding boards for musical instruments; for the last-named purpose, a variety of the Spruce Fir found on the mountains of Styria, Bavaria and Bohemia is particularly suitable on account of the relatively broad annual rings of its wood, of which the dark, dense summer growth is very narrow.† Large quantities of the wood are made into charcoal, and still larger quantities are used for fuel; and in Germany an enormous bulk of Spruce wood is annually converted into paper pulp. The bark is used for tanning leather in localities in which the Spruce Fir is abundant, but it is said to be inferior to the bark of the Larch for this purpose. At Christmas-time thousands of young trees or tree-tops are decorated for the amusement of children.

The Spruce Fir is mentioned in Turner's "Names of Herbes," published in 1548, which shows that it has been cultivated in Great Britain more than three hundred and fifty years. Many fine specimens are scattered over the country, but the largest occur in the north; there is one at Studley Royal, near Ripon, 132 feet high and 12½ feet in girth near the base;‡ one at Lynedoch, near Perth, 108 feet high and 10¼ feet in girth at five feet from the ground; and another at Dronach Haugh, not far distant, 119 feet high and nearly 10 feet in girth.§ Although not a native of Great Britain undoubted proofs of the Spruce Fir having been a denizen of this country in late Tertiary times are found in the remains met with in the Pliocene Clays of Norfolk.

Picea Glehnii.

A tall tree, in favourable situations over 100 feet high with a trunk usually free of branches for 60 or more feet, but of much smaller dimensions at its northern limit. Bark of trunk reddish brown fissured into broad thin plates.‖ "Branches spreading with short internodes, reddish, covered with shaggy down; smaller branches given off at an

* Willkomm, Forstliche Flora von Deutschland und Oesterreich. ed. II. p. 82.
† Beissner, Nadelholzkunde, p. 355.
‡ Conifer Conference Report, p. 198. This tree is mentioned by Loudon in the Arboretum et Fruticetum Britannicum. Vol. IV. p. 2297. as the largest Spruce Fir known to him.
§ The dimensions of the two Perthshire trees were communicated by Mr. Pitcaithley, forester to the Earl of Mansfield, on whose estate they stand.
‖ Mayr, Abietineen des Japanischen Reiches. p. 58.

angle of about 50°; pulvini oblong-linear; buds sub-globose with brown ovate perulæ. Leaves crowded in many rows, ascending at an angle of about 45°, curved, linear, four-sided, sharply pointed, the concave sides slightly glaucous, the convex sides green. Cones cylindric or ovate-oblong, 1—2 inches long and 0·75 inch in diameter; scales leathery, slightly striated, wedge-shaped, the upper free edge rounded, denticulate; bracts much shorter than the scale, broadly lanceolate. Seed wings obliquely obovate."—Masters in *Gardeners' Chronicle* XIII. (1880), p. 300.

Picea Glehnii. Masters in Journ. Linn. Soc. XVIII. 512, with fig. (1881); Gard. Chron. *loc. cit. supra.*; and Journ. R. Hort. Soc. XIV. 222 Mayr. Abiet des Jap. Reiches. 56. Tafel IV. fig. 11. Beissner. Nadelholzk. 377.

Abies Glehnii. Schmidt. Reisen im Amurland und auf der Insel Sachalin, 1866, p 176, with fig.

Like *Picea ajanensis* with which it is in places associated, *P. Glehnii* is a northern tree, restricted, so far as at present known, to the southern part of the island of Saghalien, the island of Yeso, and districts in the adjacent coast region of Russian Manchuria, but nowhere very abundant except around Lake Kucharro in Yeso where it attains its greatest development. The wood is light and soft, and where the tree is common and easily accessible, it is much used by the natives for all kinds of carpentry.

Picea Glehnii was discovered during an exploration of the Amur region and the island of Saghalien in the early "sixties" by the German botanist Friedrich Schmidt who was accompanied by Glehn after whom it is named. Botanically it is described as standing midway between *P. obovata* and *P. Alcockiana*, thus forming one of the connecting links in the series of Piceas which spread across the Euro-asiatic continent from Norway to Japan. According to Beissner *P. Glehnii* has been introduced into Germany and probably into Great Britain,* but no estimate can be yet formed of its merits as a garden or forest tree in this country.

Picea nigra.

A low or medium-sized tree 25—50 feet high, but under exceptional conditions attaining a height of nearly 100 feet with a straight trunk diminishing regularly from the base to the summit. Usually the trunk is slender, often not more than a foot in diameter, covered with reddish brown bark which in the oldest trees growing in Great Britain is fissured into small irregular plates. On the borders of forest lakes *Picea nigra* is often a stunted tree a few feet high, and at its northern limit a semi-prostrate shrub. As seen in Great Britain—branches spreading and much ramified, the lowermost decumbent, those above the middle more or less ascending. Branchlets short, mostly distichous, but sometimes in pseudo-whorls of three—four. Buds small, ovoid, chestnut-brown. Leaves persistent five—seven years, spirally crowded, four-angled with short callous tips, straight or slightly curved towards their axis, 0·25—0·75 inch long, with glaucous stomatiferous bands on

* Of the very few sprays sent to me as *Picea Glehnii* some were indistinguishable from *P. Alcockiana*, and the others were certainly *P. ajanensis*.

the two sides turned towards the axis, bluish green on the two opposite sides. Staminate flowers sub-globose, dark red, about an eighth of an inch long. Cones ovoid-cylindric, obtuse, 1·25—1·5 inch long, almost globose after the dispersion of the seeds, at first dark brown-purple, at maturity greyish brown and persisting on the tree several years; scales broadly oval, denticulate. Seed-wings obovate, oblique, 0·5 inch long.

Picea nigra, Link in Linnaea, XV. 520 (1841). Carrière, Traité Conif. ed. II. 323. Engelmann in Gard. Chron. XI. (1879), p. 334, excl. var. *rubra*. Sargent, Forest Trees N. Amer. 10th Census U.S.A. IX. 202. Macoun, Cat. Canad. Plants, 468. Beissner, Nadelholzk. 332, with figs. Masters in Journ. R. Hort. Soc. XIV. 222.

P. Mariana, Sargent, Silva N. Amer. XII. 28, t. 596.

Abies nigra, Michaux, Hist. Arb. N. Amer. I. 123, t. 11 (1810). Loudon, Arb. et Frut. Brit. IV. 2312, with figs Forbes, Pinet. Woburn, 97, t. 34. Hoopes, Evergreens, 169. Gordon, Pinet. ed. II. 13.

A. Mariana, Miller, Dict. ed. VIII. No. 5 (1768).*

Pinus nigra, Lambert, Genus Pinus, I. t. 27 (1803). Hooker, W. Fl. Bor. Amer. II. 163. Endlicher, Synops. Conif. 115. Parlatore, D. C. Prodr. XVI. 413.

Eng. and Amer. Black Spruce. Fr. Sapinette noir. Germ. Schwarzfichte. Ital. Abete nero.

Picea nigra is distributed over nearly the whole of the British Dominion of North America from Newfoundland to Yukon whence it spreads into Alaska. Its northern limit is the limit of arborescent vegetation which on the North American continent occurs about lat. 67° N. in the Mackenzie valley, but on the eastern side of the continent this limit is near the southern shore of Ungava Bay or nearly ten degrees further south. South of the Dominion boundary the Black Spruce is most abundant around the great lakes where it attains its largest size. It spreads through the New England States into New York, New Jersey and Pennsylvania, occupying for the most part the swampy districts, but it is nowhere very common. Distributed over such an enormous area and growing under manifold conditions of climate and environment, the Black Spruce is found to vary greatly in habit and dimensions: in the cold sphagnum swamps it rarely attains a great size, but on the alluvial lands of Athabasca, even as far north as the 58th parallel, trees 80 feet high and three feet in diameter have been noted. But perhaps the most remarkable conditions under which the Black Spruce is enabled to find a foothold, occur in northern Wisconsin where it is called the Muskeag Spruce; its aspect and state in this region are thus described by H. E. Ayres in the American "Garden and Forest," Vol. VII. p. 504:—

"On the borders of small forest lakes which are being covered with sedges and sphagnum, *Picea nigra* is able to exist without mineral soil, and one may put them under water by standing on the bog at their roots. They grow very slowly, the annual rings of their small trunk being sometimes so minute as to be indistinguishable by the naked eye. These little old trees are found bearing cones when only

* This is the oldest specific name but it was left in abeyance for more than a century by most subsequent authors.

two or three feet high, and as their energies appear to be entirely expended in producing seeds, the fertile branches become the only vigorous ones. The cones are densely crowded near the top of the tree, while the trunk below is often destitute of living branches, although unshaded and growing far from other trees. These dense tufts of dark branches, like plumes upon poles, present a strange spectacle to the traveller who for the first time crosses the larger muskeags, especially at twilight, for he seems to be looking over a weird procession stretching mile after mile until lost in the distance. On the smaller muskeags there is often a regular gradation of size from the smallest seedlings by the water in the centre of the bog to the tall slender trees, sometimes 60 feet high, upon the shores of the basin with their drooping branches which are freely developed in the better soil of the high margins, and trunks which rarely exceed eight inches in diameter."

In striking contrast to the Muskeag form is a remarkable variety found on the highest summits of the Adirondacks. It is the variation of the tree into a mere procumbent shrub, so small that it offers but little impediment to him who would walk over it. These bushes are more or less flattened in outline, the branches issuing nearly from the opposite sides of the trunk as in the Ground Hemlock (Canadian Yew). They grow in dense patches, completely covering the ground, and in numerous instances with their apices all pointing the same way.

The wood of the Black Spruce is light and soft, but not strong. Within the United States and in the border counties of the Canadian Dominion it is used chiefly for the manufacture of paper pulp; in Manitoba and Saskatchewan where the trees afford planks of greater scantling, the timber is used for the same purposes as that of the common Spruce in Europe. Of the minor products the most extensively used are Spruce gum and Spruce beer.

Spruce gum is the resinous exudation of the Black and other eastern American Spruces. It is collected in considerable quantities in winter in New England and Canada by men on snow-shoes carrying long poles armed with chisels, with which the viscous masses are knocked or cut off and caught in small cups attached to the poles just below the chisels. It is dissolved in alcohol and occasionally used in medicine.

Spruce beer was formerly made by boiling the branches of the Black and Red Spruces with honey; it is now made from the essence of Spruce, which is a liquid of the colour and consistency of molasses with a bitter, astringent, acid flavour; it is obtained by boiling the young branches of the Black and Red Spruces in water, and evaporating the decoction. To prepare the beverage, the essence of Spruce is boiled in water flavoured with various ingredients and then mixed with molasses, or occasionally with sugar, allowed to ferment, and bottled.* Spruce beer is considered a pleasant beverage in hot weather.

The Black Spruce was introduced into Great Britain by Bishop Compton about the year 1700, or a little earlier †; and has since been more generally cultivated in this country than either of the three eastern American Spruce Firs, although its ornamental qualities are not of

* Silva of North America, XII. 31. † Aiton, Hortus Kewensis, ed. II. Vol. V. p. 319.

a very high order, especially on dry soils for which it is totally unsuited. In moist retentive loams where it retains its leaves for several years and acquires a dense habit, the distinct hue of its foliage renders it an acceptable tree for contrast. Besides the many varieties found wild in North America, others have originated under cultivation in Europe, but none of them have any especial value as decorative plants in this country. In Germany, where the Black Spruce is much cultivated as a decorative tree, more attention is given to deviations from the common form, and some of the varieties as *Doumetti* and *Mariana* are, according to Beissner, highly prized.

Picea obovata.

A tree 60—80 feet high, resembling the common Spruce in habit and aspect. Branches slender, more or less pendent or depressed. Branchlets pubescent the first year, with light reddish brown bark marked by shallow longitudinal oblique ridges decurrent from the pulvini of the leaves. Buds conic, scarcely 0·25 inch long, with chestnut-brown perulæ. Leaves four-angled, spine-tipped, 0·5—0·75 inch long, bright green; on the upper side of the branchlets more or less pointing forwards at an acute angle to the axis, and mostly incurved; on the under side erect or pseudo-distichous in two—three ranks. Cones ovoid-cylindric, approaching spindle-shaped, 2·5—3 inches long, reddish brown; scales orbicular, cuneate with a narrow claw, roundish or truncate on the apical side; seed wings oval, about half as long as the scale.

Picea obovata, Ledebour, Fl. Altaica, III. t. 499; IV. 201 (1833). Link in Linnæa, XV. 518 (1841). Carrière, Traité Conif. ed. II. 237. Willkomm, Forstl. Fl. ed. II 93. Beissner, Nadelholzk. 368. Masters in Journ. Linn. Soc. XVIII. 506; and Journ. R. Hort. Soc. XIV. 223.
Abies obovata, London, Arb. et Frut. Brit. IV. 2329. Gordon, Pinet. ed. II. 14.
Pinus obovata, Endlicher, Synops. Conif. 119. Parlatore, D. C. Prodr. XVI. 415.
Eng. Siberian Spruce. Fr. Sapinette de Siberie. Germ. Altai Fichte, Sibirische Fichte.

Picea obovata covers extensive areas in east and north-east Russia, whence it spreads eastwards through the greater part of Siberia to the Sea of Okhotsk, and also into Kamtschatka and the Kurile Islands. Its northern limit in Europe is just within the Arctic Circle where it crosses the Ural mountains, the highest latitude of its range, which nearly coincides with the northern limit of arborescent vegetation, receding southwards through Asia with the increasing cold of the climate. The southern limit is but imperfectly known, but is believed to follow the trend of the Altai mountains as far as the Amur region, ascending to 4,000 feet above sea-level, and in places forming extensive forests.

Willkomm considers *Picea obovata* to be a climatic variety of *P. excelsa*, whose place it takes in the great region over which it is spread. Transitional forms in the size and shape of the cones and also of the cone-scales are frequent in Russia where the two Spruces meet, some of which may, however, be due to hybridity. Seedlings of *P. obovata* raised under cultivation usually preserve the distinctive characters.* The Siberian Spruce is scarcely known in Great Britain, and no full description of it appears to have been published. It is cultivated in north Germany and Russia as an ornamental tree, where, on account of its slender, sub-pendulous habit, it affords a pleasing addition to the few coniferous trees available for so vigorous a climate. A variety discovered by Maximowicz in the extreme part of its range, and introduced by him under the name of *P. obovata japonica*, is also in cultivation in German gardens; † and another, or the same variety, has been introduced into British nurseries as *P. Maximowiczii*, but like the typical form it soon perishes under the stimulus of the higher temperature of this country. In such a climate as that of northern Russia and Siberia, the economic importance of *P. obovata* is very great.

Picea Omorica.

A tall, slender tree with a spire-like top, in places attaining a height of 125 or more feet, with a trunk not more than 18—24 inches in diameter covered with reddish brown bark. Branches short in proportion to height of trunk, the lowermost decurved and upturned at the tip, those above horizontal or ascending. Branchlets distichous and mostly opposite, often with a third weaker growth on the under side of the axial shoot; bark pale brown, prominently fluted longitudinally, the youngest growths pubescent. Buds globose-conic, about an eighth of an inch long, invested with red-brown, ovate-lanceolate perulæ. Leaves persistent four—five years, sessile, narrowly linear, flattened with thickened midrib and short callous tip, 0·25—0·75 inch long, with two greyish white stomatiferous bands on the (morphologically) upper or ventral side, lustrous green on the dorsal side; those on the ascending shoots standing out from all sides; on the lateral shoots pointing forwards on the upper side, pseudo-distichous in three—four ranks on the under side. Staminate flowers shortly stalked, ovoid-cylindric, bright red, 0·5—0·75 inch long, surrounded at the base by numerous involucral bracts. Cones ovoid-conic, obtuse, 1·5—2 inches long and 0·75—1 inch in diameter, bluish black while growing, dark brown when mature, standing out horizontally or sub-pendulous; scales suborbicular, convex, with undulate denticulate margin.

Picea Omorica, Pancic ex Bolle in Monatschrift des Vereins zur Beförderung des Gartenbaues, 1877. Masters in Gard. Chron. VII. (1877), pp. 470, 620; XXI. (1884), p. 308, with fig.; Journ. Linn. Soc. XXII. 203, with fig.; and Journ. R. Hort. Soc. XIV. 223. Willkomm. Forstl. Fl. ed. II. 99. Beissner, Nadelholzk. 382, with fig.

Eng. Servian Spruce. Germ. Omorika-Fichte.

Picea Omorica has a very restricted habitat on the mountains of south-west Servia and their prolongation into the neighbouring States of Bosnia and Montenegro, occurring singly or in small groves at elevations ranging from 2,000 to 4,000 feet, forming forests only in

* Beissner, Nadelholzkunde, 369.

† I am indebted to Mr. Späth of Baumschuleweg, near Berlin, for branchlets of *Picea obovata* and its variety *japonica*.

the most inaccessible places. It was discovered near Zaovina in Servia, in 1872, by Dr. Pancic of Belgrade, and subsequently introduced by him into European gardens.

The Servian Spruce Fir is of considerable scientific interest on account of its comparatively recent discovery and its restricted habitat; and moreover, that its nearest affinities are not the two species geographically contiguous to it—*P. excelsa* and *P. orientalis*—but two that are most remote, *P. sitchensis* (north-west America) and *P. ajanensis* (Japan), forming with them a distinct section of the genus. Willkomm is of opinion that *P. Omorica* had formerly a more extensive distribution but became exterminated for the sake of its timber, and that it has been preserved within its present narrow limits by its greater inaccessibility. The name Omorica, or Morica, is the vernacular name by which it is known in the region it inhabits. Its introduction into British gardens is too recent to admit of any expression of opinion respecting its merits as an ornamental tree, the only purpose for which it should be planted in this country. It grows slowly during early life, but it has proved hardy thus far, and it is quite distinct in habit and aspect from every other Spruce Fir.

Picea orientalis.

A medium-sized or tall tree according to situation; the trunk 50—80 feet high and 1·5—2·5 feet in diameter, covered with ash-brown rugose bark which in old trees is fissured into irregular thin plates. In Great Britain, densely branched from the base upwards and presenting a pyramidal outline broken by projecting branches. Branches horizontal, the uppermost slightly ascending, ramification distichous; branchlets opposite or alternate with pale reddish brown bark fluted with shallow cortical out-growths as in *Picea excelsa*. Buds broadly conic, acute, 0·25 inch long, chestnut-brown. Leaves persistent seven—nine years, spirally crowded and closely appressed to the branchlets except on the under side where they spread laterally at a small angle to the shoot, obscurely four-angled, obtuse, 0·3—0·5 inch long, dark lustrous green. Staminate flowers solitary or in pairs mostly near the end of shoots of the preceding year, cylindric-conic obtuse, carmine-red, surrounded at the base by small involucral bracts in two series; connective of anther suborbicular and minutely denticulate. Cones conic-cylindric, 2—5 inches long and 0·75 inch in diameter; at first dull violet-purple changing to brown when mature; scales obovate-oblong, 0·65 inch long, closely imbricated, the exposed apical margin entire. Seed wings obovate-oblong, half as long as the scale.

Picea orientalis, Carrière, Traité Conif. ed. I. 244 (1855); and ed. II. 325 (1867). Boissier, Fl. orient. V. 700. Willkomm, Forstl. Fl. ed. II. 97. Masters in Gard. Chron. XXV. (1886), p. 333, with fig.; III ser. 3 (1888), p. 754; and Journ. R. Hort. Soc. XIV. 223. Beissner, Nadelholzk. 374, with fig.

Abies orientalis, Poiret. Dict. VI. 518 (1804). Loudon, Arb. et Frut. Brit. IV. 2318. Gordon, Pinet. ed. II. 15. Lawson. Pinet. Brit. II 163, t. 23 and figs.

Pinus orientalis, Linnæus, Sp. Plant. ed. II. 1421 (1763). Bieberstein, Fl. Taurico-Caucas. II. 409 Endlicher, Synops. Conif. 116. Parlatore, D. C. Prodr. XVI. 414.

Eng. Eastern or Oriental Spruce. Fr. Sapinette d'Orient. Germ. Morgenlandische Fichte, Sapindusfichte. Ital. Abete orientale.

The botanical history and geographical distribution of the Oriental Spruce is only to be gleaned from a few scattered records by explorers of the region over which it is spread, commencing from the early part of the eighteenth century. It was first detected by Tournefort on the mountains south-east of Trebizond, where it is still abundant, and a brief description of it is given in his "Voyages," published in 1717. After a long interval followed the Russian botanists sent to explore the Caucasian region, the earliest of whom was Pallas, who described the tree in his "Flora Rossica" as *Pinus Picea*, thus mistaking it for the European Spruce, but Bieberstein some years later recognised it as a distinct species under Tournefort's name of *Pinus orientalis*. It was described by Loudon in the "Arboretum et Fruticetum Britannicum" as an unintroduced species at the date of publication of that work (1838), but it is supposed to have been introduced into Great Britain two or three years afterwards. Subsequent explorations of the Caucasian region show that the geographical range of *Picea orientalis* is almost conterminous with that of *Abies Nordmanniana* with which it is in many places associated, but it ascends to a higher altitude. Its western limit is on the mountains south-east of Trebizond whence it spreads over the whole mountainous region bounded on the north by the high chain of Caucasus proper, as far east as Tiflis, its further spread in that direction being prevented by the arid climate of the steppes of eastern Georgia. On all the mountains it has a vertical range varying from 2,000 to 6,000 feet above sea-level, always ascending to

Fig. 109. *Picea orientalis.* Branchlet with staminate flowers.
(From the *Gardeners' Chronicle.*)

Picea orientalis at Highnam Court, Gloucester.

the highest limits that can be reached, a circumstance that accounts for its hardiness in a higher latitude.

Nothing authoritative is found respecting the economic uses of *Picea orientalis*. Whatever may be the quality of its timber it is probably not much used in the Caucasian provinces, that of *Abies Nordmanniana* being more easily accessible. In this country *Picea orientalis* is planted solely as an ornamental tree, and as such it is one of the most effective of the Spruce Firs; * although the habit is of the same pyramidal character the formality is much diminished by the projection of many of its slender branchlets, which makes the outline peaked and pointed. The colour of the foliage is not only distinct but also attractive; when the buds first cast off their scaly protection, and burst into growth in spring, the tender shoots are bright yellow, and as they lengthen, the leaves become a soft delicate green, forming a beautiful contrast to the rich colouring of the mature foliage. *A. orientalis* should have a place in every collection of Conifers; it is quite hardy, but of rather slow growth in dry soils; a space with a radius of not less than 15 to 20 feet should be allowed for it.

Picea polita.

A tall or medium-sized tree according to situation and environment, in exceptional cases attaining a height of 100 feet in the warmer parts of Japan. In Great Britain the oldest trees scarcely exceed 30 feet high, with a broadly conical outline interrupted by projecting branches. Bark of trunk rugose, reddish brown. Branches spreading or ascending, much ramified at the distal end, and covered with brown bark roughened by the convex pulvini of the fallen leaves. Branchlets distichous and opposite, with many adventitious shoots of weaker growth both on the upper and lower side of the branch; bark light yellow-brown with oblique rounded ridges. Buds globose-conic, 0·25—0·4 inch long, with ovate shining reddish brown perulæ. Leaves persistent seven—nine years, spirally arranged around their axes, spreading on all sides from it, or slightly curved upwards, acicular, 0·5—0·75 inch long, obscurely four-angled, flattened at the tip into a pungent mucro, light green. Cones ovoid-cylindric, obtuse, 3—4 inches long and 1·5—2 inches in diameter; scales suborbicular, abruptly cuneate at the base, the outer margin rounded and minutely erose. Seed-wings obovate-oblong, two-thirds the length of the scale.

Picea polita, Carrière, Traité Conif. ed. I. 256 (1855); and ed. II. 342 (1867). Masters in Journ. Linn. Soc. XVIII. 507; Gard. Chron. XIII. (1880), p. 233, with fig.; and Journ. R. Hort. Soc. XIV. 223. Mayr. Abiet. des Jap. Reiches, 46, Tafel III. fig. 7. Beissner, Nadelholzk. 380, with fig.

Abies polita, Siebold and Zuccarini. Fl. Jap. II. 20, t. 111 (1842). Murray. Pines and Firs of Japan, 77, with figs. Gordon. Pinet. ed. II. 16.

Pinus polita, Endlicher, Synops. Conif. 121 (1847). Parlatore, D. C. Prodr. XVI. 417.

Eng. Prickly Fir, Tiger's-tail Spruce. Fr. Epicea à queue de Tigre. Germ. Stachelfichte, Rosenfichte, Glattzweigigefichte. Jap. Hari-momi, Tora-momi.

* Among the many fine specimens of *Picea orientalis* scattered over Great Britain and Ireland, those at Highnam Court, Bayfordbury, Orton Hall, Dunkeld, Murthly Castle, Abercairny, Penrhyn Castle, Fota Island, Powerscourt, are especially noteworthy.

Picea polita is the most distinct of the Japanese Spruce Firs, one that has not been confused with any other, nor encumbered with a perplexing synonymy. It has now become very rare in the wild state in Japan: isolated trees, often of miserable aspect, only are to be seen scattered over the mountainous districts from the extreme south to about the 38th parallel of north latitude, beyond which it is nowhere found wild. It is much cultivated by the Japanese for the decoration of their gardens and temple enclosures, and for these

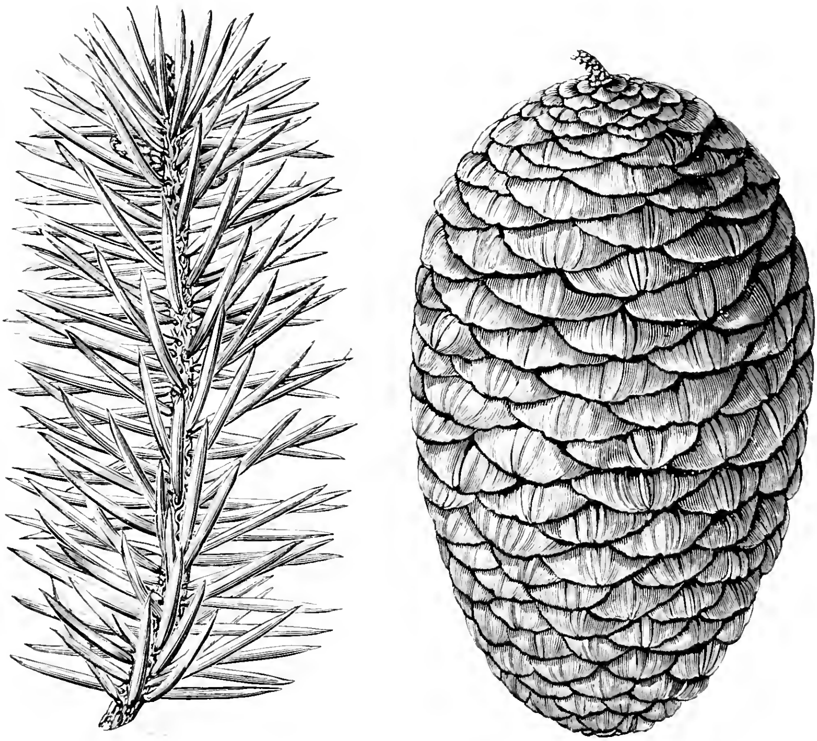


Fig. 110. Foliage and cone of *Picea polita*.

purposes it has obtained a much more extended distribution, but under cultivation it is invariably of smaller dimensions. In Great Britain, in its young state when fairly vigorous, it is one of the most attractive of Firs; the light yellowish bark of the branchlets, the shining red-brown buds and the lively green of the foliage present a variety of colours that is seldom seen so effectively in any other species. It does not, however, thrive so well in the drier climate of England as in Japan and in New Zealand, where it has been introduced, and beautiful as it is in its young state, it cannot be said to improve much with age although quite hardy.*

Regarded in all its aspects, *Picea polita* gives the impression of its being an archaic form of Picea that has nearly reached the span of its existence, and is now gradually passing away. Its nearest affinities are *P. Smithiana* of the Himalaya, and *P. Schrenkiana* of Turkestan, the three species forming a sub-section of the genus, distinguished chiefly by the position and colour of the leaves which are less crowded than in the other Spruce Firs; by the perular scales and shape of the winter buds; and by the scales of the cones being smooth, with the exposed margin nearly entire.

Picea polita was introduced by the late John Gould Veitch in 1861. The specific name *polita* (polished or adorned) was probably selected in reference to the lustrous smoothness of the leaves and leaf-buds.

Picea pungens.

A slender tree 80—100 feet high, but occasionally considerably more, with a trunk rarely exceeding 3 feet in diameter, and covered with brownish grey bark fissured into small oblong plates. In early life up to about forty years *Picea pungens* is furnished with whorls of branches at regular but rather distant intervals, gradually shorter upwards, forming a symmetrical tree with a broadly conical outline; in old age it is described as being generally destitute of lower branches, and with a thin, pyramidal crown. Branchlets stoutish, rigid, with pale yellow-brown bark: buds broadly conic, obtuse, with light chestnut-brown perulæ reflexed at the apex. Leaves persistent five—seven years, standing out from all sides of the branchlets and pointing forwards at an angle of about 45° to the axis, four-sided, straight, rigid and spine-tipped, 0·75—1·25 inch long, bright green, mostly with a distinct glaucescence which varies much in different individuals from bluish grey to silvery white. Staminate flowers ovoid-cylindric, more than 0·5 inch long, with anthers tinged with red. Cones sub-cylindric, slightly tapering towards the apex, sub-sessile or shortly stalked, 2·5—4 inches long; scales rhomboidal, sub-acute or rounded at the apex, conspicuously striated on the exposed side and undulated at the margin, light orange-brown. Seed-wings oblong-truncate, half as long as the scale.

Picea pungens, Engelmann in Gard. Chron. XI. (1879), p. 334. Masters in Gard. Chron. X. ser. 3 (1891), p. 547, with fig.; and Journ. R. Hort. Soc. XIV. 233. Sargent, Forest Trees N. Amer. 10th Census U.S.A. IX. 205. Mayr, Wald. Nordamer. 352. Beissner, Nadelholzk. 346.
P. Parryana, Sargent, Silva N. Amer. XII. 47, t. 600 (1898).
P. commutata of Dutch and Belgian Nurseries (not Parlatore).
Eng. and Amer. Blue Spruce, Colorado Spruce.

With the exception of *Picea Breweriana*, *P. pungens* is the most restricted in habitat and numbers of all the American Spruce Firs. It occurs on the Rocky Mountains towards the southern part of the range at elevations between 6,000 and 9,000 feet. "Nowhere very

* The best specimens of *Picea polita* are seen in the southern and south-western counties, especially in Devon and Cornwall.

abundant, it is generally scattered along the mountain streams of Colorado and eastern Utah and northwards to those of the Wind River mountains of Wyoming." *

Fig. 111. *Picea pungens glauca.*
(From the *Gardeners' Chronicle.*)

This handsome Spruce Fir was discovered on Pike's Peak in Colorado by Dr. Parry in 1862, at the same time as *P. Engelmanni*, and was probably introduced with that species with which it is still confused in many gardens. It is unquestionably the most beautiful of all Spruce Firs for garden decoration, a distinction it owes to the remarkable glaucescence of its foliage which, however, varies much in intensity in different seedlings, but when most heightened is of a silvery greyish

* Silva of North America, XII. 48.

blue. Between this and the green form which is quite rare, is to be found every possible gradation in colour, so that varietal names founded on it have but little value or significance. *P. pungens* is quite hardy and grows somewhat slowly at first in all ordinary soils and situations. Among the most noticeable deviations from the common type in habit is one with pendulous branches which originated in the nursery of Messrs. Koster at Boskoop, in Holland; and one figured in the "Gartenflora" for 1891, at page 70, under the name of *König Albert von Sachsen*; a vigorous-growing, long-leaved variety that originated in the nursery of Herr Weisse at Kamenz, in Germany.

Picea rubra.

A larger tree than *Picea nigra* with which it was for a long time confused, usually 70—80 feet high, but sometimes exceeding 100 feet high with a trunk 2—3 feet in diameter covered with bark much resembling that of *P. nigra*. Branchlets stoutish with pale brown bark marked with longitudinal ridges. Buds small, broadly conic with reddish brown perulæ. Leaves spirally crowded around the branchlets, standing out on all sides, pointing forwards and more or less falcately curved, obscurely four-angled with a short callous tip, 0·5—0·75 inch long, at first bluish green changing to dark green. Staminate flowers sub-cylindric, about 0·5 inch long, with red anthers. Cones ovoid-cylindric, obtuse, about 2 inches long and 0·75 inch in diameter, shortly stalked, chestnut-brown when mature; scales broadly obovate-cuneate with entire margin, obscurely striated on the exposed side.*

Picea rubra, Link in Linnaea, XV. 521 (1841). Carrière, Traité Conif. ed. II. 322. Beissner, Nadelholzk. 338, with fig.

P. nigra var. rubra, Engelmann in Gard. Chron. XI. (1879), p. 334. Macoun, Cat. Canad. Plants, 362.

P. rubens, Sargent. Silva N. Amer. XII. 33, t. 597 (1898).

Abies rubra, Loudon, Arb. et Frut. Brit. IV. 2316, with fig. Forbes, Pinet. Woburn, 101, t. 35. Gordon. Pinet. ed. II. 17.

Pinus rubra, Lambert, Genus Pinus. I. t. 28 (1803). Hooker, W. Fl. Bor. Amer. II. 164. Endlicher, Synops. Conif. 113. Parlatore, D. C. Prodr. XVI. 413.†

Eng. and Amer. Red Spruce. Fr. Sapinette rouge. Germ. Rochfichte.

The area over which the Red Spruce is distributed may be stated in general terms to comprise the border counties of the Canadian Dominion south of the valley of the St. Lawrence and north-eastern States of the American Union, whence it spreads southwards along the Alleghany mountains to the high peaks of North Carolina. It is the most valuable timber tree of the region over which it is spread; its wood is used for all descriptions of carpentry, and also for conversion into paper pulp.

I have followed the highest authority on American trees in retaining *Picea rubra* distinct from *P. nigra*; it presents, however, one of those doubtful cases in which the views of botanists must unavoidably differ

* Fertile branchlets communicated from the Arnold Arboretum, Harvard University, Massachusetts, U.S.A.

† The extremely perplexing synonymy of *Picea rubra* and the numerous and often contradictory literary references to it are skilfully dealt with by the author of the Silva of North America, Vol. XII. *loc. cit. supra.*

owing to the want of more definite characters to establish satisfactorily its specific rank. The characters chiefly relied on to distinguish specifically *P. rubra* from *P. nigra* are:—the larger size and different shape of the staminate flowers of the first named; the leaves of the Red Spruce are the longer of the two, and dark lustrous green, whilst those of the Black Spruce have a bluish tinge and are frequently very glaucous: the Red Spruce is the larger tree, growing only on well-drained hill-sides, whilst the Black Spruce inhabits wet sphagnum-covered bogs. Very little is known of the Red Spruce in Great Britain: the few specimens that are pointed out as such, are half-denuded, unsightly-looking objects that afford no certain data for identification.*

Picea Schrenkiana.

A tall tree with pendulous branches and branchlets much resembling *Picea Smithiana* in habit and aspect. In Great Britain the branchlets of the young trees are somewhat rigid, more like those of *P. polita* with the bark, buds and foliage of *P. Smithiana*. Leaves acicular-linear, obscurely four-angled, with a short callous tip, somewhat rigid, straight or falcately curved, 0·75—1 inch long, pointing forwards on all sides at an angle of about 45° to the axis, and darker in colour than those of *P. Smithiana* and *P. polita*. Cones cylindric, obtuse, 3·5—4 inches long and 1—1·25 inch in diameter, dark lustrous brown: scales obovate-cuneate with entire margin, convex on the dorsal side.†

Picea Schrenkiana, Fischer and Meyer in Bull. de l'Acad. St. Petersb. X. 253 (1842). Beissner, Nadelholzk. 371.

P. obovata var. Schrenkiana, Carrière, Traité Conif. ed. II. 338. Masters in Journ. Linn. Soc. XVIII.

Abies Schrenkiana, Gordon, Pinet. ed. II. 18.

Pinus Schrenkiana, Endlicher. Synops. Conif. 120.

P. obovata var. Schrenkiana, Parlatore, D. C. Prodr. XVI. 415.

The Spruce Fir originally named *Picea Schrenkiana* by Fischer and Meyer was discovered by Schrenk in the Siberian Kirghiz about the year 1841. The Fir described above, which is also that described by Beissner as *P. Schrenkiana*, was detected by Dr. Albert Regel nearly forty years afterwards on the Thian-Schan and Ala-tau mountains in southern Turkestan. Cones and seeds of the Turkestan tree were sent to the Imperial Botanic Garden at St. Petersburg, whence seeds and plants were subsequently distributed among several European gardens, and the young trees both in Great Britain and Germany possess the characteristics described above.

Schrenk's original discovery is stated by Fischer and Meyer to be closely allied to the Siberian *Picea obovata* and was referred to it as a

* There are two large trees at Dropmore labelled *Picea rubra* so like *P. excelsa* that, in the absence of cones, their identification is involved in some doubt.

† Fresh specimens of branchlets with buds and foliage were communicated from the Veitchian nursery at Coombe Wood, and by Mr. Späth from his nursery at Baumschulenweg, near Berlin. Cones gathered by Dr. Albert Regel in Turkestan were presented to Messrs. Veitch by the late Dr. Ed. Regel.

variety by Carrière and Parlatore. But the nearest affinity of the Turkestan tree as indicated by the young specimens in cultivation is so obviously the Himalayan *P. Smithiana* that it is extremely doubtful whether it is the same species as the original *P. Schrenkiana* of Fischer and Meyer.* Should proof be hereafter forthcoming that this surmise is correct, it is clear that the Turkestan tree must have another name, and no more appropriate one could be found than *P. Regeliana* which would commemorate both the discoverer and his father, the excellent botanist who so long and successfully directed the Imperial Botanic Garden at St. Petersburg. It will be noted that the geographical position of the two forms favours what is here stated respecting their affinities; the Siberian Kirghiz is included in or is at least contiguous to the habitat of *P. obovata*, and is separated by a desert region from the mountains of Turkestan which are connected by the Hindu-Koosh and its offsets with the Himalaya of Afghanistan on which *P. Smithiana* is very abundant. Like all coniferous trees inhabiting a rigorous climate *P. Schrenkiana* does not grow satisfactorily under the stimulus of the higher winter temperature of Great Britain, but further trial is needed before its suitableness or otherwise for the gardens and Pineta of this country can be determined.

Picea sitchensis.

A tree of very variable height and dimensions, usually about 100 feet high, but trees 200—250 feet high with a conspicuously tapering trunk 12—15 feet in diameter near the base are not uncommon along the coast of Washington and Oregon; at the extreme northern limit of its distribution it is reduced to a low shrub. In Great Britain when standing alone and growing in favourable situations, it has a broadly pyramidal outline, the bark of the oldest trees usually much and irregularly fissured. Branches spreading horizontally or slightly depressed, the lowermost often long in proportion to height of trunk. Bark of branchlets pale yellowish brown; buds ovoid-conic, sub-acute, 0·25 inch long with reddish brown, ovate, obtuse perulæ. Leaves persistent three—seven years according to the soil in which the tree is growing; linear, flattened, rigid and spine-tipped, 0·5—0·75 inch long, but occasionally larger on vigorous shoots, spirally crowded around the branchlets, the longer ones on the under side sub-distichous in two—three ranks; the shorter ones on the upper side pointing forwards at a small angle to the axis, with a silvery white stomatiferous band on each side of the thickened midrib on the ventral side, light lustrous green on the dorsal side. Staminate flowers numerous, on lateral branchlets of the preceding year, cylindric, reddish crimson, shortly stalked, surrounded at

* With the object of obtaining, if possible, more definite information on this point, I addressed a communication pointing out the difficulty to Dr. Fischer de Waldheim, the Director of the Imperial Botanic Garden at St. Petersburg, who courteously replied that there were several specimens of *Picea Schrenkiana* gathered in Turkestan preserved in the herbarium of the Garden of which two or three scarcely differ from *P. Smithiana*, whilst other types are easily distinguished from it by their shorter and thicker acicular leaves; the greater number are, however, intermediate forms. The Director adds: "Peut-étre toutes les variations ne forment qu'une seule espèce. Il est bien difficile de le dire pour sûr à cause de trop peu d'exemplaires disponibles, d'autant plus que ces changements dépendent du lieu de croissance selon l'altitude, etc."

the base by numerous involucral bracts. Cones cylindric, obtuse, 2·5—3·5 inches long and 1·25 inch in diameter, often curved before falling; scales ovate-elliptic, 0·75 inch long, irregularly denticulate beyond the middle; bract awl-shaped, about one-half as long as the scale.

Picea sitchensis, Carrière. Traité Conif. ed. I. 260 (1855). Engelmann in Brewer and Watson's Bot. Califor. II. 122. Macoun. Cat. Canad. Plants, 470. Mayr. Wald. Nordamer. 338. Beissner. Nadelholzk. 390, with figs. Masters in Journ. R. Hort. Soc. XIV. 224. Sargent, Silva N. Amer. XII. 55. t. 602.

P. Menziesii. Carrière. Traité Conif. ed. II. 318 (1867). Masters in Gard. Chron. XXV. (1886). p. 728, with figs.

Abies Menziesii, Lindley in Penny Cycl. I. 32 (1833). London. Arb. et Frut. Brit. IV. 2321, with fig. Forbes. Pinet. Woburn. 93. t. 32. Gordon. Pinet. ed. II. 12.

Pinus sitchensis. Bongard. Vég. de Sitcha. 46 (1832). Endlicher. Synops. Conif. 123 (1847).

P. Menziesii, Douglas ex Lambert. Genus Pinus, ed. II. Vol. III. 161 (1837). Parlatore. D. C. Prodr. XVI. 418.

Eng. Menzies' Spruce. Amer. Tideland Spruce. Germ. Sitka-Fichte.

Picea sitchensis is confined to a narrow belt extending many hundreds of miles along the Pacific coast of north-west America from Alaska near the 60th parallel of north latitude southwards to Cape Mendocino in California, rarely spreading inland more than fifty miles, in places forming a continuous forest of considerable extent, elsewhere associated with *Abietia Douglasii*, *Tsuga Albertiana* and *Thuia gigantea*. It attains its greatest development in the littoral districts of Washington and Oregon where it becomes the largest of all Spruce Firs and the most important timber tree of the region.* Further north under the altered conditions of climate, its dimensions are considerably diminished until it is reduced to a low shrub at its extreme northern limit. The wood is light, soft, straight-grained, compact but not strong, and of a light brown colour tinged with red. In the coast region of Oregon and Washington it is used for well-nigh every purpose for which timber is in request, not only for house building and out-of-door carpentry generally, but also for boat building, cooperage and household utensils; and further north, where the trees are much smaller, it is not less serviceable to the inhabitants, both settlers and Indians.

In Great Britain the growth and aspect of *Picea sitchensis* are much influenced by the soil and situation in which it is planted. It does not thrive in light dry soils whether near or away from the sea coast; in such places in very dry seasons it loses all its foliage older than that of the current year and has a denuded appearance; in a retentive loam and even in constantly wet ground it grows rapidly into a handsome well-

* No tree in the American forest grows with greater vigour or shows stronger evidences of vitality, and there are few more impressive and beautiful objects in the forests of temperate North America than one of these mighty Spruce trees with its spire-like head raised high above its broad base of widely sweeping and gracefully upturned branches resting on the surface of the ground; its slender branchlets loaded with cones nodding to the slightest breeze, and its leaves now silvery white, now dark and lustrous, shimmering in the sunlight.—Silva of North America. Vol. XII. p. 57.

furnished tree with the colour of its foliage much heightened;* the leader shoot increases in height from 18—27 inches annually, and the trees for the most part cone freely after the first twenty-five years, results suggestive of the suitableness of this tree for afforesting waste lands in Scotland and Ireland that could not be more profitably used for other crops.

Picea sitchensis first became known to science through Archibald Menzies who discovered it on the shores of Puget Sound in 1793. It was introduced into Great Britain in 1831 by the Horticultural Society of London through David Douglas who named it in compliment to the discoverer, and it was published by Lindley under the name of *Abies Menziesii* in 1833; it had, however, been found by Mertens on the island of Sitka a few years previously and described by Bongard as *Pinus sitchensis* in his "Végétation de Sitcha," published in 1832; Bongard's name therefore has priority and is now generally accepted; the tree is best known in British plantations as *Abies Menziesii*.

ARCHIBALD MENZIES (1754—1842) was born at Weims, in Perthshire. He was early placed in the Botanic Garden at Edinburgh, and, through the assistance of Dr. John Hope, Professor of Botany, he was enabled to prosecute his studies so as to take the diploma of surgeon. In 1778, he made a tour through the Northern Islands for the purpose of collecting plants for the Botanic Garden. He then went to Carnarvon to assist a medical man, and he finally became assistant-surgeon in the Navy. He visited Halifax Staten Island, the Sandwich Islands, China and north-western America. In 1790, he accompanied Vancouver on his celebrated voyage; he visited King George's Island, the south coast of New Holland, and part of New Zealand, Otaheite, Chile and the north-west of America. He returned to England in 1795. Among the results of this voyage was the introduction of *Araucaria imbricata* from southern Chile and the first certain intelligence of the existence of the gigantic coniferous vegetation of north-west America, including the discovery of *Sequoia sempervirens*, *Abietia Douglasii*, *Picea sitchensis* and *Thuia gigantea*. He made large collections of plants, as well as of other objects of Natural History during these voyages. Many of them were new, and have been described by Sir J. E. Smith, Robert Brown, Sir W. Hooker and others. He afterwards served in the West Indies. About the beginning of the century he quitted the Navy and passed the remainder of his days in the vicinity of London. His collection of plants was left to the Botanic Garden, Edinburgh; it consists chiefly of cryptogamous plants, Grasses and Cyperaceæ.

Picea Smithiana.

A tree 120—150 feet high with a conical outline and with a trunk 5—7 feet in diameter near the base, covered with brownish grey bark tesselated with shallow cracks. In Great Britain an elegant tree of elongated conical outline usually furnished with branches from the base. Branches spreading and ramified laterally, the lowermost more or less deflexed and often sweeping the ground. Branchlets opposite or alternate, quite pendulous, often much elongated, with yellowish white bark spirally grooved. Buds ovoid-cylindric, the larger terminal ones 0·25 inch long, with ovate reddish brown perulæ. Leaves persistent four—five years, linear-acicular, obscurely four-angled, compressed laterally, pungent, 0·75—2·5 inches long, pointing forwards and falcately

* Fine specimens of *Picea sitchensis* from 70—100 feet high are frequent:—In England at Monk Coniston, Lancashire; Patterdale Hall, Cumberland; Bowood Park and Fonthill Abbey, Wiltshire; Bicton, Devonshire; Carclew, Cornwall. In Scotland at Castle Menzies, Murthly Castle, Ochtertyre, Keillour, and Scone Palace in Perthshire. In Ireland at Curraghmore, Co. Waterford; Fota Island, Cork; Coollattin, Co. Wicklow; Castlewellan, Co. Down; Shane's Castle, Antrim; and other places.

curved. Staminate flowers the largest in the genus, broadly cylindric, obtuse, 1–1·25 inch long and 0·5 inch in diameter, light sulphur-yellow; connective of anther roundish, obscurely crenulate; the involucral bracts lanceolate-oblong in two—three series.* Cones terminal, cylindric-conic, obtuse, 4–6 inches long and 1·5–2 inches in diameter; scales broadly obovate from a cuneate base, the outer margin rounded and entire.

Picea Smithiana,† Boissier, Fl. orient. V. 699 (1884).
P. Morinda, Link in Linnaea, XV. 522 (1841). Carrière, Traité Conif. ed. II. 340. Masters in Gard. Chron. XXIV. (1885), p. 393, with fig.; and Journ. R. Hort. Soc. XIV. 46. Hooker fil, Fl. Brit. Ind. V. 653. Beissner, Nadelholzk. 373.
Abies Smithiana, Loudon, Arb. et Frut. Brit. IV. 2317, with figs. (1838). Forbes, Pinet. Woburn, 103, t. 36. Gordon, Pinet. ed. II. 19. Brandis, Forest Fl. N.W. India, 525. Aitchison in Journ. Linn. Soc. XVIII. 98.
A. Khutrow, Loudon, Encycl. of Trees, 1032, with figs. (1842).
A. Morinda, Nelson, Pinaceæ, 49; and Hort.
Pinus Smithiana, Wallich, Plant. asiat. rar. III. 24, t. 246 (1832). Lambert, Genus Pinus, III. t. 88. Parlatore, D. C. Prodr. XVI. 416.
P. Khutrow, Royle, Illus. Him. Plants, 353, t. 84 Endlicher, Synops. Conif. 122.
Eng. Himalayan Spruce, Indian Spruce. Germ. Indische-Fichte. Ital. Abete dell' Himalaya. Ind. vernacular, Khutrow, Morinda, and others.

Picea Smithiana occurs throughout the temperate Himalaya from Bhotan to Afghanistan, with a vertical range of from 6,000 to 11,000 feet elevation and occasionally higher. It inhabits chiefly the western and northern slopes, in some places forming pure forests of greater or less extent, in others intermixed with *Cedrus Deodara*, *Abies Webbiana*, *Pinus excelsa* and other trees. As seen throughout this region, except where it grows in compact masses, the tree is furnished with branches to the ground, the primaries horizontal and spreading out further than those of *Abies Webbiana*; their extremities are very bushy with numerous leafy, tassel-like branchlets hanging vertically, which give the tree a peculiarly graceful appearance; the crown is tall and conical and the foliage dense.‡ The wood is white, soft and straight-grained, but not durable, the outer wood turning red and decaying rapidly on exposure. It is used chiefly for indoor carpentry and for fuel; in the higher mountain valleys the herdsmen use the bark for roofing the sheds built for protecting their cattle in severe weather.

This beautiful tree was introduced into Great Britain in 1818 by Dr. Gowan of Cupar, who had received cones from his son under the

* *See* page 123.

† The intention of Dr. Wallich, who first described and figured this tree, to dedicate it to the first President of the Linnean Society is stated so precisely that his name is unhesitatingly adopted here. Unfortunately Wallich's figure is but very indifferently executed, and it is also inverted, so that when Professor Link selected the vernacular name Morinda for the tree in the Berlin Botanic Garden, he did so in the belief that it was not the same species as that represented by Wallich's figure. "In Pineto Woburnense arbor haec ad Pinum Smithianum (Wall) relata est; at folia in icone Wallichiana multo latiora, majus incurva, minus pungentia. Convenit vero P. Morinda nostra optime cum Roylei icone et ea quæ in Pineto Woburnense exhibetur, quemobrem separavi."—Linnaea, XV. 522. As no second species of Picea occurs in the Himalayan region, Wallich's name has priority of publication.

‡ Brandis, Forest Flora of North-west India, p. 526.

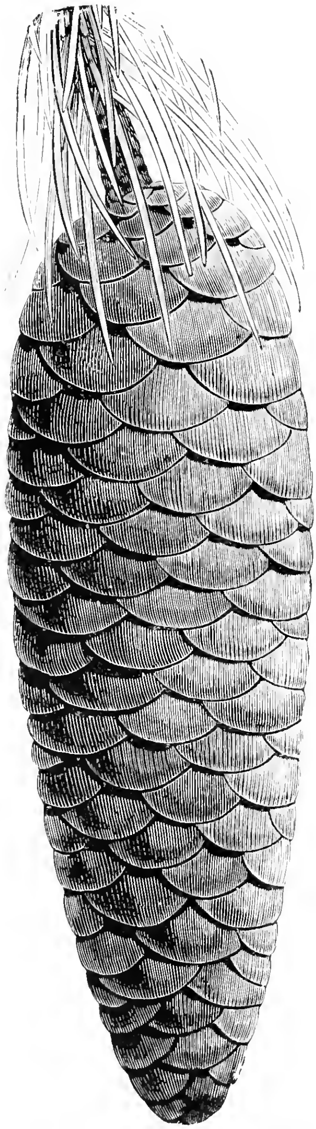


Fig. 112. Cone of *Picea Smithiana*.

name Khutrow (weeping Fir), and which he presented to the Earl of Hopetoun. * From the seeds six plants were raised, one of which now nearly 80 feet high and reported healthy and vigorous, is still standing in the grounds of Hopetoun House in West Lothian. † When planted in a moist soil and sheltered situation the Himalayan Spruce grows rapidly; in dry soils its growth is slower and the foliage becomes thin. Owing probably to peculiarities in the climate of the Himalayan region and the high elevation at which this Fir grows — conditions that cannot be secured for it in Great Britain—failures are frequent; the plants cannot receive here so long an annual period of rest as they do on their native mountains, where the winter snows cover them for four or five months of the year; they start into growth in the first mild days of early spring, and the tender shoots are often cut off by frosts later in the season, the effect of which is to weaken permanently, if it does not kill, the plants. A north-west aspect, or one shaded or protected by high trees is recommended for it, provided the soil is loamy and not too dry. The lower branches of some of the largest specimens of *Picea Smithiana* in this country have attained lengths of from 12 to 16 feet, so that, in order to secure a good specimen of this noble Fir, a space having a radius greater than these dimensions must be allowed for it.

The species was named by Dr. Wallich in compliment to Sir James Edward Smith, First President of the Linnean Society.

* It is highly probable that the original discoverer of the species was Dr. Buchanan-Hamilton who travelled in Nepal in 1802—1803.

† Of the many other specimens of this highly picturesque tree that adorn the parks and gardens of this country, mention may be made of the exceptionally fine one at Poltimore, near Exeter and of others at Bicton, Bowood Park, Tortworth Court, Penrhyn Castle; Golden Grove, Carmarthen; Hallstead, Cumberland; Orton Hall, Hewell Grange, and Linton Park. In Scotland at Gordon Castle, Methven Castle, Ochtertyre, Castle Kennedy, Keir House, Dunblane. In Ireland at Powerscourt, Charleville and Coollatin, Co. Wicklow; Courtown, Co. Wexford; Fota Island, Cork; Woodstock, Kilkenny; Shane's Castle, Antrim.

James Edward Smith (1759–1828) was born at Norwich. He was induced by his love of science to study medicine, for which purpose he proceeded to Edinburgh University where he obtained in 1782 Dr. Hope's Gold Medal for the best botanical collection. He shortly afterwards came to London, and in 1784 he purchased the whole of the books, manuscripts and natural history collections of Linnæus which cost £1,088, and which after his death became the property of the Linnean Society. Two years later he made a tour through Holland, France, Italy and Switzerland, of which he published an account. In 1788, with the assistance of Sir Joseph Banks, Dr. Goodenough, Bishop of Norwich, and a few others, the Linnean Society was founded and Smith was elected first President. In 1796 he removed to his native city of Norwich, but paid a yearly visit of two months to London when he gave a course of lectures on Botany at the Royal Institution in Albemarle Street. In 1814 he was knighted by the Prince Regent when he presented a copy of the Transactions of the Linnean Society. His published works are numerous, but that by which he will be best remembered is his "English Botany," in thirty-six volumes containing 2,592 coloured plates by Sowerby.

TSUGA.

Carrière, Traité Conif. ed. I. 185 (1855). Bentham and Hooker, Gen. Plant. III. 440 (1881). Eichler in Engler and Prantl, Nat. Pfl. Fam. 80 (1887). Masters in Journ. Linn. Soc. XXX. 28 (1893).

The group of trees known as Hemlock Firs* are readily distinguishable from all the other Abietineæ by their habit and foliage, especially by their slender, often drooping, terminal shoots clothed with leaves having an anatomical structure different from that of all the other Firs, and on which much stress is placed as a mark of the generic distinctness of the group; this characteristic, combined with others observable in the flowers and fruit to be presently noticed, has secured the admission of Carrière's genus Tsuga by most recent authors.

In their vegetation, the Hemlock Firs are normally tall evergreen trees with straight erect trunks from which the primary branches are produced in pseudo-whorls, which are mostly much ramified. The slender branchlets are marked with prominent pulvini at the base of the leaves, and with cortical outgrowths descending from them. (*See* Fig. 14 *B.*, page 29.) Under climatic influence, those species inhabiting high latitudes or ascending to high mountain altitudes are reduced to low dense bushes or shrubs at their northern and highest vertical limits.

The leaves are flattened or slightly angular, one-nerved and distinctly petiolate, spirally arranged around the shoot, but made pseudo-distichous by a twist of the short footstalk. The most obvious anatomical character which distinguishes the leaves of the Tsugas from those of all other Firs is the position of the resin canal; this is shown in the accompanying figure of a transverse section of the leaf of *Tsuga Brunoniana*, the minute structure of which does not differ essentially from that of

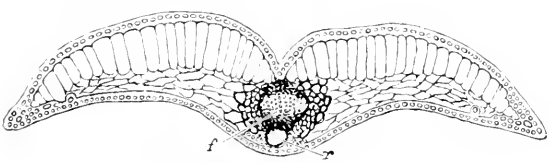


Fig. 113. Transverse section of leaf of *Tsuga Brunoniana*, × 30. *r*, resin duct; *f*, fibrovascular bundle.

* I have failed to ascertain the origin of this common name; it has been applied to the type species, *Tsuga canadensis*, from time immemorial, and thence extended to the others. The Germans have a similar appellative in Schierlingstanne.

the other species of Tsuga; the resin canal is indicated by the letter *r*, and the fibro-vascular bundle of the midrib by *f*.

The essential characters of the flowers and fruits may be thus formulated:—

Flowers monœcious. Staminate flowers in the axils of the uppermost leaves of shoots of the preceding year, small, globose or globose-cylindric, stipitate, and surrounded at the base by numerous small involucral bracts. Anthers with a short spur at the base and dehiscing transversely; pollen cells globose

Ovuliferous flowers very small, mostly terminal on lateral branchlets of the preceding year; bracts shorter than the scales. Cones solitary, pendulous, with persistent scales and inconspicuous enclosed bracts, and ripening the first year.

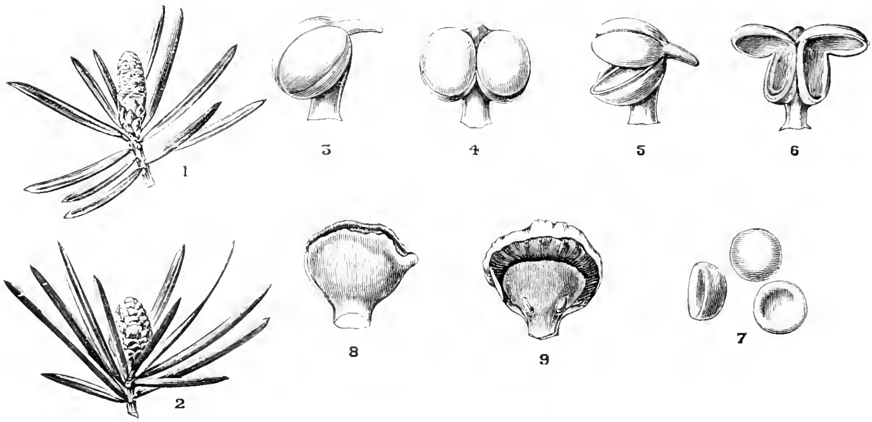


Fig. 114. *Tsuga Brunoniana*. 1. Staminate. 2. Ovuliferous flower, nat. size. 3, side—4, front view of anthers before dehiscence; 5 and 6, after dehiscence x 10; 7, pollen grains x 120; 8 back—9, front view of scale and bract.

The Tsugas thence appear to be made up of characters derived from Abies, Larix and Picea. The leaves are those of an Abies on superficial view, but differ in the presence of only one central resin canal instead of two lateral ones always found in the leaves of Abies; the cones are those of a Larch with the bract always shorter than the scale; the wood conforms structurally to that of a Picea.

Whilst the above characters are common throughout the genus, there is one species—*Tsuga Mertensiana*—which differs from the rest in some morphological details observable in the leaves and cones which are of sufficient value to separate that species sectionally from the others; the Tsugas therefore admit of a division into two sections thus distinguished:—

Eutsuga. Leaves flat, obtuse, remotely serrulate at the margins and with stomata on the under side only. Cones small, globose (as broad as long).

HESPEROPEUKE.* Leaves convex, acute, often keeled on the upper side and with stomata on both sides. Cones ovoid-cylindric (much longer than broad).

All the species are described in the following pages; of these three are Asiatic, each of which has but a limited geographical range: two are east North American, one the type species widely distributed, and the other a comparatively recent discovery restricted to a locality of small extent on the southern Alleghany mountains; the remaining two are west North American, one a tree of the coast and plains, and the other chiefly of the mountains at high altitudes. The Hemlock Firs are cultivated in Great Britain almost solely for ornamental purposes; they are trees of graceful habit and aspect, and whether standing alone or in contrast with other trees are effective subjects for the lawn, park and landscape. As timber trees they are not much in repute even in their native countries; the wood is for the most part loose in grain, soft in texture and soon decays on exposure to the weather. Much of the vigour of the trees is expended in the formation of branches rather than in the development of the trunk which is frequently knotty and of small scantling.

Tsuga is the Japanese vernacular name of the two native species.

Tsuga Albertiana.

A stately tree 100—200 feet high with a trunk 2—6 feet in diameter, but much smaller at its northern limit. Bark of trunk thick, reddish brown, coarse in texture and irregularly fissured. Primary branches spreading or slightly ascending and ramified laterally; secondary branches slender and much ramified, the ramification chiefly lateral with many short slender growths on the upper side; the youngest shoots both terminal and lateral pubescent, slender, flexible and pendulous; bark pale yellow-brown marked with leaf pulvini and short cortical outgrowths decurrent from them. Buds small, clavate, pubescent, reddish brown. Leaves persistent four—five years, linear, flattish, obtuse or sub-acute, 0·5—0·75 inch long, shortly and abruptly petiolate, pseudo-distichous, dark green with a small median groove above and with two stomatiferous bands beneath. Staminate flowers mostly clustered near the apex of short lateral shoots of the preceding year, cylindric, 0·25 inch long, reddish crimson changing to dull violet, the basal involucral bracts in two series. Ovuliferous flowers terminal, solitary, composed of fewer scales than the staminate flowers, and of the same rich colour before fertilisation and with the basal involucral bracts more numerous. Cones ovoid-cylindric, about an inch long, composed of twenty-five—thirty scales arranged spirally in five series, pale brown striated on the outer dorsal side.

* Separated from Tsuga as a distinct genus under this name by Lemmon and other Californian botanists.

Tsuga Albertiana, *supra*.

T. Mertensiana, Carrière, Traité Conif. ed. II. 250 (excl. Pinus Mertensiana, Bongard). Engelmann in Brewer and Watson's Bot. Califor. II. 126. Macoun, Cat. Canad Plants, 417. Beissner, Nadelholzk. 403, with fig. Masters in Gard. Chron. XXIII. (1885), p. 175, with fig.; and Journ. R. Hort. Soc. XIV. 255.

T. heterophylla, Sargent. Silva N. Amer. XII. 73, t 605 (1898).

Abies Albertiana, Murray in Proceed. R. Hort. Soc. III. 149, with fig. (1863). Lawson, Pinet. Brit II. 111, t. 16, and figs Kent in Veitch's Manual, ed. I. 113. Hutchinson in Trans. High. Agr. Soc. 1879.

A. Mertensiana, Gordon, Pinet. ed. II. 29 (excl. Pinus Mertensiana, Bongard).

A. Bridgesii, Kellogg in Proceed. Califor. Acad. Sc. II 8 (1863)

Pinus canadensis, Bongard, Veg. de Sitka in Mem. Acad. Imp. St. Petersb. II. 163 (1832), not Linnæus. Hooker, W. Fl. Bor. Amer. II. 164 (in part).

P. Mertensiana, Parlatore, D. C. Prodr. XVI. 428 (not Bongard).

Eng. Prince Albert's Fir. Amer. Western Hemlock Fir. Fr Tsuga de Californie. Germ. Westamerikanische Schierlingstanne. Ital. Abete del Principe Alberto.

Tsuga Albertiana is the largest of the Hemlock Firs, simulating in its stately proportions the other gigantic Abietineæ of north-west America, with some of which it is in places associated. Its northern limit, so far as at present known, is the island of Sitka and the adjacent littoral of Alaska, whence it spreads southwards through the islands and coast region of British Columbia to north California. It also has a considerable range inland: from the Selkirk and Gold mountains in British Columbia it extends southwards into Idaho along the Bitter Root, and also along the Cascade mountains to southern Oregon. It was discovered in 1826 by David Douglas during his first mission to north-west America, who mistook it for *T. canadensis*: Bongard fell into the same error in his "Observations sur la Végétation de l'île de Sitka," when dealing with Mertens' herbarium specimens gathered in Sitka shortly afterwards. There is, however, evidence that the tree had been previously seen by Menzies in 1792, during Vancouver's cruise along the north-west coast of America, and he too might have mistaken it for the Canadian Hemlock, from which there is little to distinguish it besides its larger size, its larger cones with more elongated scales, its larger seed wings, and its finer and straighter-grained wood.

Tsuga Albertiana was introduced into Great Britain in 1851 by the Scottish Oregon Association through their collector, John Jeffrey, and named in compliment to the late Prince Consort who was a patron of the Association. As seen in this country it is a very graceful tree and one of the most effective Conifers for the park and landscape on account of its broad sweeping habit, and presenting generally the appearance of "a pile of thick foliage out of which spring a multitude of long whip-like shoots which hang down like the slender sprays of a Weeping Willow." The older trees are now assuming a distinctly pyramidal outline broken by the long, lithe, terminal shoots, their lowermost branches making a sweep of over 30 feet, so that a space with a radius greater than this must be allowed to secure a good specimen.* No coniferous tree

* Fine specimens of *Tsuga Albertiana* 70 to 80 feet high are growing at Westonbirt, Gloucestershire; Eastnor Castle, Herefordshire; Fonthill Abbey, Wilts; Linton Park, Maidstone; Monk Coniston, Lancashire; Castle Menzies and Methven Castle, Perthshire; Riccarton. Midlothian. Trees 60 to 70 feet high are frequent from Perthshire southwards.

Tsuga Albertiana.
(From the *Gardeners' Chronicle.*

from north-west America has more readily adapted itself to the altered conditions of soil and climate in Great Britain than *T. Albertiana*; it thrives in most situations and in many kinds of soils, but most freely in a cool moist soil, or in loams with a porous subsoil; it will grow even on peat-bog but not on chalk. The annual rate of growth of the leader shoot varies according to soil and situation from 15 to 25 inches.

The wood is light, hard, and cross-grained but not strong; it is much used for building and rough carpentry; the bark furnishes the most valuable tanning material in the region.*

Tsuga Brunoniana.

A lofty tree 70—120 feet high, the trunks of the largest 6—9 feet in diameter near the base† and covered with thick, rough bark. Branches spreading; branchlets slender, brittle and pendulous; bark pale brown with shallow longitudinal furrows. Leaves narrowly linear, very shortly petiolate, sub-acute, 0·5—1·25 inch long, pseudo-distichous, dark green with a shallow median groove above and with two silvery white stomatiferous bands beneath. Staminate flowers solitary or in pairs on short lateral growths of the preceding year, cylindric, 0·25 inch long, light yellow, surrounded at the base by minute involucral bracts in three series (*see* Fig. 114, *supra*). Ovuliferous flowers terminal, sub-globose, 0·4 inch in diameter; scales reflexed at the apex, at first light bluish violet changing to dark slaty blue with age; bracts oblong, membraneous and crumpled. Cones ovoid-cylindric, about an inch long, composed of twenty—twenty-five orbicular-oblong, imbricated scales; striated on the dorsal, exposed side. Seeds very small with an oblong whitish wing.

Tsuga Brunoniana, Carrière, Traité Conif. ed. I. 188 (1855); and ed. II. 247 (1867). Hooker fil in Gard. Chron. XXVI. (1886). p. 72, with fig.; and Fl. Brit. Ind. V. 654. Masters in Gard. Chron. XXVI. (1886), p. 500, with fig.; and Journ. R. Hort. Soc. XIV. 254. Beissner. Nadelholzk. 397.

Abies Brunoniana, Lindley in Penny Cyclop. I. 31 (1833). Gordon, Pinet. ed. II. 21.

A. dumosa, Loudon, Arb. et Frut. Brit. IV. 2325, with figs. (1838). Brandis, Forest Fl. N.W. India, 527.

Pinus Brunoniana, Wallich, Plant. asiat. rar. III. 24, t. 247 (1832). Endlicher, Synops. Conif. 84.

P. dumosa, Lambert, Genus Pinus, ed. II. Vol. II. t. 46 (1837). Parlatore, D. C. Prodr. XVI. 429.

Eng. Indian Hemlock Fir, Himalayan Hemlock Spruce. Fr. Tsuga de l'Himalaya. Germ. Brown's Hemlocktanne.

This beautiful tree was originally discovered early in the second decade of the nineteenth century by Captain Webb in north-east Kumaon; for our knowledge of it as it is seen in its native home we are chiefly indebted to Sir Joseph Hooker who communicated the following particulars respecting it to the

* Silva of North America, XII. 75.

† In the list of trees of the Darjeeling region Mr. Gamble gives 60 to 80 feet as the average stature of *Tsuga Brunoniana*, and 10 to 15 feet as the average girth at four feet from the ground.

"Gardeners' Chronicle" *loc. cit. supra*, together with the figure of a tree sketched in Nepal:—

"I first met with this graceful tree on the banks of the Tambur river in eastern Nepal and have described it in my Journal as a beautiful species forming a stately blunt pyramid with branches spreading like the Cedar but not so stiff, and drooping gracefully on all sides; its surrounding scenery is as grand as any depicted by Salvator Rosa; a river running in sheets of foam, sombre woods, crags of gneiss rock, and tier upon tier of lofty mountains flanked and crested with groves of black Fir, *Abies Webbiana*, terminating in snow-covered rocky peaks. Here one individual was measured and found to be 20 feet in girth at about five feet from the ground; on another occasion in the Lachen valley of Sikkim, I measured a Hemlock Spruce that was 120 feet in height and 28 feet in girth, nor were these very exceptional dimensions though they greatly exceed what prevails in the Darjeeling district. The Himalayan Hemlock Spruce does not extend westwards beyond Kumaon where, according to Madden, it attains a height of 70 to 80 feet and yields inferior timber; eastwards it extends into Bhotan where Griffith met with it at 6,500 to 9,500 feet, which is a considerably lower elevation than it affects in Sikkim where its inferior limit is about 8,000 feet, and its superior 10,000 feet. The wood in Sikkim is but little used, not being durable, but the bark is employed for roofing huts."

Seeds of *Tsuga Brunoniana* have been frequently received in this country; the experience of the past forty years has, however, but too surely shown the futility of attempting to acclimatise this fine tree in Great Britain unless, indeed, a hardier race can be obtained from seeds gathered near the superior limit of its vertical range or from the few trees that have become established in this country.* In exceptionally favoured localities such as are to be found in Devon, Cornwall and the south of Ireland, *Tsuga Brunoniana* lives on for a number of years but rarely shows anything like the stately form it assumes in the Himalayan valleys.

The species was dedicated by Dr. Wallich, for many years Director of the Botanic Garden at Calcutta, to his contemporary Dr. Robert Brown, the most eminent British botanist of his time.

Tsuga canadensis.

A tall graceful tree with a pyramidal crown, at its greatest development 75—90 feet high but usually much less; in the dense forests of Canada free of branches for three-fourths of its height, in more open places furnished with branches nearly to the ground. Bark of old trees ash-brown with broad longitudinal fissures exposing a pale inner cortex, and narrow transverse fissures by which the outer cortex is broken up into irregular plates. Branches slender, spreading, the lowermost sometimes more or less deflexed by the weight of their appendages: ramification lateral. Branchlets flexible and drooping at

* The largest known to the author are at Dropmore and Strete Ralegh.

the extremity, yellow-brown, pubescent and marked with narrow, fluted, cortical out-growths. Buds small, ovoid-globose, reddish brown. Leaves persistent three—four years, shortly petiolate, linear, flat, obtuse or sub-acute, 0·25—0·75 inch long, those on the under side of the branchlets pseudo-distichous, those on the upper side erect or sub-erect, dark green with a shallow median channel above, and two glaucous stomatiferous bands beneath. Staminate flowers small, globose, shortly stipitate. Cones terminal, mostly on short lateral shoots, ovoid, obtuse, about 0·75 inch long; scales shortly clawed, broadly oval, obtuse or sub-obovate, with minutely denticulate margin, striated on the exposed side and persistent after the fall of the seeds.

Fig. 115. Fertile branchlet of *Tsuga canadensis*.

Tsuga canadensis, Carrière. Traité Conif. ed. I. 189 (1855); and ed. II. 241 (1867). Macoun. Cat. Canad. Plants. 471. Beissner, Nadelholzk. 398, with figs. Masters in Journ. R. Hort. Soc. XIV. 255. Sargent, Silva N. Amer. XII. 63, t. 603.

Abies canadensis, Michaux. Hist. Arb. Amer. I. 137, t. 13 (1810). L. C. Richard. Mém sur les Conif. 77, t. 17 (1826). Loudon. Arb. et Frut. Brit. IV. 2322, with figs. Hoopes, Evergreens, 184, with fig. Gordon, Pinet. ed. II. 22.

Picea canadensis. Link in Linnaea, XV. 523.

Pinus canadensis, Linnaeus. Sp. Plant. ed. II. 1421 (1763). Lambert, Genus Pinus, I. t. 32 (1803). Endlicher, Synops. Conif. 86. Parlatore. D. C. Prodr. XVI. 428. And many others.

Eng. and Amer. Hemlock Spruce. Fr. Sapin du Canada. Germ. Schierlingstanne. Ital. Abete del Canada.

var. alba spica (syn. *argentea*).

A variety of European origin in which the tip of all or nearly all the young shoots is cream-white. Another coloured form is known as **aurea**, but the variegation is said to be inconstant.

var.—gracilis (syn. *pendula*).

Branches and branchlets slender and sparsely ramified, all more or less drooping and clothed with leaves smaller than in the common form. Apparently intermediate between the latter and the variety *parvifolia*.

var.—parvifolia.

Smaller in all its parts than the common form; the branchlets and their ramifications more numerous and more closely set, and the leaves are but a quarter of an inch long. **microphylla** is apparently the same, or a slight variation of this.

var.—Sargentiana.

A bush about three feet high, with short pendent branches and branchlets forming a dense flat-topped mass of foliage. The variety **nana** of European gardens is the same, or a slight modification of this.

Tsuga canadensis is one of the most important ingredients of the forests around the great lakes lying between the British Dominion and the United States. From Nova Scotia it spreads westwards to Lake Superior, and southwards through the Atlantic States to Delaware; it also occurs on the Appalachian mountains which it follows southwards as far as Alabama. In Canada it still forms forests stretching for hundreds of miles: in places unmixed with any other tree, but oftener associated with the Black Spruce (*Picea nigra*) or the White Pine (*Pinus Strobus*), or both. It attains its greatest development on northern slopes and on the banks of mountain streams; in such situations it is one of the most beautiful trees of North America.

Large groves of Hemlock Firs growing on the hill slopes present a noble appearance; their tall columns free of branches for three-fourths of their height never bend before the gale. There is a general absence of undergrowth, thus affording long vistas through the shady groves; and the softened light invests the interior of these forests with an air of solemn mystery, whilst the even spread of the mossy carpet beneath affords appreciable relief to the foot-sore hunter. The human voice sounds as if confined within spacious and lofty halls.*

The wood of the Hemlock Spruce is light, soft, coarse-grained and difficult to work. The timber is being much more used than formerly as the supply of White Pine diminishes, chiefly for outdoor carpentry, railway ties, telegraph poles, etc. The dry and easily detached bark of the tree affords excellent fuel, emitting an intense heat; the fresh bark is rich in tannin, and is more used in tanning leather in the northern States than any other on account of the scarcity of oak-bark.

Tsuga canadensis was introduced into Great Britain by Peter Collinson about the year 1736, and trees of all sizes and ages may be met with from Caithness to Cornwall.

* Woods and Forests, p. 754.

In the earlier stages of growth and up to about forty years of age it is a beautiful tree of pyramidal habit owing to the uniform disposition of its branches which are usually well furnished with drooping branchlets. At an older stage the trunk often becomes forked or much divided, and the growth of the branches irregular: the top takes a flat or rounded form much like that of an old Cedar of Lebanon. It thrives in elevated airy situations where the soil is retentive, also by the side of streams, or in proximity to lakes and ponds where the roots have access to the water.

Several varieties of the Hemlock Spruce are described by continental authors, most of which are probably unknown in British gardens. Of the four here admitted *Sargentiana* is the most remarkable deviation from the type; it was originally found on the Fishkill mountains in the State of New York, and was first cultivated by Mr. H. W. Sargent whence it obtained in America the name of Sargent's Hemlock Fir.*

Tsuga caroliniana.

A low or medium-sized tree 50—60 feet high with a trunk rarely exceeding 2 feet in diameter. Bark of branchlets pale reddish brown, slightly rugose and striated; ramification distichous or pseudo-distichous

Fig. 116. Fertile branchlet of *Tsuga caroliniana*.

with numerous short erect branchlets on the upper, and here and there a longer one on the under side of the axial growths: the youngest shoots light reddish brown marked with cortical outgrowths that terminate at the base of the leaves in an enlarged reddish pulvinus. Leaves persistent two—three years, shortly petiolate, linear, sub-acute or obtuse, 0·25—0·75 inch long, dark lustrous green with a narrow median groove above, with a pale keel and stomatiferous band on each side of it beneath. Cones lateral or terminal on short lateral branchlets, ovoid or elliptic-ovoid, composed of twenty—twenty-five elliptic-oblong scales arranged in five—six series, striated on the exposed side. Seed-wing oblong, half as long as the scale.

* Garden and Forest. Vol. X. p. 491.

Tsuga caroliniana, Engelmann in Bot. Gazette. VI. 223 (1881). Sargent in Gard. Chron. XXVI. (1886), p. 780, with fig.; Garden and Forest, II. 267, with fig.; and Silva N. Amer. XII. 69, t. 604. Mayr. Wald. Nordamer. 196. Beissner, Nadelholzk. 406, with fig. Masters in Journ. R. Hort. Soc. XIV. 255.

Abies caroliniana, Chapman, Fl. ed. II. Suppl. 650 (1887).

The existence of a second species of Tsuga in the Atlantic States of North America was not even suspected till Professor L. R. Gibbes detected the subject of this notice on the southern Alleghanies in 1850; a discovery that came as a surprise both to botanists and to horticulturists, as the region had presumably been thoroughly explored previously. *Tsuga caroliniana* has since been found in considerable numbers on the rocky banks of streams on the Blue Ridge mountains from south-west Virginia to north-east Georgia, at elevations varying from 2,500 to 3,500 feet and in places even 1,000 feet higher, scattered among other trees, but rarely in groups of more than half a dozen together. It was introduced into British gardens in 1886 through the Arnold Arboretum of Harvard University, and has thus far proved hardy in the neighbourhood of London.

Tsuga caroliniana is chiefly distinguished from the type species, *T. canadensis*, with which it is sometimes found associated in its native habitat, by its larger and darker leaves of a somewhat different anatomical structure and by its larger cones with scales much longer than broad and which stand out at nearly a right angle to the axis when mature.

Tsuga diversifolia.

A large tree frequently 80 feet high with a trunk 3—4 feet in diameter covered with dark reddish brown bark. Branches relatively slender, spreading or slightly ascending and much ramified at the distal end. Branchlets very slender, the youngest shoots pubescent. Buds globose, dark chestnut brown. Leaves persistent two—three years, shortly petiolate, the petiole parallel with the axis of the shoot that produces it, the blade spreading at a right angle to it, linear, emarginate or obtuse, 0·25—0·5 inch long, lustrous green with a shallow median groove above, paler with two greyish stomatiferous lines beneath. Cones pendent, ovoid-cylindric, 0·75 inch long, shortly stalked, the stalk clothed with persistent bracts, composed of four — five series of spirally arranged suborbicular scales, rugose on the exposed side. Seed-wing oblong, nearly as long as the scale.

Tsuga diversifolia. Maximowicz in Melange. Biol. Acad. Sc. Petersb. VI. 373 (1866). Masters in Journ. Linn. Soc. XVIII. 514; and Journ. R. Hort. Soc. XIV. 255. Mayr. Abiet. des Jap. Reiches, 61, Tafel IV. fig. 13. Beissner, Nadelholzk. 396. Sargent, Forest Fl. Jap. 81. t. 25; Garden and Forest VI. 495, with fig.; and X. 491. fig. 63.

Abies Tsuga, Hort. (not Siebold).

Eng. Japanese northern Hemlock. Germ. Maximowicz' Tsuga. Jap. Kometsuga.

Tsuga diversifolia was first recognised as a species distinct from the *Abies Tsuga* of Siebold and Zuccarini by the Russian botanist Maximowicz who described it under this name in the "Mélanges

Biologiques" of the Imperial Academy of St. Petersburg in 1866. Cones had, however, been brought from Japan by the late John Gould Veitch in 1861 unfortunately mixed with cones of *T. Sieboldii*, and both species were cultivated in the Veitchian nursery at Coombe Wood for many years under the names of *Abies Tsuga* and *A. Tsuga nana*; J. G. Veitch, therefore, was not only the introducer of the species but also, unknown to himself, the discoverer of it. Of the two Hemlock Firs, natives of Japan, *T. diversifolia* is the northern species and is abundant on the central mountains from Lake Umoto northwards to Mount Hakkoda.

"The great forest which covers the Nikko mountains at an altitude of more than 5,000 feet above the ocean is composed almost entirely of the northern Hemlock, *Tsuga diversifolia*. This Hemlock forest, which is the only forest in Hondo that seems to have been left practically undisturbed by man, is the most beautiful which we saw in Japan. The trees grow to a great size, and though they grow close together, they are less crowded than the trees in an American Hemlock forest under which no other plant can grow, and light enough reaches the forest floor to permit the growth of ferns, mosses and many flowering undershrubs which clothe the rocky slopes up which this forest stretches. A most beautiful spot is the walk cut through this forest along the shores of Lake Umoto." *

Tsuga diversifolia is distinguished from *T. Sieboldii* by its darker red bark and more slender branchlets covered with reddish pubescence; by its shorter and narrower leaves of a darker green; and especially by its smaller cones, the scales of which are nearly as long as broad.

Tsuga Mertensiana.

An alpine tree of variable dimensions according to altitude and environment, rarely exceeding 100 feet high with a trunk 5—7 feet in diameter, with thick, cracked bark coming off in scales; at its superior limit reduced to a low dense bush. In Great Britain an elegant tree of slow growth: trunk slender and tapering, bark reddish brown fissured into square or oblong plates. Branches horizontal and much ramified, the secondary branches lateral and rigid, from which spring numerous branchlets, some lateral, but the greater number short and erect; bark of branchlets light brown obscurely fluted longitudinally from the pulvini of the leaves downwards.† Buds numerous, terminal and axillary, very small, ovoid-conic, light brown. Leaves persistent several years, spirally crowded around the branchlets, spreading on all sides on the erect shoots, pseudo-distichous on the horizontal ones; linear-obtuse with a distinct midrib, sometimes concave or subcymbiform above; keeled, with two glaucous stomatiferous bands beneath; in colour varying from dark lustrous green to greyish blue caused by glaucescence. Staminate flowers cylindric-oblong, 0·4 inch long, on

* Sargent, Forest Flora of Japan, p. 81.

† At Murthly Castle, Perthshire, is a tree of *Tsuga Mertensiana* of more vigorous growth than usual, in which the branches are elongated and depressed at an angle of about 45° to the trunk.

a slender stipes of about the same length, surrounded at the base by broadly ovate involucral bracts in three series; anthers club-shaped with a purplish violet connective. Cones shortly stalked, cylindric-fusiform, 2–2·5 inches long, at first violet-purple changing to brown when mature; scales obovate-cuneate, minutely rugose or striated longitudinally on the exposed side; bract minute, closely appressed to the scale. Seeds small with a relatively large oblong wing.

Tsuga Mertensiana, Sargent, Silva N. Amer. XII. 77, t. 606 (not Carrière).

T. Pattoniana, Engelmann in Brewer and Watson's Bot. Califor. II. 121 (1880). Macoun, Cat. Canad. Plants, 473. Masters in Gard. Chron. XII. ser. 3 (1892), p. 10, with fig; and Journ. R. Hort. Soc. XIV. 255. Beissner, Nadelholzk, 407, with figs.

T. Hookeriana, Carrière, Traité Conif. ed. II. 252 (1867).

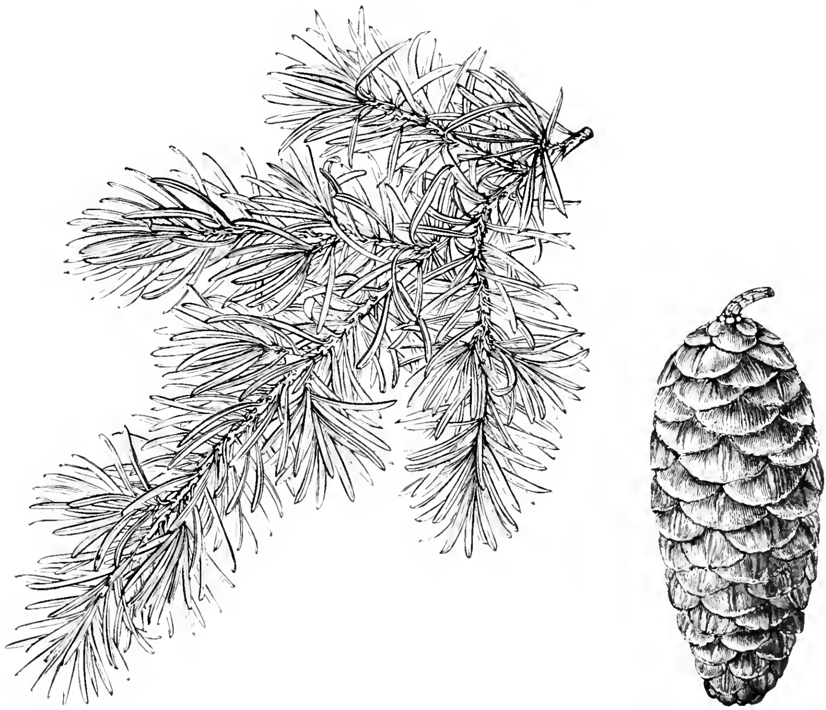


Fig. 117. Branchlet and cone of *Tsuga Mertensiana*.

Abies Pattoniana, Balfour, Rep. Oregon Assoc. 1 (1853). Lawson, Pinet. Brit. I 157, t. 22. Gordon, Pinet. ed. II. 30.

A. Hookeriana, Murray in Edinb. New Phil. Journ. 289 (1855). Lawson, Pinet. Brit. II. 153, tt. 21, 22.

A. Williamsonii, Newberry, Pacif. Ry. Rep. VI. 53, t. 7 (1857).

Pinus Mertensiana, Bongard, Veg. de Sitcha. 54 (1832). Mem de l'Acad. St. Petersb. II. 163. Endlicher, Synops. Conif. 111.

P. Pattoniana, Parlatore, D. C. Prodr. XVI. 429.

Tsuga Mertensiana has a meridional range in north-west America from south-eastern Alaska through British Columbia, Washington and Oregon into California as far as the sources of the King river; it also has a considerable spread laterally on both sides of the international boundary, from Mount Benson in Vancouver Island to the Bitter Root mountains of Idaho. Except in Alaska it always grows at a great elevation, its vertical range being from 2,750 to 10,000 feet, the higher altitude being reached on the Sierras of California. In many parts of the mountain systems over which this tree is spread, the forest towards the higher limit of arborescent vegetation is composed entirely of it; in other places it is mixed with *Pinus flexilis*; at these high altitudes it dwindles to a shapeless shrub scarcely half the height of a man. When standing alone in favourable situations the lower branches are retained and lengthen considerably, the upper branches often decurved and the branchlets with their cones pendent. It attains its greatest development on the Cascade mountains in southern Oregon where individual trees 100 feet high with stout massive stems five and six feet in diameter are abundant.* The wood is light, soft and close-grained but not strong, susceptible of a good polish and of a light brown or reddish colour; it is only occasionally used on account of the inaccessibility of the forests.

This beautiful tree was originally discovered by Mertens in 1827 while in the service of the Russian Government near its northern limit on Baranoff Island near Sitka where it takes the form of a much-branched, straggling shrub. The herbarium specimens gathered by Mertens were dealt with by Bongard of St. Petersburg, who described this tree as a new species under the name of *Pinus Mertensiana* in compliment to the discoverer. Unfortunately, this name was taken up by Carrière for another Hemlock Fir which grows on the island, *Tsuga Albertiana*, which Bongard in common with other early explorers in north-west America mistook for the Canadian type but which is not known to occur wild within two thousand miles of Sitka.† Most recent authors have followed Carrière in this misapplication of Bongard's name and which has for the time resulted in much regrettable confusion.

The tree was re-discovered by Jeffrey on Mount Baker while collecting for the Scottish Oregon Association and introduced through him, receiving the name of *Abies Pattoniana* in compliment to the late Mr. George Patton of the Cairnies in Perthshire, a prominent member of the Association. Three years later it was detected on Mount Scott by William Murray, and his discovery was described by his brother Andrew Murray in Lawson's "Pinetum Britannicum" as a different species under the name of *Abies Hookeriana*, but which has been reduced to a synonym of the older names by the American botanists. In British gardens the name *Hookeriana* is still retained to distinguish the glaucous from the green-leaved variety.

* Garden and Forest, Vol. X. p. 1.

† The following is Bongard's description of *Tsuga Mertensiana* which should set at rest any doubts as to the identity of the tree:—*Pinus Mertensiana* n. sp. Foliis solitariis linearibus obtusinsculis, basi in petiolum attenuatis, integerrimis; strobili squamis reniformibus integris. Ramosissima; rami ramulique delapsis foliis valde tuberculosi. Folia solitaria, approximata, linearia, basi in petiolum minutum attenuata, obtusinscula, supra plana, subtus nervo medio prominulo, integerrima, 5‴ longa, lineaque paulo angustiora. Strobili, solitarii, sessiles, oblongi, obtusi, 1·5 pollicem, plus minusve. Squamæ reniformes, integræ, 5‴ et quod excedit latae. Observations sur la Vegétation de Sitcha, p. 54.

Tsuga Mertensiana at Eastnor Castle.

Tsuga Mertensiana is one of the handsomest of coniferous trees of small or medium dimensions for the decoration of the lawn where the larger trees are unsuitable. It grows fairly well in most soils that are well drained, the growth of the leader shoot rarely exceeding six to nine inches annually; to secure good specimens a space with a radius of not less than fifteen feet should be allowed for them. The species keeps in memory the name of one of the most energetic of botanical explorers of the early part of the nineteenth century.

KARL HEINRICH MERTENS (1796—1830) was the son of Dr. Franz Karl Mertens who was the head of an Institution in Bremen, and the author of several botanical papers, and who is commemorated by the genus Mertensia (Boragineæ). Karl Heinrich was born in Bremen where he received his early education and acquired a fondness for natural history, especially Botany which he studied later in Paris with Jussieu, Desfontaines, Lamarck and Mirbel, and where he made the acquaintance of Dawson Turner by whom he was invited to London and introduced to Dr. Robert Brown, Sir Joseph Banks and the elder Hooker. Returning to Germany in 1817, he commenced the study of medicine in Göttingen and then in Halle where he took the Doctor's degree in 1820 and began to practise his profession in Berlin, which, however, he soon left to make his home in his native city. An intense love of natural history and a desire for travel, made the prospect of a quiet professional life in Bremen unbearable, and Mertens went to St Petersburg in the hope of being appointed naturalist to the expedition which was fitted out there under the command of Kotzebue. Failing to obtain this position, he remained two years in Russia practising his profession, and finally in the spring of 1826 was appointed naturalist and physician to the expedition which sailed that year under Captain Lutki to make a scientific voyage of exploration round the world. During the next four years Mertens visited England, Teneriffe, Rio de Janeiro, Cape Horn, Valparaiso, the coast of Alaska, Kamtschatka, the Caroline Islands, Manila, the Cape of Good Hope and St Helena. Returning to St. Petersburg, he presented to the Academy of Sciences of that city a number of papers chiefly devoted to the Invertebratæ collected during the voyage. He was still engaged in studying his collection when he joined, in 1830, his old commander Lutki on a cruise along the coast of France and Ireland, during which he contracted a nervous fever from which he died shortly after his return to Russia.*

Tsuga Sieboldii.

A stately tree, attaining at its greatest development a height of 80—90 feet, at its highest vertical range considerably less, everywhere much resembling the type species, *Tsuga canadensis*, in habit and aspect. Branchlets slender with cinereous-brown striated bark, much ramified distichously; the youngest shoots glabrous, pale yellowish brown, marked longitudinally by cortical ridges, terminating at the base of the leaves in a relatively prominent red pulvinus or cushion. Buds small, globose, enclosed in numerous minute, chestnut-brown perulæ. Leaves persistent three—four years, petiolate, the petiole nearly parallel with the axis of the shoot, linear, obtuse or emarginate, 0·25—1 inch long, the shorter leaves produced from the upper, the longer ones from the lower side of the shoot, dark lustrous green and distinctly channelled above, with two greyish, stomatiferous bands beneath. Staminate flowers globose-cylindric, stipitate with a stiff, slender stalk surrounded at the base by numerous small, ovate, involucral bracts. Cones sub-globose, about an inch in diameter, composed of four—five series of spirally arranged, imbricated, orbicular scales, striated on the exposed side. Seed-wing roundish oblong, about three-fourths as long as the scale.

* From the Silva of North America, Vol. XII. p. 80.

Tsuga Sieboldii, Carrière, Traité Conif. ed. I. 186 (1855); and ed. II. 245 (1867) in part). Masters in Journ. Linn. Soc. XVIII. 512; and Journ. R. Hort. Soc. XIV. 256. Mayr, Abiet. des Jap. Reiches, 59, Tafel IV. fig. 12. Beissner, Nadelholzk. 394, with figs.

T. Araragi, Sargent in Garden and Forest, X. 491, fig. 62.

Abies Tsuga, Siebold and Zuccarini, Fl. Jap. II. 14, t. 106 (1842). Murray, Pines and Firs of Japan, 84, with figs (in part). Gordon, Pinet. ed. II. 32 (in part).

Pinus Tsuga, Endlicher, Synops. Conif. 83 (1847). Parlatore, D. C. Prodr. XVI. 428 (in part).

Eng. Japanese Hemlock Fir. Fr. Tsuga du Japon. Germ. Japanische Hemlockstanne. Jap. Tsuga Araragi.

As already stated under *Tsuga diversifolia* there are two species of Tsuga endemic in Japan, or two easily distinguishable forms recognised as such, of which *T. Sieboldii* became known to science many years

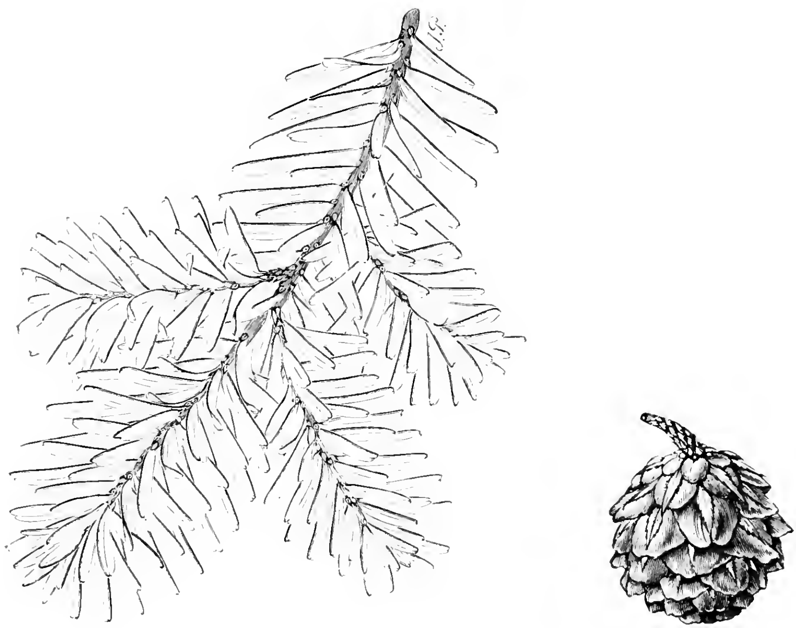


Fig. 118. Branchlet and cone of *Tsuga Sieboldii*.

before the second species was admitted. It was discovered by the eminent traveller whose name it bears during his residence in Japan, 1823—1830, and was introduced by him into European gardens shortly after the establishment of his Jardin d'Acclimatation at Leyden in Holland in 1850. *T. Sieboldii* takes the place of *T. diversifolia* south of Nikko, ascending in places to a considerable elevation, nowhere forming a continuous forest, but scattered in groves among deciduous trees or mixed with *Pinus densiflora*. Like most of the native trees it has been planted for ornament or utility in numberless places so that its original geographical limits have long since been obliterated. Dr. Mayr states that the wood is very durable when exposed to the weather, but not much used on account of the difficulty of transport.

Philip Franz Von Siebold (1796—1866) was born at Würzburg in Bavaria, and belonged to a family which has given several distinguished members to the medical profession. He received a first-class education in his native town and obtained the degree of Doctor in 1820. Two years afterwards he went to Java as medical officer in the Dutch service, and that Government having decided upon dispatching a scientific expedition to Japan, Von Siebold was attached to it as medical officer and naturalist. Having arrived there in 1823, he was compelled, like all foreigners, to confine his explorations to the immediate vicinity of Nagasaki, the only port then accessible, but he soon acquired greater freedom in consequence of the repute attached to his name as a man of science. In 1824 he accompanied the Dutch ambassador to Jeddo (Tokio), but two years later, when on the point of returning to Java, his life was endangered by the excessive zeal of one of his friends who had furnished him with a hitherto unpublished map of the empire, and Von Siebold, who risked his own life to save that of his friend, was thrown into prison. He returned to Europe in 1830, quitted the Dutch service, and employed himself in the arrangement of his rich store of scientific materials which he had collected in Japan. One of the most important works issued by him after his return to Europe was his "Flora Japonica," the first volume of which was published in 1835, and the second in 1842. About the year 1850 he established a nursery and "Jardin d'Acclimatation" at Leyden, for the cultivation and distribution of new plants from the Far East, and during the succeeding fifteen years he introduced from China and Japan a large number of plants previously unknown in European gardens, many of which have proved valuable additions to the Arboretum and Flower Garden. He died at Munich in October, 1866.

ABIETIA.

Pseudotsuga,* Carrière, Traité Conif. ed. II. 256 (1867). Bentham and Hooker, Gen. Plant. III. 441 (1881). Masters in Journ. Linn. Soc. XXX. (1893). Tsuga sect. Pseudotsuga, Eichler in Engler and Prantl, Nat. Pfl. Fam. 80 (1887).

The Douglas Fir does not strictly conform to either of the three genera among which the Firs, in a popular sense, are distributed. It differs from all of them in the anatomy of the wood, the tracheides of which are spirally marked; and in the structure of the leaves which have an interrupted, not continuous layer of hypoderm cells (see page 33—35); the leaves agree, however, with Abies in the presence of two lateral resin canals. The staminate flowers of the Douglas Fir have the resemblance of those of Picea but with the anthers spurred as in Abies and Tsuga and differing from the

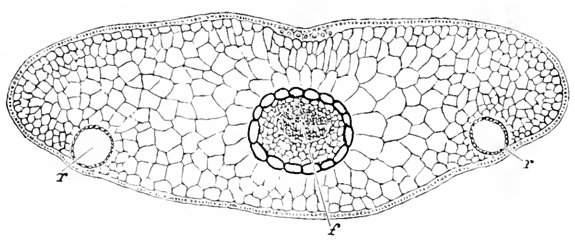


Fig. 119. Transverse section of leaf of *Abietia Douglasii*. × 50; *r r*, resin ducts; *f*, fibrovascular bundle.

* An uncouth, barbarous name, half Greek, half Japanese, "utterly bad in construction" and misleading in such meaning as it has, and which I have refused to adopt as a protest against the admission of such names into scientific nomenclature. Also in compliance with Art. 60, sect. 4 of the Laws of Botanical Nomenclature adopted at the International Botanical Congress held at Paris in 1867 which enacts that—"Every one is bound to reject a name which is formed by a combination of two languages."

latter in being spirally crowded around a staminal column and not in globose clusters; the anther cells split obliquely and not transversely as in Abies and Tsuga. In the cones are combined characters occurring in all the other genera: they are pendulous as in Picea and Tsuga but differ from both in the bracts being longer than the scales and prominently exserted as in some of the species of Abies. The preponderance of agreement is with Abies but with such a marked difference in the cones that the Douglas Fir has been generically separated from it by most recent authors.

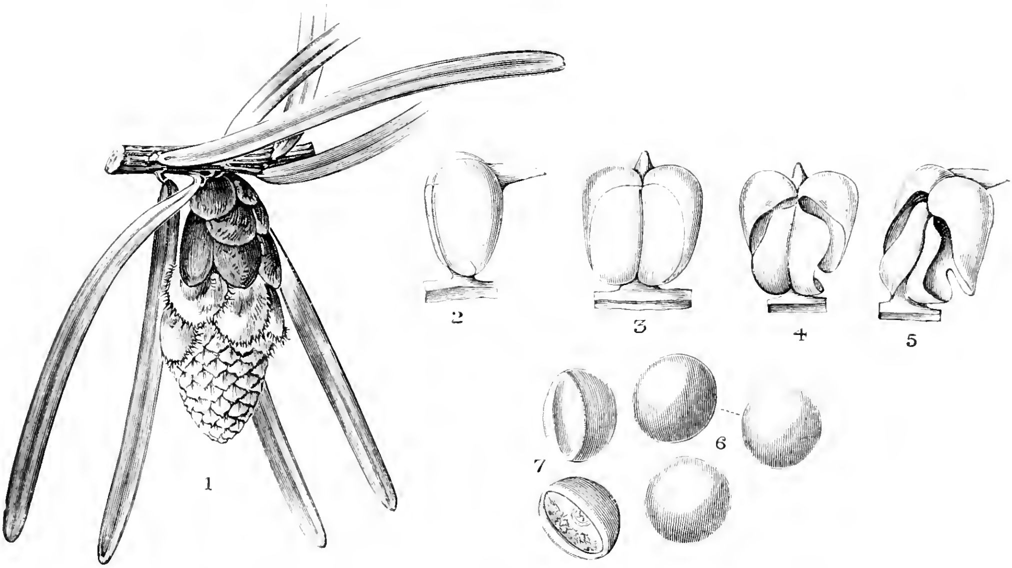


Fig. 120. 1, Staminate flower of *Abietia Douglasii*; nat. size. 2 and 3, side and front view of anthers before dehiscence; 4 and 5, after dehiscence, × 10; 6, three fresh pollen grains; 7, two pollen grains after exposure to dry air fifteen minutes, × 120.

Another Fir aberrant in some of its characteristics from every other, was discovered by Robert Fortune in south-east China and introduced by him about the year 1846. It was cultivated under the name of *Abies Fortunei* but all the originally raised seedlings planted out in this country seem to have perished in the course of a few years and a similar fate has probably befallen plants raised from seeds obtained since, doubtless from climatic causes. As Fortune's Fir is apparently not destined to have a place in the British Pinetum, the interest attached to it in this country is solely scientific and the notice of it in these pages is accordingly brief; its history and peculiarities are elaborately discussed by the authors quoted after the description, and to their writings the reader is referred. The most marked characteristic which distinguishes Fortune's Fir from every other is the umbellate arrangement of the staminate flowers, and on this ground chiefly Dr. Maxwell Masters in his recent revision of the Coniferae has adopted the genus Keteleeria, created many years ago for its reception by Carrière, the author of the "Traité Général des Conifères," by reason of the somewhat vaguely defined difference observable in its growth and aspect.* Looked at from every point of view Fortune's Fir comes nearest to the Douglas Fir, and is here provisionally joined with it. These Firs are intermediate forms: the Douglas Fir bridges over the difference between the Hemlock and Silver Firs, and Fortune's Fir the difference between the Spruce and Silver Firs; moreover the Spruce Firs are connected with the Hemlocks by the flat-leaved species of the section Omorica. Whilst for practical purposes it may be the most convenient course to retain the different groups of Firs under separate generic names, doubts may reasonably arise whether that course is most compatible with a strictly scientific classification of them, seeing that all the Firs have, like all the Pines, easily recognisable common characters, and like the Pines are connected together by discernible links.

Abietia Douglasii.

A tree of very variable dimensions, under favourable conditions in Washington and Oregon near the Pacific coast, 175—200 or more feet with a trunk 4—6·5 feet in diameter, and where the trees are crowded, usually denuded of branches for one-half or more of the

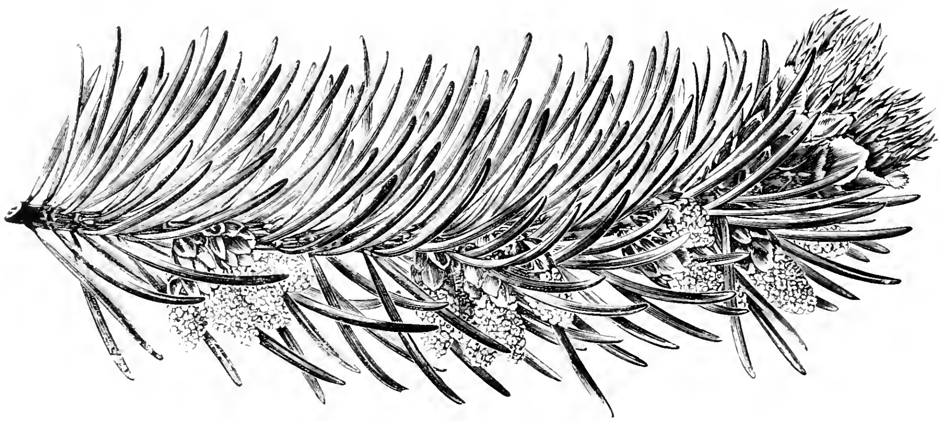


Fig. 121. Branchlet of *Abietia Douglasii* with foliage and staminate flowers.

height and with a thin narrow crown, which in very old trees becomes flat-topped;† on the drier slopes of the Rocky Mountains not more than 80—100 feet high with a trunk 2—3 feet in diameter; even reduced to a low shrub at its highest vertical limit. Bark of adult trees 3—5 inches thick, reddish brown, deeply and irregularly fissured; in the forests of Oregon and Vancouver Island often much thicker and separated into broad rounded ridges broken on the surface into dark red-brown scales. In Great Britain the oldest trees have a pyramidal outline much broken by projecting branches. Bark of trunk dark brown and much fissured, the general direction of the fissures longitudinal and

* Sa végétation, ainsi que son facies général, ont également quelque chose de particulier qui ne se rencontre dans aucun genre ni même dans aucune section etablis. p. 262.

† Individual trees have been felled in the neighbourhood of Puget Sound over 250 feet high with trunks 5 to 7 feet in diameter. A section of an exceptionally large tree preserved in the Natural History Museum at South Kensington is about 7½ feet in diameter.

exposing a reddish brown inner cortex. Branches slender, and where the tree is standing alone the lowermost attaining lengths of 25—35 feet or even more, more or less depressed by the weight of their appendages and often sweeping the ground; those above horizontal, sometimes upturned at the distal end; the uppermost more or less ascending. Branchlets slender, distichous and mostly opposite, depressed or sub-pendent. Buds conic, acute, 0·25—0·5 inch long, with oval-

Fig. 122. Fertile branchlet of *Abietia Douglasii.*

oblong, lustrous sienna brown perulæ fringed with whitish hairs. Leaves persistent six—seven years, pseudo-distichous in three—four ranks, narrowly linear, flat, 0·75—1·25 inch long, obtuse or mucronate at the apex, frequently falcately curved upwards, bright lustrous green with an obscure median line above, paler with a more or less glaucous stomatiferous band between the midrib and the thickened margins beneath. Staminate flowers mostly on the under side of branchlets of the preceding year, axillary obtusely conic, about 0·75 inch long, surrounded at the base by broadly oval, obtuse involucral bracts in three–four series: anther connective spurred; pollen grains spherical. Cones terminal on short lateral branchlets, pendent, ovoid-conic, 2·5—4 inches long, and 1—1·25 inch in diameter; scales suborbicular with a short cuneate claw and obscurely sinuate margin; bracts longer than the scales, narrowly oblong at the base with a prominent midrib; with two spreading lobes at the apex and the midrib prolonged into a rigid linear awn. Seeds marked with an irregular white spot and having a lenticular wing about one-sixth the size of the scale.

Abietia Douglasii, *supra*.
Abies Douglasii, Lindley in Penny Cyclop. I. 32 (1833). Loudon, Arb. et Frut. Brit. IV. 2319, with figs. Forbes, Pinet. Woburn. 127, t. 45. Hoopes, Evergreens, 189. Lawson, Pinet. Brit. II. 115, tt. 17, 18, and figs. Gordon, Pinet. ed. II. 24.
Tsuga Douglasii, Carrière, Traité Conif. ed. I. 192 (1855).
Pseudotsuga Douglasii, Carrière, Traité Conif. ed. II. 256 (1867). McNab in Proceed. R. Irish Acad. II. ser. 3, p. 703, fig. 32. Engelmann in Brewer and Watson's Bot. Califor. II. 120. Beissner, Nadelholzk. 411, with figs. Masters in Journ. R. Hort. Soc. XIV. 245. Macoun, Cat. Canad. Plants, 473.
P. mucronata, Sargent, Silva N. Amer. XII. 87, t. 607 (1898).
Picea Douglasii, Link in Linnaea, XV. 524 (1841).
Pinus Douglasii, Don in Lambert's Genus Pinus, III. 163 (1837). Hooker, W. Fl. Bor. Amer. II. 162, t. 183. Endlicher, Synops. Conif. 87. Parlatore, D. C. Prodr. XVI. 430.
P. taxifolia,* Lambert, Genus Pinus, 51, t. 33 (1803).
Eng. Douglas Fir. Amer. Douglas Spruce, Red Fir. Fr. Sapin de Douglas. Germ. Douglas-Tanne, Douglas-Fichte. Ital. Abete di Douglas.

var.—glauca.

A smaller tree with shorter, stouter branches, but distinguished from the type chiefly by its foliage and smaller cones. The leaves during the first season are bluish green above and more glaucous beneath than in any of the older forms.

A. Douglasii glauca. Pseudotsuga Douglasii glauca, Beissner, Nadelholzk. 419.
Abies coloradensis, Hort.

var.—macrocarpa.

A smaller tree with longer and more distant branches that are usually pendulous below, and with shorter, stouter winter buds and shorter leaves. Its most distinctive character is its larger cones, often produced in great numbers on the upper branches and which are 4—6·5 inches long and 2 inches in diameter.

A. Douglasii macrocarpa. Pseudotsuga Douglasii macrocarpa, Engelmann in Brewer and Watson's Bot. Califor. II. 120. P. macrocarpa, Mayr, Wald Nordamer. 278. Sargent in Garden and Forest, X. 24, with fig.; and Silva N. Amer. XII. 93, t. 608.

var.—pendula.

Branches quite pendulous with lax and drooping branchlets, and with the leaves usually more glaucous on the under side than in the common form.

A. Douglasii pendula. Pseudotsuga Douglasii pendula, Engelmann ex Beissner, Nadelholzk. 417. Pinus Douglasii pendula, Parlatore, D. C. Prodr. XVI. 430.

* This is the oldest specific name: it was applied to the herbarium specimen gathered by Menzies in 1792, but was not taken up subsequently by any British author till it was brought into use by horticulturists to designate a geographical variety.

var.—Standishii.

A remarkable variety, raised from English-grown seed gathered from a Douglas Fir standing in close proximity to some large Silver Firs. It has the habit and general aspect of the species, but the leaves are larger, deeper green above and quite silvery beneath, like those of a Silver Fir.*

A. Douglasii Standishii. Abies Douglasii Standishii. Gordon. Pinet. ed. II. 26 Pseudotsuga Douglasii Standishii. Masters in Journ. R. Hort. Soc. XIV. 245.

var.—taxifolia

A smaller tree with shorter branches more regularly developed and giving the tree a more contracted conical outline than the common form. The leaves are longer and usually darker in colour.

A. Douglasii taxifolia. Pseudotsuga Douglasii taxifolia. Carrière, Traité Conif. ed. II. Beissner, Nadelholzk. 418.

The varieties described above are the most distinct deviations from the Oregon type of *Abietia Douglasii* yet observed. With the exception of *macrocarpa*, they are all occasionally met with in British gardens. Other varieties selected from the seed beds have been named *argentea*, *brevifolia*, *compacta*, *elegans*, *fastigiata*, *monstrosa*, *nana*, *stricta*, names sufficiently indicative of their most obvious characteristic so long as they retain it. **Stairii** is a variety with light golden yellow foliage that originated many years ago at Castle Kennedy in Wigtownshire, the seat of the Earl of Stair, and is still propagated in Scottish nurseries.

Abietia Douglasii is the most widely distributed tree of western North America; its distribution is comparable in some respects with that of *Pinus ponderosa*, but the area over which it is spread is considerably greater, especially in a meridional direction. With the exception of the lowland plains and valleys of southern British Columbia, Washington and Oregon where it forms dense forests, it is mostly a tree of the mountains. Its northern limit is placed at about lat. 55° near Lake Tacla in British Columbia; from this point it follows the Rocky Mountains system southwards through the whole breadth of the United States to western Texas and thence into Mexico for several hundred miles, its southern limit, so far as at present known, being near the city of San Luis Potosi, just within the northern tropic. In the coast region including Vancouver Island, it spreads from the Skeena river southwards through the Pacific States to the Santa Lucia in south California. In the territory lying between the Rocky Mountains and the coast ranges it follows the general trend of the Cascade mountains and the Sierra Nevada as far as the latitude of Los Angeles, reappearing in isolated groups on the San Bernardino, the San Jacinto and other ranges in the extreme south of California. In the dry region east of the Californian mountains it grows chiefly on rocky slopes usually mixed with other trees. Its vertical range varies with the climate and

* Known only from a single tree in the Pinetum of the late Mr. J. D. Bassett at Leighton Buzzard.

latitude of the region: on the Californian Sierras it seldom ascends higher than 5,500 feet above the level of the ocean; in northern Arizona it forms forests between 8,000 and 9,000 feet elevation and in Colorado up to 11,000 feet.

The foregoing outline of the distribution of the Douglas Fir brings out prominently the following remarkable facts:—it is the most widely distributed not only of all American Firs but of all American trees—it is spread over thirty-two degrees of latitude, a meridional range greater than that of any other coniferous tree excepting perhaps the common Juniper; it must thence possess a constitution that "enables it to endure the fierce gales and long winters of the north and the nearly perpetual sunshine of the Mexican Cordilleras; to thrive in the rain and fog which sweep almost continuously along the Pacific coast range, and on the arid mountain slopes of the interior, where for months every year, rain never falls."* The Douglas Fir is not only one of the most interesting, but it is also one of the most valuable of trees; its size, its capacity of adapting itself to new surroundings and the excellence of its timber, all contribute to make it one of the most important inhabitants of the forests of western America. It attains its greatest development in the humid lowlands of western Washington and Oregon, especially around Puget Sound and on the western slopes of the Sierra Nevada where the precipitation from the Pacific Ocean is greatest: in these regions it often attains a height of 300 feet with a trunk 9 to 12 feet in diameter.† When standing alone on the low damp plains as it often does on the steep slopes of the mountain cañons, its lofty trunk is frequently feathered with branches from the ground upwards; in the bottom lands of the Columbia basin, the trees often stand so close together that the traveller can with difficulty push his way between the lofty trunks free of branches for upwards of 200 feet and supporting a canopy of foliage so dense that the sun's rays never pierce it.‡ While thus attaining gigantic proportions in the plains, it also flourishes high up on the mountains of California at an altitude of 5,000 to 6,000 feet, and in Colorado still higher, but at these elevations it is always a much smaller tree.

Over so extensive a region and under so many diverse circumstances of climate and environment, sometimes of the most opposite description, the wood of the Douglas Fir is found to vary much in quality and colour; some trees produce yellow, others light red wood; the yellow is the finer and the red the coarser-grained wood, but the difference seems to be largely due to the age of the tree. In southern British Columbia, Washington and Oregon, Douglas Fir timber is used for all kinds of construction, house-building, spars and masts for ships, and also for fuel. The wood of the variety *macrocarpa* is heavy, hard, strong and durable; it is largely used for fuel.§

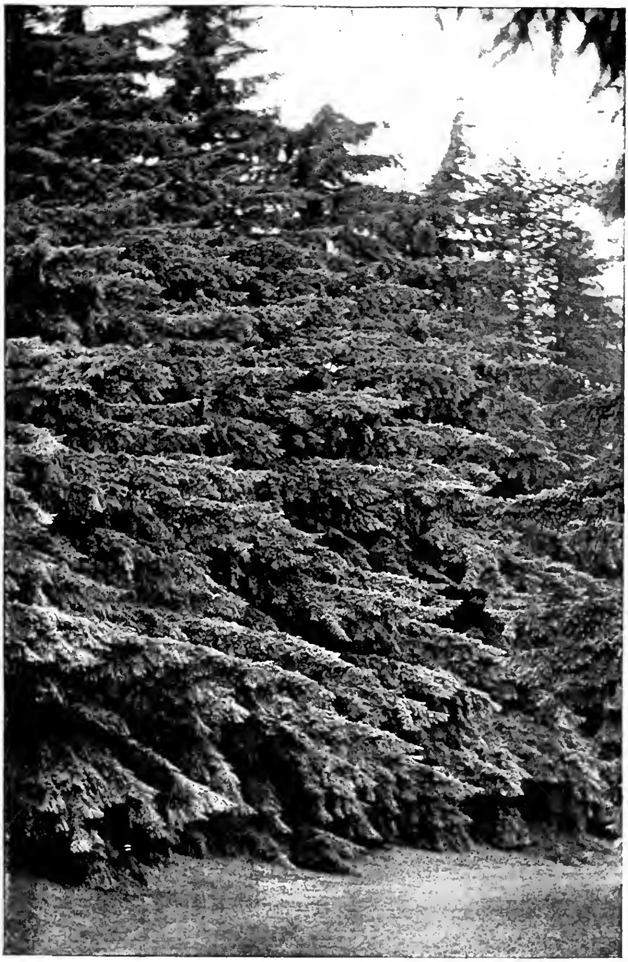
* Silva of North America, XII. p. 91.

† The British public have had for many years past an opportunity of forming an idea of the stupendous dimensions attained by this tree. In the Royal Gardens at Kew is erected a flagstaff brought from Vancouver Island; it consists of a single piece 159 feet in length, 22 inches in diameter at the base tapering to 8 inches at the summit; it weighs three tons and contains 157 cubic feet of timber. The tree from which this flagstaff was made was two hundred and fifty years old, as indicated by its concentric rings.

‡ Garden and Forest, IV. p. 205.

§ Silva of North America, XII. pp. 90, 91.

Abietia Douglasii was originally discovered by Archibald Menzies * on the shores of Nootka Sound in 1792 during Vancouver's voyage round the world. From his herbarium specimens it was figured and described by Lambert in the "Genus Pinus" published in 1803, under the name of *Pinus taxifolia*, which is therefore the oldest



Douglas Firs at Murthly Castle.
(From *The Garden*.)

published name, but which was not taken up by any subsequent British author. It was next seen by Lewis and Clark during their perilous journey across the North American Continent in 1805—1806,

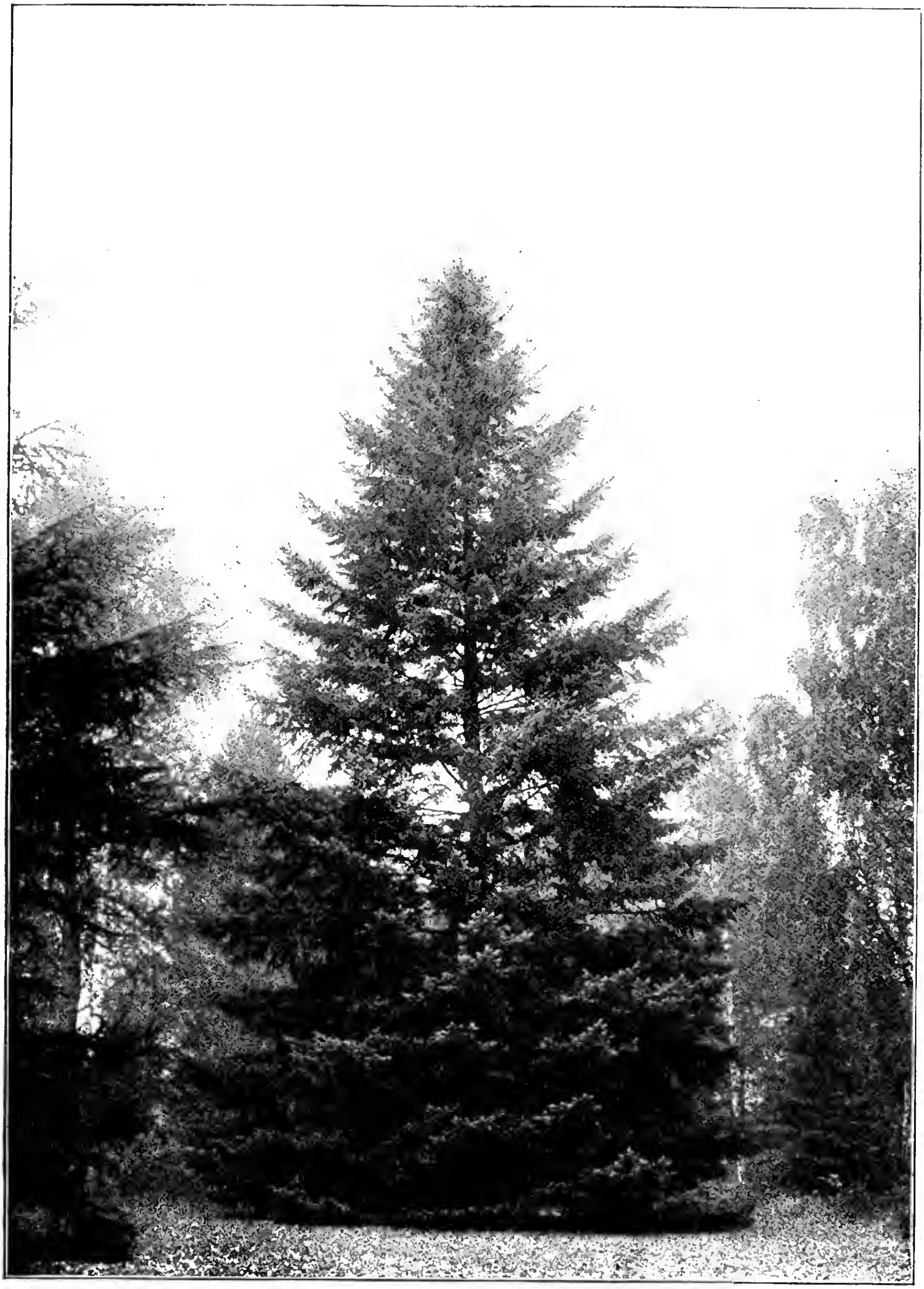
* At Castle Menzies in the highlands of Perthshire, not far from the birthplace of Archibald Menzies, are some of the finest specimens of the Douglas Fir in Great Britain.

and was described by them in the narrative of the expedition. It was re-discovered by David Douglas in 1827, and introduced by him in the following year. Shortly afterwards Dr. Lindley, setting aside Lambert's name, selected this tree as the most suitable subject for commemorating the intrepid explorer and the eminent services rendered by him to British arboriculture and horticulture.

The Douglas Fir is unquestionably one of the most valuable trees ever introduced into Great Britain. It has been planted throughout the length and breadth of the land, but not with unvarying results. Where exposed to the force of gales and high winds, breakage of the leader shoot often occurs; and when exposed to piercing winds from the north-east and east, or planted in land with insufficient drainage or where the soil is too shallow, the Douglas Fir, notwithstanding its marvellous constitution, does not thrive satisfactorily. Hypothetically the cause of failure in such situations has been assigned to the fact that all, or nearly all, the older trees in Great Britain were raised from seed produced by trees growing in the alluvial lands in the neighbourhood of the Pacific coast in the comparatively mild climate of Washington and Oregon where cold, piercing winds are unknown. In most parts of this country where not so exposed, especially in the south and south-western counties of England; in Wales and Ireland; in Perthshire and the south-western counties of Scotland, the growth of the Douglas Fir is very rapid during early life, and it has gained the confidence of many foresters as a valuable tree for afforesting waste lands suitably situated. Some of the most thriving plantations of Douglas Fir are to be seen in Perthshire, the native county of Douglas, where the tree has been planted with no unstinted hand, especially on the estates of the Earl of Mansfield at Scone and Lynedoch. Two fine trees at the last-named place, planted in 1834, are among the oldest in the country; the tallest is 100 feet high (97 feet in August, 1896); the other is over 80 feet high, and has produced cones freely from which hundreds of seedlings have been raised. At Murthly Castle in the same county, the Douglas Firs are a prominent feature of the grounds; trees from 80 to 100 feet high form two long vistas of imposing aspect, and a belt on the south side of the Tay river is remarkable for the uniform and stately growth of the trees composing it.*

The annual rate of growth of the Douglas Fir during the first thirty—thirty-five years varies with the locality. In Devon and Cornwall it is quite 30 inches; in Hampshire and other southern counties it is somewhat less; in the eastern and northern counties (Cambridge, Lincoln and Northumberland) it is about 18 inches; in the western counties (Shropshire and Wales) it is from 24 to 27 inches; in Perthshire the annual growth ranges from 18 to 27 inches according to locality; in Argyll and the western counties from 15 to 20 inches; and in Ross and Sutherland from 12 to 15 inches. In Ireland the rate of growth equals that in Devonshire, and an instance is recorded of a tree in the county of Meath having made

* Other noteworthy specimens of the Douglas Fir upwards of or exceeding 100 feet in height are growing at Dropmore, Bowood Park, Bicton, Powderham Castle, Carclew; in Scotland at Castle Menzies, Dunkeld, Rossie Priory, Dorris; in Ireland at Castlewellan, Coollattin, Powerscourt.



Abietia Douglasii at The Frythe, near Welwyn.

an annual growth of 33 inches. When planted for ornamental purposes, the Douglas Fir should have a clear space with a radius of more than 30 feet assigned to it. In an open place admitting of a free circulation of air, it is found to retain its lower branches in health and vigour for an almost indefinite period—a circumstance which greatly enhances its value as an ornamental tree.

Of the varieties described in page 478, *glauca*, *macrocarpa* and *taxifolia* are geographical forms. *Glauca* is known in many gardens as the Colorado variety in reference to its origin, although it is not found exclusively in that State but along the Rocky Mountains almost from north to south. *Macrocarpa* is a local form inhabiting the San Bernardino mountains in south California and their continuation into northern Mexico: it is figured and described in the "Silva of North America" as a distinct species on the ground that the characters which separate it from the type are permanent and that no intermediate forms have been found, although the type abounds in the region north and south of that inhabited by *macrocarpa*. *Taxifolia* is also a local form which has been somewhat vaguely stated to occur in Oregon and Mexico, but more definite information respecting its origin is wanting.

As a tree for ornamental planting the variety *taxifolia* is superior in some respects to the Oregon and Vancouver type; it is more symmetrical in growth and habit, taking up much less space, and frequently growing satisfactorily in places where the originally introduced form does not thrive. Our illustration represents a fine specimen at The Frythe, near Welwyn, Herts, and there are several trees of this variety of great beauty at Eastnor Castle.

Our article on the Douglas Fir would be incomplete without some further notice of him whose name it bears. It has been said that "there is scarcely a spot deserving the name of a garden, either in Europe or in the United States, in which some of the discoveries of David Douglas do not form the chief attraction." The frequent mention of his name in these pages as the discoverer and introducer of some of the finest coniferous trees that adorn the lawns and parks of Britain, affords abundant evidence that the above quotation contains very much, if not the whole truth, and that to no single individual is modern horticulture more indebted than to David Douglas. His untimely end, the unfortunate circumstances that prevented the publication of his journals, together with the length of time that has elapsed since the introduction to gardens of his finest discoveries, have all tended to dim the memory of his great achievements. The noble Fir that properly bears his name will, it is true, perpetuate it to distant ages.

David Douglas (1799—1834) was borne at Scone, near Perth, where his father was a working mason. He received a plain education at the parish school, and at an early age showed a strong inclination for gardening, which led to his being apprenticed in the gardens of the Earl of Mansfield, at Scone Palace, for a term of seven years. David was fond of books and the study of plants, and during this period he made himself well acquainted with the native and exotic plants within his reach, and acquired an elementary knowledge of Botany. He greatly improved and extended this knowledge during the two years he served with Sir Robert Preston, of Valleyfield, where he went to live after the completion of his apprenticeship. In 1820 he removed to Glasgow, where he was employed in the Botanic Garden of the University. Here he greatly enlarged his knowledge of Botany, and attracted by his intelligence the notice of Dr. (afterwards Sir W. J.) Hooker, at that time Professor of Botany in Glasgow University, and who made him his companion in his botanical excursions to the Highlands and other parts of Scotland for the purpose of collecting materials for his "Flora Scotica." By Sir William Hooker he was recommended to the Horticultural Society of London, and thus he became known to Mr. Sabine, at that time the able Secretary of the Society, through whose influenee he was appointed Collector to the Society. His first destination was China, but owing to the unsettled state of the country, that rich field, afterwards partially but successfully explored by Mr. Robert Fortune under more auspicious circumstances, was abandoned for a time, and Douglas was sent to the United States in 1823, whence he made many valuable additions to our hardy fruits, besides procuring several fine plants till then unknown to British Horticulture. In 1824 it was resolved to send him to the Columbia river, on the western side of the Continent, to explore the vegetable productions of the country adjoining, and southwards to California, of which scarcely anything was at that time known, although a glimpse of the forests of gigantic Coniferæ covering the coast range had been obtained by Archibald Menzies a quarter of a century previous, when accompanying Vancouver on his interesting voyage. An opportunity occurred through the agency of the Hudson's Bay Company, and he landed at Fort Vancouver, on the banks of the Columbia river, for the first time in April, 1825. From that time till his return to England in 1827 he sent home many beautiful plants, with seeds and dried specimens. Among his earliest introductions were *Abietia Douglasii*, *Pinus ponderosa* and *P. Lambertiana*. In the spring of 1827 he went from Fort Vancouver across the Rocky Mountains to Hudson's Bay, where he met Captain (afterwards Sir John) Franklin, Dr. Richardson, and Captain (afterwards Sir George) Back, returning from their second overland Arctic Expedition. With these travellers he returned to England, bringing with him the results of his researches. He remained in London two years, and sailed again for the Columbia river in 1829. In addition to his mission as a collector for the Horticultural Society, he was employed by the Colonial Office to take observations on magnetic and atmospheric phenomena, the department supplying him with instruments and contributing towards his expenses. He reached the Columbia river in June, 1830, and spent the remainder of the year in exploring the neighbouring country, and made some valuable additions to the Pinetum, the most important being *Abies nobilis* and *Picea sitchensis*. The next year he travelled southwards into California, then a comparatively unknown land, where he found a rich harvest of new plants. In 1832 he visited the Sandwich Islands, and returning to the Columbia river in the same year, undertook an expedition to the Fraser river, where he had a very narrow escape of his life, and lost many valuable papers. He finally quitted north-western America in 1833, having previously resigned his appointment as collector to the Horticultural Society in consequence of a revolution in the affairs of the Society which led to the resignation of Mr. Sabine, the Secretary, with whom Douglas identified his interests. He sailed for the Sandwich Islands, where he had remained some months, when an accident put an end to his existence. The natives of the Sandwich Islands were in the habit of making pits in which they caught wild cattle. In one of his excursions Douglas fell accidentally into one of these pits, in which an infuriated animal was already trapped; the animal fell upon him, and he was found, dreadfully mangled and quite dead, July 12th, 1834. An elegant monument with a suitable inscription has been erected to his memory by subscription in the parish churchyard of New Scone, Perthshire.

Abietia Fortunei.

A large tree with much of the habit and aspect of a Cedar of Lebanon, the trunk covered with thick rugged bark; the branches spreading horizontally and much ramified at the distal end. Branchlets glabrous, orange-red, mostly distichous and opposite with occasional adventitious shorter and weaker shoots on the upper side of the axial growth. Buds small, ovoid, with orange-brown perulæ, the lowermost of which are prolonged into an acuminate tip. Leaves persistent, spirally arranged but rendered pseudo-distichous by a half twist of the short petiole, linear, rigid, mucronate or spine-tipped, 1—1·25 inch long, dark lustrous green with a narrow median keel above, paler with two glaucous stomatiferous bands beneath. Staminate flowers cylindric, obtuse, about 0·5 inch long, produced in umbels of eight—ten on branchlets of the preceding year, the umbel shortly pedunculate and surrounded at the base by small involucral bracts. Cones erect, variable in size, ovoid or ovoid-cylindric, much resembling those of *Pinus Cembra*; scales convex, sub-orbicular, somewhat longer than broad, with a short cuneate claw and rounded apical margin; bracts linear, about half as long as the scales, expanded into a small sub-quadrate plate near the apex and terminating in a mucronate tip. Seeds angular and wedge-shaped with a relatively broad roundish oblong wing.

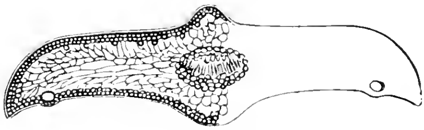


Fig. 123.
Transverse section of leaf of *Abietia Fortunei*.
(From the *Gardeners' Chronicle*.)

Abietia Fortunei, *supra*.
Abies Fortunei, Murray, Pines and Firs of Japan, 49, with figs. (1863). Hance in Journ. Bot. XX. 39. Masters in Journ. Linn. Soc. XVIII. 519; XXII 197, with figs; Gard. Chron. XXI. (1884), p. 348, with fig.: and XXV. (1886), p 428, with figs.
A. jezoensis, Lindley in Gard. Chron. 1850, p. 311, with fig. (not Siebold and Zuccarini).
Keteleeria Fortunei, Carrière, Traité Conif. ed. II. 260 (1867). Pirotta in Bull. Soc. Toscana di Orticultura, 1887, p. 263. Masters in Gard Chron. II. ser. 3 (1887), p. 440; and Journ. R. Hort. Soc. XIV. 216. Mayr, Abiet. des Jap. Reiches, 99. Beissner, Nadelholzk 421, with figs
Pinus Fortunei, Parlatore, D. C. Prodr. XVI. 430 (1868).

This remarkable Fir was originally discovered by Fortune in 1844 or 1845 near a temple at Foo-chow-foo (Fu-chau-fu of modern maps), who saw but a single tree which had apparently been planted there. Nothing more was seen of it till 1873 when it was re-discovered by Dr. Hance in the same locality, and five years later by Mr. Charles Maries who found it in great numbers on the coast range of Fo-kien (Fu-chau) associated with *Pinus Massoniana* (*P. sinensis*). Another species was discovered in China in 1869 by the French missionary, the Abbé David, which has been described by M. Franchet under the name of *Abies (Tsuga) Davidiana*; and seeds of an Abietia under this name have been recently sent to the Veitchian establishment from south China by E. H. Wilson.

ABIES.

Link, Abhandl. Acad. Berl. (1827), p. 181. Bentham and Hooker, Gen. Plant. III. 441 (1881). Eichler in Engler and Prantl. Nat. Pfl. Fam. 81 (1887). Masters in Journ. Linn Soc. XXX. 34 (1893).

As here circumscribed, Abies is a genus of evergreen trees often of lofty stature, well marked by the symmetry of their habit especially during the period of early life which has caused them to be ranked among the most ornamental subjects available for the lawn, pleasure ground and park in our climate. In a popular sense the species are distinguished by their tall straight trunks regularly furnished with tiers of branches ramified laterally: by their flattened leaves mostly spreading in two opposite directions, and characterised anatomically by the presence of two lateral resin canals lying near the epidermis of the under side; and by their erect cones, the scales of which soon fall off after the seed is mature leaving the axis on the tree from which, however, it soon disappears. Botanically the genus is thus distinguished:—

Inflorescence monœcious. Staminate flowers numerous, axillary on branchlets of the preceding year, shortly stalked, cylindric or ovoid-cylindric, and surrounded at the base by numerous involucral bracts. Stamens spirally crowded around a central axis; anthers shortly stipitate, with a small knob- or spur-like projection, dehiscing transversely and variously coloured.

Ovuliferous flowers few, usually on the upper side of the highermost branches, globose or cylindric, erect, composed of numerous imbricated scales spirally inserted on a central axis, each bearing near the base on the ventral (inner) side, two inverted ovules.

Cones cylindric, rarely ovoid, composed of thin, ligneous imbricated scales, mostly of fan-like shape, in many series, each bearing on the ventral face two seeds of which the testa or outer coat is prolonged into a membraneous wing, and on the dorsal face a narrow mucronate bract shorter or longer than the scale and adnate to it at the base.

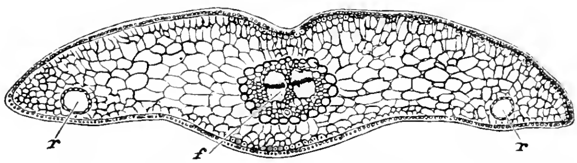


Fig. 124. Transverse section of leaf of *Abies pectinata* × 32; *r*, resin canals; *f*, fibro-vascular bundle.

Twenty-four species of Abies or forms recognised as such are described in the following pages, but some of them are connected by intermediate forms that render the technical expression of specific characters in such cases extremely difficult. Throughout the genus a general uniformity in habit and structure prevails so that sectional divisions of it are scarcely necessary. The greatest deviations from the common type occur in three of the western North American species, and taking these into account the late Dr. Engelmann proposed the following sections.*

EUABIES. Leaves flat, grooved above, stomatiferous sometimes on the upper and sometimes on the lower surface.

BRACTEATÆ. Leaves flat without stomata on the upper surface *(Abies bracteata)*.

NOBILES. Leaves flat or tetragonal, stomatiferous on both surfaces *(A. nobilis* and *A. magnifica)*.†

* Transactions of the St. Louis Academy, Vol. III, p. 596. Gordon (Pinetum, ed. II. p. 197) distributed the Silver Firs in two sections, placing in one those species in which the bracts of the cone are longer than the scale and exserted, and in the other those in which the bracts are shorter and enclosed; a distinction that is quite futile as Beissner has pointed out, since the length of the bract is variable in the same species, being sometimes exserted, sometimes enclosed, as in *Abies balsamea*, *A. magnifica*, *A. Veitchii*.

† Besides the sectional character on which Engelmann has placed the greatest stress, *Abies bracteata* differs from all the other species in its larger leaves, longer winter buds with white perulæ, and especially in its ovoid cones with long bristle-like exserted bracts. *A. nobilis* and *A. magnifica* differ from all other Abies in their large cones and bluish-green crowded leaves.

Besides the twenty-four species here enumerated, Maximoviez has described two others in the "Bulletin de l'Académie imperiale de St. Petersburg," which he discovered in Manchuria. One of these, *Abies nephrolepis*, is without much doubt a continental form of *A. Veitchii*; the other, *A. holophylla*, cannot from the description and the imperfect herbarium specimens preserved in this country, be referred to any known species, although it may be either *A. firma* or *A. homolepis*. Three hybrids are reported; one raised artificially in France by the late Henri de Vilmorin, between *A. Pinsapo* and *A. cephalonica*; a second is described by Carrière in the "Revue horticole" for 1890, page 230, under the name of *A. insignis*, and is supposed to have

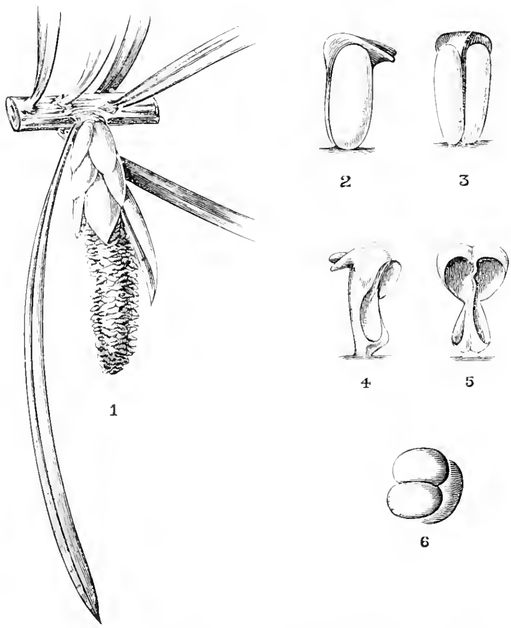


Fig. 125. *Abies bracteata*. 1, Staminate flower nat. size; 2 and 3, side and front view of anthers before—4 and 5, after dehiscence × 5. 6, Pollen grain × 120.

originated from the accidental fertilisation of an ovuliferous cone of *A. Pinsapo* by pollen of *A. Nordmanniana* growing near a nursery at Bulgnéville (Vosges); and lastly a supposed natural hybrid between *A. lasiocarpa* and *A. amabilis* was detected by Professor Sargent on the Olympic mountains in north-west Washington.

The Silver Firs are distributed through the northern hemisphere from the Pacific coast of North America eastwards over both continents to Japan, but generally speaking, they occupy a more southern zone than the Spruce Firs with which they are in places associated. The only species which spread into sub-arctic lands are *Abies lasiocarpa* and *A. balsamea* in America, and *A. sibirica* and

A. sachalinensis in Asia; on the other hand, one species, *A. religiosa*, has its home within the tropics in south Mexico and Guatemala. With the exception of *A. balsamea*, *A. grandis* and *A. sibirica*, all the species are mountain trees ascending to elevations above sea-level, which vary greatly in different regions, but which are evidently influenced by the trend and altitude of the mountain chains and by the latitude of the place. In their economic aspect the Silver Firs are inferior to the Spruce Firs and Larches and even to many of the true Pines; their timber is, for the most part, coarse-grained, soft and perishable, but much used where trees are abundant. In Great Britain all the Abies are used solely for ornamental planting, *A. pectinata* being an occasional exception and employed by the forester for purposes of utility.

Abies amabilis.

A lofty tree often 150—200 feet high, but at high altitudes not more than 60—80 feet high with a trunk 3—4 feet in diameter near the base. Bark of old trees thick and fissured into reddish grey plates, of young trees thin and quite smooth; in Great Britain usually roughened by numerous warty protuberances. Branches relatively short, the lowermost depressed, those above horizontal or slightly ascending. Branchlets distichous and opposite, spreading at nearly a right angle to their primaries, the youngest shoots hairy (hirtellous). Buds small, ovoid-conic, with dark reddish brown perulæ. Leaves persistent eight ten years, spirally crowded, those on the lower side of the branchlets by a twist of the short petiole pseudo-distichous in three-four ranks; those on the upper side more or less appressed to the shoot and pointing forwards, linear, flat and emarginate; on fertile and vigorous branchlets acute, 0·75—1·5 inch long, dark green above with a slight azure tint peculiar to this species and by which it may often be distinguished; with a glaucous stomatiferous band on each side of the narrow midrib beneath. Staminate flowers* often densely clustered, cylindric, obtuse, about 0·5 inch long, with dark red-crimson anthers. Cones cylindric, slightly tapering to a retuse apex, 4—5·5 inches long and 2—2·5 inches in diameter, dark violet-blue changing with age to dark brown; scales not much broader than long, sub-rhomboidal, inflexed at the apical margin; bracts half as long as the scales, obovate-oblong, abruptly contracted to an acuminate tip. Seed wings obliquely cuneate, almost as broad as long.

Abies amabilis, Forbes, Pinet. Woburn, 125, t. 44 (1839). Carrière, Traité Conif. ed. II. 296. Hoopes, Evergreens, 209. McNab in Proceed. R. Irish Acad. II. ser. 2. 677, fig. 3. Engelmann in Gard. Chron. XIV. (1880), p. 720, with figs. Masters in Journ. Linn. Soc. XXII. 171, with figs; Gard. Chron. III. ser. 3 (1888), p. 754, with fig.; and Journ. R. Hort. Soc. XIV. 189. Beissner, Nadelholzk. 468, with fig. Sargent, Silva N. Amer. XII. 125. t. 614.

Picea amabilis, London, Arb. et Frut. Brit. IV. 2342, with figs. (in part. 1838). Gordon, Pinet. ed. II. 213. excl. syn. lasiocarpa.

* Communicated by Mr. Harding from Orton Hall, and by Mr. Herrin from Dropmore

Pinus amabilis,* Douglas in Comp. Bot. Mag. II. 93 (1837). Parlatore, D. C. Prodr. XVI. 426 (in part). Endlicher, Synops. Conif. 104.

Eng. Lovely Fir. Amer. White Fir. Germ. Liebliche Weisstanne.

Abies amabilis is an alpine tree whose area of distribution, so far as at present known, is confined to the mountain ranges within the States of Oregon and Washington, and southern British Columbia from Vancouver Island to the Fraser river. On the Cascade mountains its vertical range is from 3,000 to 6,000 feet above sea-level; on the Olympic mountains of north-west Washington where it is common, and where it probably attains its greatest development, its vertical range is from 1,200 to 4,500 feet, and in Columbia the range is somewhat higher. At high altitudes it grows singly or in small isolated groves; in other places it is associated with *Tsuga Albertiana*, *Abies nobilis* and *A. grandis*, or with *Pinus monticola*, *Tsuga Mertensiana* and *Abies lasiocarpa*.†

For a long series of years *Abies amabilis* was one of the rarest of trees in the British Pinetum, and as regards its origin one of the most obscure of the north-west American Firs, so much so that on the other side of the Atlantic its very existence as a species was called into question, and this discovery of Douglas began to be regarded as a tradition and a myth. Here, however, in Great Britain, belief in its existence never faltered, for we had in our midst living evidences, very few, it is true, but representing a genuine and unquestionably distinct species. The little that is known of the discovery of *Abies amabilis* was communicated by Douglas to Sir W. J. Hooker in letters that were published by the latter in the "Companion to the Botanical Magazine" about three years after the untimely death of the explorer. From this correspondence we learn that he first saw *Abies amabilis* in September 1825 on the top of a high mountain south of the Grand Rapids of the Columbia river after a laborious climb of fifteen hours. By frequent mishaps, owing to the difficulty of making his way through forests never before traversed by a naturalist, nor perhaps even by a white man except occasionally by a trapper or hunter in the service of the Hudson's Bay Company, Douglas lost a great part of his specimens both during this and his second mission to north-west America; it was not till he had accomplished his remarkable journey up the Columbia in 1830 that he secured a few cones and seeds which he dispatched to England late in that year.‡ During the fifty years that followed, many naturalists and seed collectors visited the region of the Columbia river, but all of them failed to re-discover

* It is to be regretted that the discoverer of this and other north-west American Abies should have given them mere laudatory names. *Amabilis*, *grandis*, *nobilis*, *venusta* (Douglas) and *magnifica* (Murray) denote no recognisable specific character, and any one of them is as applicable to the other species as to that for which it is used.

† Silva of North America, XII. p. 126.

‡ As Douglas was at that time in the service of the Horticultural Society of London, the seeds were sent to the Society and were sown in their garden at Chiswick in the following year. Plants raised from these seeds were subsequently distributed among the Fellows (Trans. Hort. Soc. Lond., ser. 2, Vol. II. p. 376). I have only been able to trace three trees whose origin may be unhesitatingly attributed to this source, viz.:—one at Dropmore planted in 1835; one at Orton Hall near Peterborough; and a third at Bicton, since dead.

the true *Abies amabilis* of Douglas. Seeds of other species as *A. magnifica*, *A. lasiocarpa* and *A. concolor* var. *Lowiana* were sent to Europe by them under the name of *A. amabilis* whence arose a confused nomenclature and tangled synonymy scarcely paralleled even amongst the Coniferæ. At length the mystery which had so long

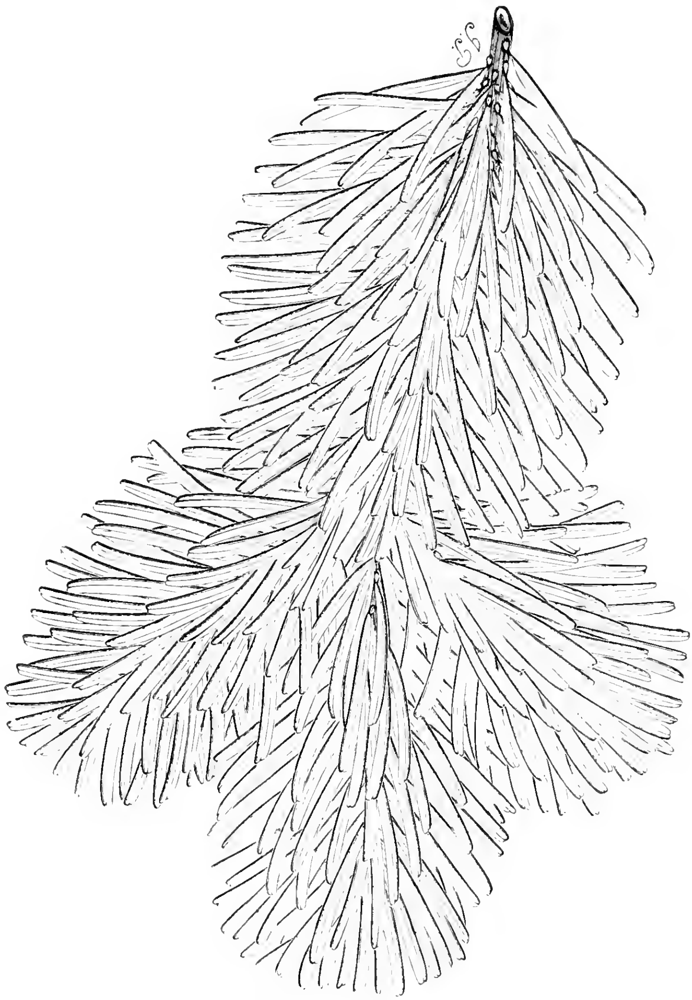


Fig. 126. Branchlet and foliage of *Abies amabilis*, nat. size.

shrouded this fine species was unveiled by the energy of the American botanists, Doctors Engelmann and Parry and Professor Sargent who, while investigating the forests of the Pacific coast during the summer and autumn of 1880 re-discovered it on the Silver Mountain near Fort Hope on the Fraser river at an altitude of 4,000 to 5,500 feet, and again shortly afterwards by Professor Sargent on the same classic ground on which Douglas, fifty-five years before, had discovered both this Fir and *Abies nobilis*. Steps were immediately taken to secure a supply of seed, of which a good quantity subsequently reached England, and many young trees raised from it have been planted in various parts of Great Britain of which those in the north and west are reported to be generally thriving satisfactorily.

Abies balsamea.

A slender tree 30—60 or more feet high, the trunk rarely exceeding 2 feet in diameter near the base, frequently much less, and when full grown usually denuded of branches for more than one-half of the height; at its highest vertical elevation and extreme northern limit, reduced to a low prostrate shrub. Bark greyish brown with numerous resin warts irregularly scattered over it. Branches comparatively short, slender and spreading. Branchlets distichous and mostly opposite, the youngest shoots pubescent. Buds small, globose or sub-conic, usually covered with a film of whitish resin. Leaves persistent three—four years, narrowly linear, obtuse or occasionally emarginate, 0·5—1 inch long, pseudo-distichous in two—three ranks, bright green above, with two whitish stomatiferous bands beneath. Staminate flowers axillary, cylindric, 0·25 inch long, pale yellow tinged with red. Cones sessile, cylindric, 3—4 inches long and about an inch in diameter, at first violet-blue but sometimes olive-green, changing to dull brown when mature; scales clawed, obovate-cuneate, about 0·75 inch long and as much broad with entire outer margin; bracts oblong, abruptly mucronate, usually shorter than the scales. Seeds small and angular.

Abies balsamea, Miller, Dict. ed. VIII. No. 3 (1768). Richard, Mém sur les Conif. 74, t. 16 (1826). Forbes, Pinet. Woburn, 109, t. 37 (1839). Link in Linnaea, XV. 530. Carrière, Traité Conif. ed. II. 292 McNab in Proceed. R. Irish Acad. II. ser. 2. 684, fig. 11. Hoopes, Evergreens, 197, with fig. Macoun, Cat. Canad. Plants, 473. Masters in Journ. R. Hort. Soc. XIV. 189; and Gard. Chron. XVII. ser. 3 (1895), p. 423, with figs. Beissner, Nadelholzk. 464. Sargent, Silva N. Amer. XII. 107, t. 610.

A. balsamifera, Michaux, Hist. Arb. N. Amer. I. 145, t. 14 (in part, 1810).

Picea balsamea, Loudon, Arb. et Frut. Brit. IV. 2339, with figs. (1838). Gordon, Pinet. ed. II. 200.

Pinus balsamea, Linnæus, Sp. Plant. II. 1002 (1753). Lambert, Genus Pinus, I. t. 31 (1803). Endlicher, Synops. Conif. 103. Parlatore, D. C. Prodr. XVI. 423.

Eng. and Amer. Balsam Fir. Balm of Gilead Fir. Fr. Baumier de Gilead. Germ. Balsam Tanne. Ital. Abete balsamico.

var.—hudsonica.

A dwarf dense shrub of spreading habit, rarely exceeding a yard in height. Branches close set; branchlets usually very short; leaves broader, shorter and of a darker green than in the type.

A. balsamea hudsonica, Engelmann in Trans. St. Louis Acad. III. 597. Beissner, Nadelholzk. 468. A. Fraseri hudsonica, Carrière, Traité Conif. ed. II. 217. Picea Fraseri hudsonica, Gordon, Pinet. ed. II. 206.

var.—macrocarpa.

The lower branches more persistent, the leaves longer and more crowded, and the cones larger than in the common form.

A. balsamea macrocarpa, Garden and Forest, V. 274; and X. 510.

Abies balsamea is one of the most widely distributed of the North American Silver Firs. Its northern limit, according to Professor Macoun, may be roughly indicated by a line drawn obliquely from James' Bay to Lake Athabasca; it is very abundant throughout the eastern provinces of the Dominion from Newfoundland to Lake Superior; southwards it spreads through the northern States to Pennsylvania and through Minnesota to north-eastern Iowa; also along the Alleghany mountains to the high peaks of Virginia Over this extensive area the tree is found to be fairly constant except in dimensions which, as with other species of Abies, are often much modified by climate, environment and altitude. *Abies balsamea* is for the most part a swamp tree, "it seems to need a constant supply of water at the roots, as many die in exceptionally dry seasons."

Abies balsamea was introduced into Great Britain by Bishop Compton in 1698,† but it has long since been proved to be unsuitable for the comparatively dry climate of England, and even in the more humid districts of Scotland and Ireland where the best specimens of it are to be seen, it is short-lived and possesses no qualities that would recommend it for arboricultural purposes. The variety *hudsonica* is a sterile form whose origin is unknown; it is recommended by horticulturists both British and American as a distinct plant for the rock garden. The variety *macrocarpa* was discovered in Wisconsin by the late Robert Douglas of Waukegan, and is said to be superior to the common form as an ornamental tree for the north-eastern States. Nine other varieties are described by Beissner, none of which are probably in cultivation in this country.

The most useful economic product of the Balsam Fir is the resinous secretion with which its vernacular name is associated and known as Canada Balsam, an aromatic liquid formerly much used in medicine but now chiefly for mounting objects for microscopic examination. The gathering of Canada Balsam at the present time is carried on in the province of Quebec, only by the poorest people who camp in the woods from the middle of June until the middle of August. Small iron cans are used furnished at the top with an iron tube sharpened at the end; the tube is pressed against the resin blister, punctures it, and the gum flows down the tube into the can. The yield of a large tree is about one pound, but the average yield is not more than half a pound.‡ The timber of *Abies balsamea* is practically worthless, and is used for temporary purposes only where the tree is abundant; the wood is light, of little strength, coarse-grained, and decays rapidly on exposure to the weather.

Abies bracteata.

A lofty tree attaining a height of 100—150 or more feet, the trunk slender in proportion to height with a diameter of not more than 2—4 feet near the base, and when isolated feathered with branches from near the ground upwards, forming in outline an elongated

* Catalogue of Canadian Plants, p. 473. † Hortus Kewensis, ed. II. Vol. V. p. 320.
‡ Silva of North America, Vol. XII. p. 109.

spire; in Great Britain the oldest trees have a more conical outline. Bark of trunk greyish brown, rugose but rarely fissured. Branches spreading or slightly ascending with distichous ramification. Branchlets opposite and rigid, with light reddish brown bark obscurely and obliquely fluted by cortical outgrowths. Buds subfusiform, acute, about 0·75 inch long, the perular scales ovate-lanceolate, closely imbricated

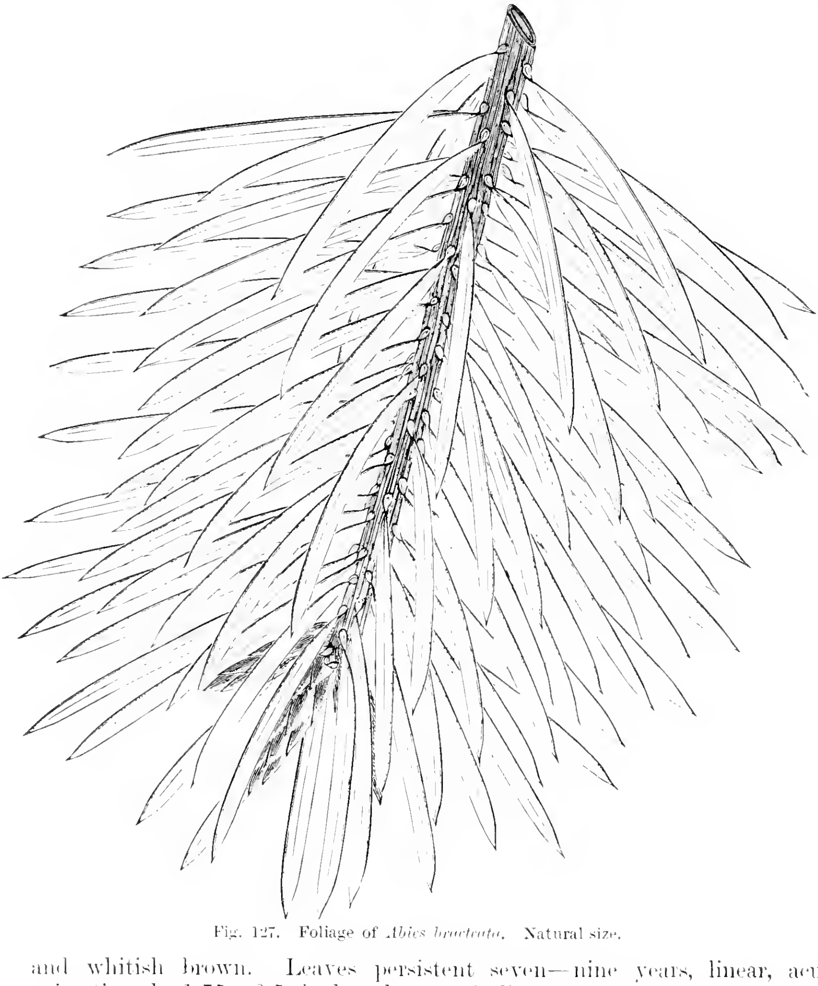


Fig. 127. Foliage of *Abies bracteata*. Natural size.

and whitish brown. Leaves persistent seven—nine years, linear, acute, spine-tipped, 1·75—2·5 inches long, spirally inserted on the axis; those on the lower sterile branches owing to a twist of the short petiole pseudo-distichous in two ranks; on the upper fertile branches spreading on all sides and often falcately curved; dark lustrous green above, with two glaucous stomatiferous bands beneath. Staminate flowers* axillary on the under side of the branchlets, cylindric, 0·75—1·25 inch long, surrounded at the base by oval, pergameneous, whitish brown involucral scales in two imbricated series; anthers pale lemon-yellow

* Communicated by Mr. Harding from Orton Hall, Peterborough.

with a small spur projecting from the dorsal side. Cones solitary, erect, ovoid-globose, 2·25—3·5 inches long and 1·75—2·25 inches broad; scales transversely roundish oblong or sub-reniform, less than an inch long and 0·6 inch broad, with a cuneate claw and incurved at the apical margin; bract oblong-cuneate, adnate to the scale to beyond the middle, then contracted to a projecting linear, rigid spine about 2 inches long, sometimes curved. Seed wings sub-quadrate, nearly as broad as long.

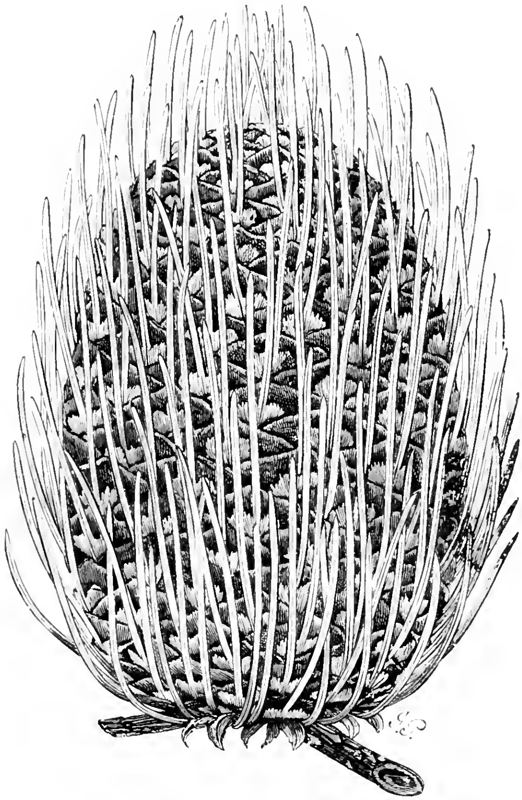


Fig. 128. Cone of *Abies bracteata*.

Abies bracteata, Nuttall, Sylva N. Amer. III. 137, t. 118 (1849). Hooker, W. Bot. Mag. t. 4740 (1853). Lindley in Gard. Chron. 1853, p. 435. Carrière, Traité Conif. ed. II. 265. McNab in Proceed. R. Irish Acad. II. ser. 2, 674, fig. 1. Engelmann in Gard. Chron. IX. (1878), p. 334; XII. (1879), p. 684; and Brewer and Watson's Bot. Califor. II. 118. Masters in Gard. Chron. V. ser. 3 (1889), p. 242, with fig.; VII. ser. 3 (1890), p. 672, with fig.; and Journ. R. Hort. Soc. XIV. 199. Beissner, Nadelholzk. 488, with fig.

A. venusta, Koch. Dendrol. II. 210 (1873). Sargent, Silva N. Amer. XII. 129, tt. 615, 616.

Picea bracteata, Loudon, Arb. et Frut. Brit. IV. 2348, with fig. (1838). Gordon, Pinet. ed. II. 202. Lawson, Pinet. Brit. II. 171, tt. 25, 26, with figs. Coleman in The Garden, XXXV. (1889), p. 12, with fig.

Pinus bracteata, Don in Trans. Linn. Soc. XVII. 442 (1837). Lambert, Genus Pinus, III. 169, t. 91. Endlicher, Synops. Conif. 89. Parlatore, D. C. Prodr. XVI. 419.

P. venusta, Douglas in Comp. Bot. Mag. II. 152, *nomen nudum* (1836).

Eng. Santa Lucia Fir. Amer. Bristle-coned Fir. Fr. Sapin à bractées. Germ. Santa Lucia Tanne. Ital. Abete di Santa Lucia.

Abies bracteata at Eastnor Castle, Ledbury.

Abies bracteata is the most remarkable of all the Silver Firs; its strict but stately habit, its massive deep green foliage, its singular cones, and especially its extremely restricted habitat, have invested it with an especial interest both for botanists and for horticulturists. Its only known habitat is on the outer western ridge of the Santa Lucia mountains in south California, where at the present time "it grows only in a few isolated groves scattered along the moist bottoms of cañons, usually at elevations of about 3,000 feet above sea-level."

This Fir was first described by David Don in the "Transactions of the Linnean Society," *loc. cit supra*, from herbarium specimens gathered by Dr. Thomas Coulter, to whom he wrongly assigned the merit of being the discoverer of the tree, a statement unfortunately accepted by most subsequent authors. The original discoverer was the intrepid Scotch explorer, David Douglas, during his mission to south California in 1830—1832,* while in the service of the Horticultural Society of London. Neither Douglas nor Coulter collected seeds of *Abies bracteata*, and when Theodor Hartweg, also in the service of the Horticultural Society of London, arrived at Monterey in 1846 for the express purpose of collecting seeds of this and other Californian Conifers, and had made his way to the Santa Lucia, he found the cones but half grown and frost-bitten, and his attempt to introduce it into European gardens was accordingly frustrated. Six years later, William Lobb, during his mission to the same region for the Veitchian firm, by great exertions obtained a supply of seeds which he transmitted to Exeter in 1853; † from these seeds originated all the oldest trees of *Abies bracteata* now growing in Europe. For upwards of thirty years afterwards all attempts to procure a further supply of seeds proved futile, and it is only quite recently that the Californian seed collectors have succeeded in obtaining from time to time very limited supplies which, in consequence of the gradual extermination of the trees by the fires which are frequent in the forests of the dry coast ranges of south California, may eventually cease altogether. ‡

In all the places in Great Britain where *Abies bracteata* has attained its greatest dimensions unscathed by the severe winters that occur at intervals in this climate, it is as strikingly beautiful as it has been represented to be on the Santa Lucia, and so distinct that no Silver Fir can be more easily detected amidst its surroundings even at a distance. It is hardly in the southern and western counties of

* *See* Sir William Hooker's Memoir of Douglas in the "Companion to the Botanical Magazine," Vol. II. By a comparison of dates it will be seen that Douglas arrived at Monterey in December 1830, but Dr. Coulter did not arrive till the following November; it was in the interim that Douglas discovered *Abies bracteata*.

† Since Lobb's excursion to the Santa Lucia, the greater part of, if not all, the trees seen by him along the summit of the central ridge, and of which he sent an account to the late Mr. James Veitch (afterwards published in the Botanical Magazine), have been destroyed by the forest fires.

‡ In view of the threatened extinction of this noble tree in its native home, I append a list of all the finest specimens in Great Britain known to me, in the hope that the owners will not allow the seeds that may hereafter be produced by them to be wasted or lost. Boconnoc, Cornwall; Castlewellan, Co. Down; Castle Kennedy, Wigtownshire; Eastnor Castle, Ledbury (2); Fonthill Abbey, Wilts; Fota Island, Cork; Highnam Court, Gloucester; Kenfield Hall, Canterbury; Kinnettles, Forfar; Newcourt, Exeter; Orton Hall, Peterborough; Possingworth, Sussex; Streatham Hall, Exeter (2); Tortworth Court, Gloucestershire (2); Upcott, Barnstaple; Warnham Court, Horsham.

England, in parts of Scotland and in Ireland; in some localities it has been reported to have been injured by late spring frosts which have destroyed the young growths that usually appear early in the season.

Abies cephalonica.

A stately medium-sized tree 50—60 or more feet high, with widely spreading branches that frequently attain a greater length in proportion to height of trunk than in any other Abies. Trunk 2·5—3 feet in diameter, slightly tapering upwards and covered with greyish brown bark fissured into small oblong plates. Branches horizontal, the lowermost usually deflexed and sweeping the ground. Branchlets distichous and opposite but not infrequently in pseudo-whorls of three—four; bark reddish brown and striated; that of the youngest shoots fluted by shallow cortical outgrowths. Buds globose, conic, sub-acute, 0·5 inch long, with red-brown perular scales often covered with a film of translucent resin. Leaves persistent seven—nine years, spirally arranged around the branchlets, shortly petiolate; on the lower sterile branchlets and on young trees, linear, flattened, somewhat dagger-shaped, spine-tipped, 0·75—1·25 inch long, and pseudo-distichous in two—three ranks; on the higher fertile branchlets and on vigorous shoots, thicker, pungent, often falcately curved and spreading from all sides of their axis; dark lustrous green with a shallow median groove above, paler with a stomatiferous band on each side of the relatively broad midrib below. Staminate flowers crowded along the under side of the branchlets, broadly cylindric, obtuse, 0·5—0·75 inch long, dark claret-red, surrounded at the base by numerous broadly ovate involucral bracts. Cones subsessile, solitary or two—three together, cylindric, obtuse, 5—7 inches long and 1·5—2 inches in diameter; scales broadly wedge-shaped, suddenly contracted into a slender claw, the apical margin rounded and entire; bracts longer than the scales, linear with a sub-quadrate expansion near the apex and terminating in a reflexed mucro. Seed-wings oblong, truncate, nearly as long as the scale.

Abies cephalonica, London, Arb. et Frut. Brit. IV. 2325, with figs. (1838). Forbes, Pinet. Woburn, 119, t. 42 (1839). Link in Linnæa, XV. 529 (1841). Carrière, Traité Conif. ed. II. 283 McNab in Proceed. R. Irish Acad. II. ser 2, 695, figs. 24, 25. Masters in Gard. Chron. XXII. (1884). p. 590, with fig.; and Journ. R. Hort. Soc. XIV. 190. Boissier, Fl. orient. V. 702. Willkomm, Forstl. Fl. ed. II. 132. Beissner, Nadelholzk. 438.

Picea cephalonica, Loudon, Encycl. of Trees, 1039, with figs. (1842). Gordon, Pinet. ed. II. 203. Lawson, Pinet. Brit. II. 175, t. 27, and figs.

Pinus cephalonica, Endlicher. Synops. Conif. 98.

P. Abies var. cephalonica, Parlatore, D. C. Prodr. XVI. 422.

Eng. Greek Fir. Germ. Cephalonische-Weisstanne. Gr. Ελατός, *κουκουναρια.*

var. Apollinis.

Trunk more slender; branches shorter with the branchlets more constantly distichous. Leaves longer, narrower, less rigid and more distinctly pseudo-distichous in two—three ranks.*

A. cephalonica Apollinis Beissner, Nadelholzk. 440. A. Apollinis, Link in Linnaea. XV. 528. Picea Apollinis, Lawson, Pinet. Brit. II. 167, t. 24. Gordon, Pinet. ed. II. 197. Pinus Abies Apollinis, Endlicher, Synops. Conif. 96. Abies cephalonica parnassica, Willkomm. Forstl. Fl. ed. II. 13 A. Reginæ Amaliæ Heldreich in Regel's Gartenfl. 1860, p. 113; and 1861, p. 286, with fig. Seemann in Gard. Chron. 1861, p 755. A. panachaica, Heldreich. And others.

* As seen in Great Britain, but some of the differences here noted are not always very clearly in evidence.

The Abies described above grows spontaneously on all the higher mountains of Greece from Thessaly southwards to Lagonia in the Peloponnesus, at elevations ranging from 2,500 to 5,000 feet, either forming pure forests or mixed with *Pinus Laricio*, *P. Pinaster* and *Fagus sylvatica*: it also occurs on Mount Enos in Cephalonica, and to this insular locality it owes its present name. Its botanical history may be thus briefly sketched:—

The presence of this Fir in Greece has been known from remote antiquity as it is unquestionably the Ἐλάτη ἡ ἄρρην of Theophrastus. By the older botanists of modern times it was believed to be the common Silver Fir *Abies pectinata*. In 1824, at the request of Mr. Henry H. Long of Hampton Lodge, near Farnham, who was desirous of knowing the species of Pine described by ancient writers under the names of πεύκη and ἐλάτη, General Charles James Napier, at that time Governor of Cephalonica, sent a packet of seeds of the Fir growing on Mount Enos to the care of his sister Lady Bunbury. The packet was duly forwarded to Hampton Lodge, but some seeds having dropped from it, Lady Bunbury gave these to Mr. Charles Hoare of Luscombe.* The seedlings raised both at Hampton Lodge and Luscombe were found some years later to differ considerably from the common Silver Fir, and they were named *Abies cephalonica* by Loudon who first published the species. In 1838 Professor Link, of Berlin, made the ascent of Mount Parnassus which he found covered towards the summit on all sides with a forest of Firs of which he gathered herbarium specimens, cones and seeds. The seeds germinated in the Berlin Botanic Garden, and finding that the plants differed from *Abies pectinata* he described the Mount Parnassus Fir in "Linnaea" as a new species under the name of *A. Apollinis*. Endlicher took up this name for the same tree, but reduced it to a variety of *A. pectinata* as Parlatore did twenty years later with the *A. cephalonica* of Loudon. About the year 1856 Herr Schmidt, Director of the Royal Gardens at Athens, during a botanical excursion in the Peloponnesus, detected an Abies in Arcadia which Professor Heldreich described in Regel's "Gartenflora" for 1860 as a new species under the name of *A. Reginæ Amaliæ*, in compliment to the former Queen of Greece who was a liberal patroness of horticulture; and in 1861, in an article on the Firs of Greece in the same publication, Professor Heldreich adopts as species *A. cephalonica*, *A. Apollinis* and *A. Reginæ Amaliæ*, and adds to these a fourth which he calls *A. panachaica*; plants under all these names were subsequently distributed from German nurseries. Whatever morphological differences may be detected in trees growing in different localities in Greece, the perfect identity in the shape and structure of the staminate flowers and cones of all of them indicate but too surely that they cannot be specifically separated. In British gardens only two forms are found differing from each other sufficiently to require separate notice—the insular form here recognised as the type, and the continental form reduced to a variety of it as *Apollinis*.†

* Loudon, Arboretum et Fruticetum Britannicum, Vol. IV. p. 2328.

† Both Willkomm and Beissner accept *Reginæ Amaliæ* as a variety distinct from *Apollinis* on the ground that the stem is more slender, the leaves shorter and not so stiff, and the cones smaller.

Abies cephalonica is hardy over the greater part of Great Britain, but owing to its starting into growth early in the season it is liable under certain circumstances of locality and environment to injury by late spring frosts. The rate of growth varies with the locality, being greater in Devon, Cornwall and the south of Ireland than in Yorkshire and north of the Tweed. Many fine specimens scattered over the country * attest its value as an ornamental tree for the park and landscape, and even for the lawn if sufficient space can be allowed for it, which should not be less than a radius of twenty-five to thirty feet from the bole. Scarcely anything is recorded of the quality of the timber, which may be assumed to be much the same as that of *A. pectinata*.

Abies cilicica.

A tall slender tree with a trunk over 100 feet high and not more than 2—2·5 feet in diameter near the ground, and when standing alone branched from the base upwards; † the average height probably ranges from 60—90 feet but much less at its highest vertical limit: the trunk of old trees covered with deeply fissured, ash-brown bark. Branches in rather close-set pseudo-whorls, the lowermost horizontal, those above ascending. Branchlets distichous,‡ mostly opposite, covered with pale brown, striated bark. Buds cylindric-conic with yellow-brown perular scales. Leaves persistent five—six years, narrowly linear, obtuse or sub-acute, 0·5—1·75 inch long, spirally inserted, those on the upper side of the branches inclined forwards almost parallel to the axis; those on the under side irregularly distichous in two—three ranks, dark lustrous green with a median groove above and with a narrow whitish stomatiferous band on each side of the thickened midrib beneath. Cones among the largest in the genus, shortly stalked, cylindric, slightly tapering towards the apex, 7—9 inches long and 1·5—2 inches in diameter; scales broadly fan-shaped, contracted at the base into a short claw, the apical margin entire; bracts half as long as the scales, narrowly spathulate with the mid-nerve prolonged into an acuminate point. Seeds angular with an orbicular cuneate wing.

Abies cilicica. Carrière, Traité Conif. ed. I. 229 (1855); and ed. II. 307 (1867). McNab, Proceed. R. Irish Acad. II. ser. 2, 694, fig 23. Boissier, Fl. orient V. 703. Willkomm, Forstl. Fl. ed. II. 109. Beissner, Nadelholzk. 448, with fig. Masters in Journ. R. Hort. Soc. XIV. 190.

Picea cilicica. Gordon, Pinet. ed. II. 214.

Pinus cilicica. Kotschy in Oesterr. Bot. Wochenbl. 1853, p. 409. Parlatore, D. C. Prodr. XVI. 422.

Eng. Cilician Fir. Germ. Ciliciscbe Weisstanne. Ital. Abete della Cilicia. Vernacular, Illeden.

The Cilician Fir inhabits the mountain system of Asia Minor known under the general name of Taurus on which it has a vertical

* Notably at Boconnoc and Carclew in Cornwall, Bicton and Powderham Castle in Devonshire, Dropmore in Bucks, Linton Park in Kent, Studley Royal in Yorkshire, Rossdhu in Dumbartonshire, Whittinghame in East Lothian, Hamwood in Co. Meath.

† Walter Siehe in Gartenflora, 1897, p. 182.

‡ Communicated by Mr. Cruden from Castle Kennedy, Wigtownshire.

range at altitudes varying from 4,000 to 6,500 feet, but the precise limits of its distribution have not yet been ascertained; these limits may, however, be assumed to be nearly conterminous with those of the Cedar of Lebanon with which it is associated wherever met with. On the southern slopes of Bulghar Dăgh and on the north side of Gulleck in Cilicia it forms pure forests of considerable extent, becoming mixed at its highest vertical limit with *Cedrus Libani* and in places with *Pinus Laricio* and *Juniperus excelsa*, and at its lower limit with an undergrowth consisting chiefly of *Daphne oleoides*, and where honeysuckles twine around the stem and mistletoe is parasitical on the branches.* It is also known to occur on Berytdah and Lebanon in northern Palestine† and it may not improbably be found on the coast range connecting these with the Cilician Taurus.

Abies cilicica was discovered in 1853 by the Austrian botanical explorer Theodor Kotschy, by whom it was introduced into European gardens. In the following year, seeds of a new species of Abies, subsequently proved to be *A. cilicica*, were received at the Muséum d'Histoire Naturelle at Paris from the French Consul at Saïda (the ancient Sidon), and later, a further supply was brought from the same region by a French traveller named Balansa.‡ All who have seen the Cilician Fir in its native home describe it as one of the most picturesque of the genus, an encomium confirmed to a great extent by the best specimens growing on the Continent and in Great Britain, but it is still comparatively rare in this country; it does not grow satisfactorily in the neighbourhood of London nor in the drier climate of the midland and eastern counties even where the Cedar of Lebanon thrives; it starts too early into growth after a mild winter and the young shoots are often killed by late spring frosts. The best specimens known to the author are at Castle Kennedy in Wigtownshire (over 30 feet high), at Rossdhu in Dumbartonshire and in the Royal Botanic Gardens at Glasnevin, Dublin.§

Abies concolor.

A tall tree but varying greatly in dimensions throughout the extensive area over which it is spread; in the more humid climate of the Californian Sierras trees are found 200–250 feet high; in the drier region of Colorado and Utah they rarely exceed 100 feet. Bark of oldest trees in Great Britain fissured into small, irregular, greyish plates with broad interspaces exposing a rough, reddish brown inner cortex. Branches horizontal or slightly depressed; ramification distichous and opposite with an occasional adventitious weaker growth beneath the normal pair of branchlets. Bark of branchlets smooth, light-brown, paler and pubescent on the herbaceous shoots. Buds ovoid-conic with

* Walter Siehe in Gartenflora, 1897, p. 182.

† Boissier, Flora Orientalis, V. p. 703.

‡ Carrière in Flore des Serres. Vol. XI. p. 67.

§ Very fine specimens of *Abies cilicica* are reported to be growing at Wellesly, Massachusetts; on the island of Scharfenberg near Berlin, and Pallanza in Italy.

closely imbricated, chestnut-brown perulæ. Leaves persistent five—seven years, spirally inserted but on the lower sterile branches twisted at the base so as to point laterally on both sides in two ranks, linear, obtuse or emarginate, 1·5—2 inches long, light glaucous green with a depressed median line above, with a pale stomatiferous band on each side of the thickened midrib below; on the fertile branches shorter, thicker and curved upwards and inwards. Staminate flowers axillary along the under side of the shoots, stipitate, cylindric, 0·5 — 0·75 inch long, light violet-pink; involucral bracts few, broadly ovate. Cones cylindric, obtuse, 3—5 inches long and about 1·5—2 inches in diameter, sometimes green, sometimes violet before maturity; scales transversely roundish oblong, gradually narrowed to a short, wedge-shaped claw; bracts a little longer than the claw, dilated from a cuneate base into a rectangular denticulate blade with a mucro on the apical margin. Seed wings large, sub-quadrate, reaching almost to the edge of the scale.

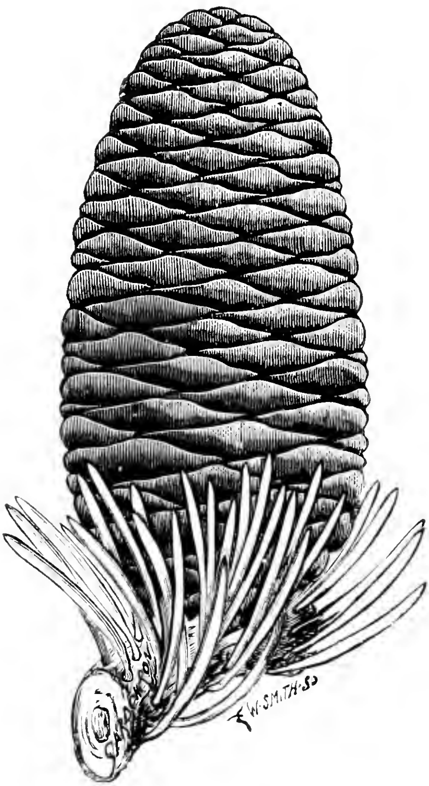


Fig. 129. Cone of *Abies concolor*. Rocky Mountains type.
(From the *Gardeners' Chronicle*.)

Abies concolor, Lindley and Gordon in Journ. Hort. Soc. Lond. V. 210, name only (1850). Engelmann in Gard. Chron. IX. (1878), p. 334; XII. (1879), p. 684, with figs.; and in Brewer and Watson's Bot. Califor. II. 118. McNab in Proceed. R. Irish Acad. II. ser. 2, 681, fig. 6. Masters in Journ. Linn. Soc. XXII. 177, with figs.; in Gard. Chron. VIII. ser. 3 (1890), p 748, with fig.; and in Journ. R. Hort Soc. XIV. 191. Beissner, Nadelholzk. 470, with figs.

Picea concolor, Gordon, Pinet. ed. II. 216 (1875).

Pinus concolor, Parlatore, D. C. Prodr. XVI. 426 (1868).

Eng. Colorado Silver Fir. Amer. White Fir. Germ. Californische Weisstanne, Gleichfarbige Weisstanne.

var. Lowiana.

Leaves of the sterile branchlets usually longer than in the Colorado type; of a darker green and not glaucescent on the upper side; with two pale stomatiferous lines beneath and spreading in two ranks on each side of the axis almost in a flat horizontal plane as in *Abies grandis*, 2—3 inches long on vigorous young trees growing in Great Britain. Cones somewhat larger and scarcely distinguishable from those of *A. grandis*.

A. concolor var. Lowiana, Lemmon, West Amer. Cone Bearers, 64 (1895). A. Lowiana, Murray in Proceed. R. Hort. Soc. III. 317, with fig. (1863). A. grandis, Carrière, Traité Conif. ed. II. 297 (in part). A. grandis var. Lowiana, Masters in Journ. Linn. Soc. XXII 175. Picea Lowiana, Gordon, Pinet. ed. II. 218. P. lasiocarpa. Hort not Hooker. P. Parsonsiana, Hort.

Abies concolor next to *A. lasiocarpa* has a more extensive geographical range than any of the American Abies whose habitat is west of the Rocky Mountains. It occurs on the mountains of New Mexico near Santa Fé, where it was first discovered by Fendler in 1847, and also in the Pike's Peak region in Colorado its eastern limit; it thence spreads westwards along the mountains of Arizona, Utah and Nevada to California; it is common on most of the mountain ranges of the last-named State at 3,500 to 8,000 feet elevation from the San Bernardino and San Jacinto mountains northwards to southern Oregon its northern limit. Throughout this great region *Abies concolor* can almost always be readily recognised by the grey bark of its trunk and the pale colour of its foliage whatever may be the altitude and the climatic conditions under which it is growing. These conditions vary considerably between the eastern and western limits; on the mountain sides of Colorado the winters are as severe as at New York; on the western slopes of the Sierra Nevada at the altitude at which this Fir grows, the climate is not very different from that of the midlands of England; whilst on the San Bernardino in south California it approaches that of the south of France. Spread over so extensive an area, and growing under such diverse conditions it is not surprising that *Abies concolor* should be found to vary in the dimensions of trunk, in the length and disposition of the leaves and in the size of the cones, and therefore that the tree should have received different names according as it was introduced from different localities. The identity of the species throughout the region has been satisfactorily established by the American botanists who have explored it, and the tangled synonymy with which the tree became encumbered and the superfluous names still in use in many places should be allowed to sink into oblivion.

Abies concolor was introduced from the Sierra Nevada of California by the Veitchian Firm at Exeter through William Lobb in 1851, and about the same time seeds were sent from southern Oregon to the Scottish Oregon Association by their collector John Jeffrey;* both collectors sent their consignments under the name of *Abies grandis*. The plants raised in the Exeter nursery were distributed under the name of *A. lasiocarpa* in the belief that they were the species so named by Sir William Hooker; those raised in the Edinburgh Botanic Garden for the Scottish Association were distributed among the members as *A. grandis*. In 1857 seeds were received from California by Messrs. Low of Clapton, and the plants raised from them were named *Picea Lowiana* by Gordon and were distributed under that name.

* James McNab in The Garden, Vol. I. p. 464.

Abies concolor at Highnam Court, Gloucester.

Some time afterwards Mr. Barron of Borrowash distributed another batch of seedlings under the name of *A. Parsonsiana*; and lastly the Colorado form found its way into European gardens under the names of *A. concolor* and *A. concolor violacea*. With respect to the so-called variety *violacea* the following extract from the American "Garden and Forest"* should finally dispose of it: "In the forests of Colorado green cones and purple cones are produced on trees standing side by side and indistinguishable except in this one particular. It is not known even if the same tree produces permanently the same coloured cones, or whether they are not in some years green and in others purple."

For British parks and pleasure grounds *Abies concolor* is one of the handsomest and most valuable of Silver Firs; in outline it is almost strictly conical, the sky-line scarcely broken by projecting branches; the branches with their appendages spread horizontally in frond-like, almost tabuliform tiers one above the other, gradually diminishing in length from the base to the summit. It is perfectly hardy, the severest winters have not been known to affect it; but to secure good specimens a space with a radius not less than twenty to twenty-five feet should be allowed for it.† As an ornamental tree it is scarcely less valuable in the more trying climate of the New England and Middle States of North America where it is almost the only West American Fir that can be satisfactorily cultivated. The wood is very light, soft, and coarse-grained, neither strong nor durable. It is only occasionally used in the western States where other timber is scarce.

The nearest affinity of *Abies concolor* is *A. grandis*, so near indeed that intermediate forms have been observed that may with equal right be referred to either; among such is one which grows on the mountains of southern Oregon which is probably that introduced by Jeffrey. In Great Britain the two are for the most part easily distinguishable: the growth of *Abies grandis* is generally more rapid, its branches longer and more slender, and its leaves shorter, more decidedly pectinate in arrangement on the sterile branches and darker in colour. From a scientific standpoint these characteristics may be considered insufficient to establish a specific distinction between the two, especially as scarcely any other differences between them can be detected; the one, *A. concolor*, is an inhabitant of the mountains, and the other, *A. grandis*, of the plains.‡

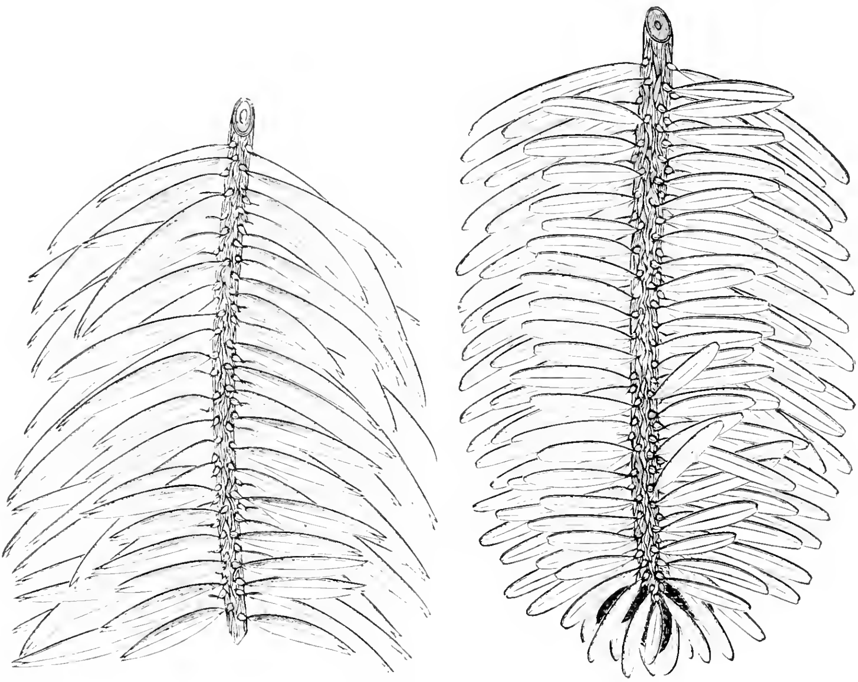
* Vol. IV. (1891), p. 28.

† In his great work "The Silva of North America," Professor Sargent states that of the Fir trees of North America *Abies concolor* best endures heat and dryness, and is able to grow on arid mountain slopes where few other trees can maintain a foothold. This is eminently suggestive of a more extended use of it in the drier parts of Great Britain especially of the Rocky Mountains form which thrives so well in the north-east Atlantic States.

‡ Other pairs of Abies of which the affinity is so close that the specific rank of the second member stands on debatable ground are *A. nobilis* and *A. magnifica*, *A. balsamea* and *A. Fraseri*, *A. pectinata* and *A. cephalonica*, *A. Webbiana* and *A. Pindrow*, *A. Veitchii* and *A. sachalinensis*. If the specific rank of the second member of the pairs here enumerated is made to depend on the characters afforded by a single organ there is ample room for doubt, but if the trees are looked at from every possible point of view, the rank must be conceded.

Abies firma.

A tall tree often attaining a height of 120 feet under cultivation, with an open head of irregular outline, the trunk 4—6 feet in diameter covered with greyish bark fissured into small plates. In Great Britain the bark of the oldest trees is pale brown with numerous transverse wrinkles. Branchlets distichous and opposite with an occasional adventitious weaker growth beneath the normal pair. Buds small,



A B

Fig. 130. Foliage of *Abies firma*. A, sterile—B, fertile branchlet.

ovoid-globose with ovate, chestnut-brown perular scales. Leaves persistent seven—nine years, narrowly linear-lanceolate, 0·5—1·75 inch long, spirally inserted; on the lower sterile branches bifid at the apex, pungent and pseudo-distichous in three—four ranks; on the upper fertile branches incurved with an obtuse or emarginate apex; dark lustrous green with a shallow median groove above, paler and faintly glaucescent along the stomatiferous bands below. Staminate flowers * numerous along the under side of short lateral and terminal branchlets, ovoid-conic, 0·5 inch long, surrounded at the base by broadly ovate, scale-like involucral bracts in two—three series. Cones cylindric or conic-cylindric, variable in size, 4—6 inches long and 1·5—2 inches in diameter; scales transversely reniform, suddenly contracted on the

* Communicated from Tortworth Court, Gloucestershire.

basal side to a short cuneate claw; bracts linear spathulate, longer than the scale and terminating in an acuminate mucro. Seed wings broadly obovate-cuneate.

Abies firma, Siebold and Zuccarini. Fl. Jap. II. 15, t. 107 (1842). Carrière, Traité Conif. ed. II. 286. Murray, Pines and Firs of Japan. 53, with figs. McNab in Proceed. R. Irish Acad. II. ser. 2, 686, fig. 14. Masters in Journ. Linn. Soc. XVIII. 514; Gard. Chron. XII. (1879), p. 198; and Journ. R. Hort. Soc. XIV. 191. Beissner, Nadelholzk. 450. with fig. Mayr. Abiet des Jap. Reiches. 34. Tafel I. fig. 2.

A. bifida. Siebold and Zuccarini, Fl. Jap. II. 18 t. 109 (1842). Carrière, Traité Conif. ed. II. 289.

A umbellata. Mayr, Abiet. des Jap. Reiches 31. Tafel 1. fig. 1 (1890).

Picea firma, Gordon, Pinet. ed. II. 284.

Pinus firma. Endlicher. Synops. Conif. 99. Parlatore, D. C. Prodr. XVI. 424.

Eng. Japanese Silver Fir. Germ. Japanische Weisstanne. Jap. Momi. To-momi.

Abies firma is the largest and handsomest of the Japanese Abies, much resembling the European *A. pectinata* in habit and aspect. Requiring generally a higher average temperature than the European Silver Fir, *A. firma* scarcely exceeds it in average height, although individual trees of gigantic dimensions are frequent owing to the preference given to it for planting in temple enclosures in which trees upwards of 150 feet high have been observed, when it usually takes the form represented in the accompanying illustration. It is only in enclosed places, or where crowded with other trees, that *A. firma* forms a straight tapering shaft: in more open places the trunk is often bent and irregularly branched. According to Mayr its habitat is within the warmer temperate region of Japan lying between the thirty-fourth and thirty-sixth parallels of north latitude where it is still to be found wild in the less accessible districts in small groves or standing singly in the midst of deciduous trees. Its vertical range varies considerably: at its northern limit it ascends no higher than 700 feet, whilst at its southern limit it is found at nearly 7,000 feet above sea-level. Everywhere else it has been planted as an ornamental tree in parks, gardens and temple enclosures as far north as the fortieth parallel beyond which it is not seen. As it was detected by Mr. James H. Veitch in southern Corea it is

Fig. 131. *Abies firma* in Japan.

highly probable that its geographical range is not restricted to Japan, but that it is also distributed over a considerable area of the coast region of the Asiatic continent far into Amurland if the *A. holophylla* of Maximowicz should prove to be the same species.

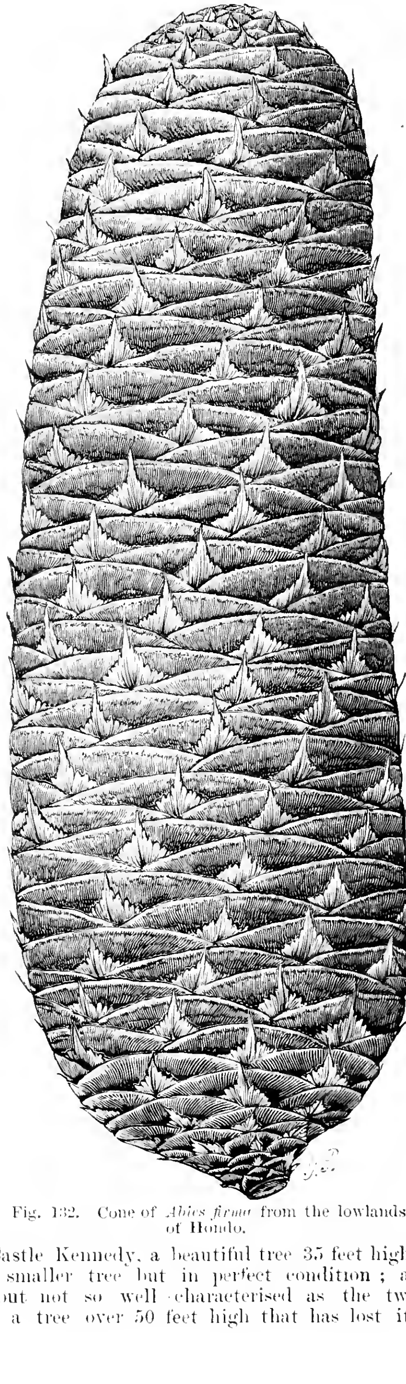


Fig. 132. Cone of *Abies firma* from the lowlands of Hondo.

First seen by Thunberg during his brief stay in Japan in 1777, but referred by him to the European *Abies pectinata*, *A. firma* became definitely known to science through Siebold and Zuccarini's description and figures published in 1842 from specimens gathered by the first named author who only saw trees in cultivation in gardens at Nagasaki and along the main road leading from that place to Tokio. In addition to these they also published a figure and description of a sterile branchlet under the name of *A. bifida*, in the belief that it belonged to another species whence both names came into use in European gardens for a time. *A. firma* was introduced in 1861 by the late John Gould Veitch, and again in 1878 by Maries who observed great variability in the foliage and habit of the cultivated trees. It has, however, proved disappointing both in Great Britain and the north-eastern States of America which may be explained by Mayr's statement respecting its habitat.* As a timber tree *Abies firma* is not much in repute; the wood is soft, straight-grained and easy to work but not durable; it is scarcely distinguishable from that of *A. pectinata*.

The best specimens known to me are—at Castle Kennedy, a beautiful tree 35 feet high, in robust health; at Hamwood, Co. Meath, a smaller tree but in perfect condition; at Tortworth Court, a tree over 30 feet high, but not so well characterised as the two preceding ones; and at Carclew, in Cornwall, a tree over 50 feet high that has lost its lowermost branches from overcrowding.

Abies Fraseri.

A slender short-lived tree with a trunk rarely attaining a height of 70 feet and a diameter of 2·5 feet; more commonly 30—40 feet high and 18—24 inches in diameter near the ground and covered with greyish brown bark marked with broad shallow fissures. Branches spreading, slender, rather close-set and ramified distichously. Branchlets opposite or alternate with pale furrowed bark. Buds ovoid-cylindric, with small chestnut-brown perulæ usually coated with a film of resin. Leaves persistent four—five years, linear, flat, obtuse or emarginate, 0·25—0·75 inch long, spirally inserted on the axis and spreading at nearly a right angle to it, dark green above, with a pale stomatiferous band on each side of a distinct midrib below. Staminate flowers axillary near the tips of the branchlets, numerous, often crowded, cylindric, 0·25 inch long, surrounded at the base by a few involucral bracts. Cones solitary or in clusters of two and three together, ovoid-cylindric, about two inches long and somewhat more than an inch broad; scales orbicular-cuneate with entire apical margin and contracted on the basal side to a narrow claw; bract longer than the scale, oblong-cuneate, mucronate, with lacerated margins and reflexed tip.

Abies Fraseri, Lindley in Penny Cyclop. I. 30 (1833). Forbes, Pinet. Woburn. 111, t. 38. Link in Linnaea, XV. 531. Carrière, Traité Conif. ed. II. 270. Hoopes, Evergreens, 202. McNab, Proceed. R. Irish Acad. II. ser. 2, 684, fig. 10. Sargent in Garden and Forest, II (1889), p. 472, with fig.; and Silva N. Amer. XII. 105, t. 609. Beissner, Nadelholzk. 462. Masters in Gard. Chron. VIII. ser. 3 (1890), p. 684, with fig.; and Journ R. Hort. Soc XIV. 191.

Picea Fraseri, Loudon, Arb. et Frut. Brit. IV. 2340, with figs. Gordon, Pinet. ed. II. 205.

Pinus Fraseri, Lambert, Genus Pinus, ed. II. Vol. II. t. 42 (1837). Endlicher, Synops. Conif. 91. Parlatore, D. C. Prodr. XVI. 419.

Eng. Fraser's Fir. Amer. Double Balsam Fir. Germ. Fraser's Balsamtanne. Ital. Abete di Fraser.

Discovered by the Scotch botanist and collector whose name it bears so long ago as the first decade of the nineteenth century, it is remarkable that very little was definitely known of the habitat of *Abies Fraseri* till the publication of the article by Professor Sargent in the "Garden and Forest" quoted above, from which the following particulars are taken:—

"*Abies Fraseri* is found only on a few of the highest slopes of the southern Appalachian mountains of Carolina and Tennessee between 4,000 and 6,000 feet elevation, so that next to *A. bracteata* it is by far the most restricted in its distribution of the North American Abies. The principal forest covers the high slopes of the Black Mountain range, a lateral spur from the Blue Ridge near Ashville in North Carolina."

Abies Fraseri was first distributed from the Hammersmith nursery of Messrs. Lee, shortly after Fraser's death in 1811, but it has now become extremely rare in British Pineta. The tree is short-lived, and the original introductions have probably long since disappeared; moreover seeds of a variety of *A. balsamea* with slightly exserted bracts collected in Pennsylvania have been substituted for it, and plants raised from these are occasionally met with in nursery and other gardens. Within the last twenty years the true *A. Fraseri* of Carolina has been distributed from the Arnold Arboretum, Massachusetts, U.S.A., among the amateurs of North America and Europe; it has, however, proved practically worthless for British arboriculture. The wood is coarse-grained, not easily worked, and soon decays on exposure to the weather.

JOHN FRASER (1750—1811) was a native of Inverness-shire. He came to London in 1770, and having obtained the assistance of Sir J. E. Smith, first President of the Linnean Society, Mr. Aiton of the Royal Gardens at Kew, and other prominent botanists of that time, he proceeded to North America to collect plants. He landed in Newfoundland in 1780 where he remained for some time. In 1785 he went to the southern States with the view of exploring the Alleghany mountains and neighbouring territory of which little was known botanically. Here he became cognisant of the wealth of plants suitable for British horticulture with which the region abounds, and to the introduction of which he may be said to have devoted the greater part of the remainder of his life. Between 1780 and 1795 he crossed and re-crossed the Atlantic four times, disposing of his collections on each occasion to London nurserymen and to amateurs who chose to purchase them. In 1795 he visited Russia and secured the patronage of the Empress Catherine which was continued by her successor the Emperor Paul, but it resulted in disastrous consequences to himself. In 1799 accompanied by his son John he again embarked for the southern States, and in the following year proceeded to Cuba. The vessel was wrecked on a coral reef about eighty miles from Havana, and after six days of suffering, he, with six of the crew, was picked up by a Spanish boat and conveyed to Havana where he met the distinguished German travellers Humboldt and Bompland, who procured for him permission to explore the island. Returning to America in 1802, Fraser embarked for England, but misfortune again attended him, for after being at sea some time the ship sprang a leak, and passengers and crew were compelled to labour at the pumps night and day till they reached the nearest land. On arriving in England a still heavier trial awaited him in the intelligence which he received of the death of his patron the Emperor Paul. He repaired, however, to St. Petersburg to claim the recompense to which he deemed himself justly entitled, but after months of disheartening delay his claim was finally rejected by the Emperor Alexander. In 1807 again accompanied by his son John, he undertook another long and perilous journey through the wild forest region of the southern States, and returned to England in 1810. A short time previous to his embarkation, while returning from the mountains of Charlestown, his horse fell and he unfortunately broke several of his ribs, the distance from surgical aid aggravating the consequences. For several months after reaching London he was confined to his bed till death released him from his sufferings in April, 1811. Among the plants introduced by him were *Rhododendron catawbiense*, *R. (Azalea) calendulaceum*, *Andromeda floribunda*, *A. speciosa*, *A. Catesbæi*, *Phlox amœna*, *P. subulata*, *Sarracenia rubra*, and many others of far greater horticultural value than the Abies that commemorates his name.

Abies grandis.

A lofty tree, the tallest in the genus, attaining a height of 250—300 feet in the valleys of western Oregon and Washington, but much less on the mountain slopes at its highest vertical limit. Trunk tapering and slender in proportion to height, 3—5 or more feet in diameter near the ground,* covered with smooth brownish bark. In Great Britain the bark of the oldest trees is fissured into thin irregular plates exposing a reddish brown inner cortex. Branches horizontal or depressed, with smooth striated brown bark. Branchlets distichous and mostly opposite. Buds small, ovoid-conic, sub-acute, about 0·25 inch in diameter, with light reddish brown perular scales often covered with a film of translucent resin. Leaves persistent five—seven years, linear, obtuse or emarginate, dark lustrous green with a median groove above, paler with two glaucous stomatiferous bands

* A section of a trunk 317 years old in the Natural History Museum at South Kensington is 5¼ feet in diameter inside the bark.

below; on the lower sterile branches pseudo-distichous, spreading in double rows at nearly a right angle to the axis almost in a flat horizontal plane: those in the lower row 1·75—2·25 inches long, those in the upper one 0·5—1 inch long; on the upper fertile branches pointing in various directions but mostly upwards at a small angle to the axis and nearly all of equal length. Staminate flowers shortly stipitate, cylindric, 0·5 inch long, light violet-pink and surrounded at the base by small, involucral bracts in two—three series. Cones sessile or sub-sessile, slightly narrowed at the obtuse apex, 4—5 inches long and 1·5—2 inches in diameter; scales closely imbricated, crescent-shaped passing into broadly fan-shaped, incurved along the exposed margin and shortly clawed; bracts small, variable in size and shape but always shorter than the scale, sub-spathulate with an apiculus at the apex. Seed-wings broadly wedge-shaped.

Abies grandis. Lindley in Penny Cyclop. I. 30 (1833). Forbes, Pinet. Woburn, 123, t. 43 (1839). Carrière, Traité Conif. ed. II. 296. McNab in Proceed. R. Irish Acad. II. ser. 2. 678, fig. 4. Engelmann in Gard. Chron. IX. (1878), p. 300; XII. (1879), p. 684; and Brewer and Watson's Bot. Califor. II. 118. Hoopes, Evergreens, 211. Masters in Gard. Chron. XV. (1881), p. 179; Journ. Linn. Soc. XXII. 174, with figs.; and Journ. R. Hort. Soc. XIV. 192. Beissner, Nadelholzk. 476, with fig.

A. Gordoniana. Carrière, Traité Conif. ed. II. 298 (1867).

Picea grandis. Loudon, Arb. et Frut. Brit. IV. 2347, with figs. Gordon, Pinet. ed. II. 216.

Pinus grandis. Douglas in Comp. Bot. Mag. II. 147 (1836). Endlicher, Synops. Conif. 105. Hooker, W. Fl. Bor. Amer II 163. Parlatore, D. C. Prodr. XVI. 427.

Eng. Tall Silver Fir. Amer. White Fir of Oregon. Germ. Grosse-Weisstanne, Grosse Küstentanne.

Abies grandis is a tree of the plains and valleys rather than of the mountains; it attains its greatest development in the rich moist soil of the lowlands of western Washington and Oregon. On the mountains it nowhere ascends above 4,000 feet, and where this elevation is reached its dimensions are much reduced. It occurs in Vancouver Island and British Columbia whence it spreads southwards in the vicinity of the coast to Mendocino in north California: inland it spreads through Oregon and Washington as far as the Bitter Root mountains of Idaho and the Rocky Mountains of northern Montana its eastern limit. Its economic value to the inhabitants of these States is considerable; the wood is light, soft and easily worked but not strong; it is chiefly used for indoor carpentry, packing cases, cooperage, etc.

Abies grandis was discovered by David Douglas during his excursion up the Columbia river in 1830, of which mention has been already made under *A. amabilis*. He sent seeds to the Horticultural Society of London, of which very few appear to have germinated, as Loudon mentions that there was but one plant, a foot high, in the Society's garden at Chiswick in 1837, but others had been distributed among the Fellows.* No more seeds of *Abies grandis* were received in this country for nearly a quarter of a century. In 1851 William Lobb

* Transactions of the Horticultural Society of London. Vol. II. ser. 3. p. 376, but I have been unable to discover any of them, unless the tree at Dropmore is one.

made an excursion to the Columbia valley and collected seeds of this and other coniferous trees which were received at the Veitchian nursery at Exeter in the following year; and about the same time seeds were received by the Scottish Oregon Association from their collector, John Jeffrey, from which originated the many fine specimens growing in Perthshire and adjacent counties. It is a singular fact that another quarter of a century elapsed before any further consignments of seeds of *A. grandis* reached Great Britain, a circumstance that can be partly accounted for by the difficulty of procuring cones that are produced only near the tops of lofty trees over 200 feet high.

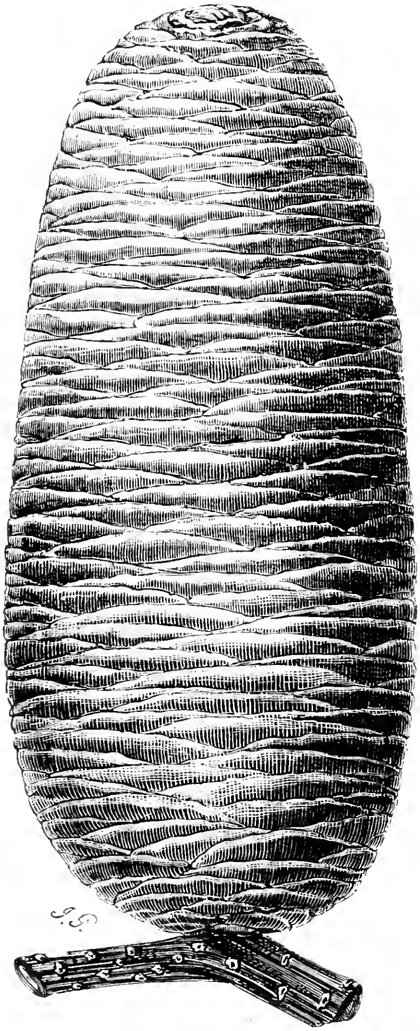


Fig. 133. Cone of *Abies grandis*.

In Great Britain *Abies grandis* is a fast-growing tree, its leader shoot increasing in height annually from 18 to 27 inches according to locality, but much more in exceptionally favoured spots such as occur in parts of Scotland, in Wales and in Ireland.* The branches spread mostly in a horizontal direction, the tree presenting in outline the form of an elongated cone less formal than *A. concolor*. As a park and landscape tree it is one of the best of the Abies, but it is less suitable for the lawn unless a space with a radius greater than twenty-five feet can be allowed for it. The excellent quality of the timber of *A. grandis*, its rapid growth and hardiness, and its adaptability to many soils and situations, all point to it as a suitable tree for afforesting waste lands in this country, especially in localities in which the climatic conditions come nearest to those of Oregon and British Columbia. The oldest trees in this country are cone-bearing, and seeds are therefore easily procurable.

* At Riccarton in Midlothian an *Abies grandis* grew 53 feet in twelve years, or an average of 4 feet 5 inches annually (Conifer Conference Report, p. 82). Other remarkably vigorous trees are growing at Penrhyn Castle, Revesby Abbey, Orton Hall, Eastnor Castle, Madresfield Court, Monk Coniston, Dolphinton, Poltalloch, Castle Menzies, Abercairney, Murthly Castle, The Cairnies, Carton, Curraghmore, Powerscourt, and many other places.

Abies homolepis.

A massive mountain tree 70—90 feet high, but occasionally higher at its lower vertical limit; in old age with a broad round head, the uppermost branches longer than those below them. Bark of trunk greyish brown with broad, shallow fissures exposing a reddish brown inner cortex. Branchlets rigid, distichous and opposite with an occasional weaker shoot on the under side of the normal pair; bark light tawny-brown distinctly fluted with cortical outgrowths obliquely decurrent from the pulvini of the leaves. Buds broadly conic with ovate-lanceolate, chestnut-brown perular scales. Leaves persistent five—seven years, linear, mucronate or obtuse, 0·75—1·25 inch long, spirally inserted but by a twist of the short petiole pseudo-distichous in three-four ranks, grass-green with a narrow median groove above, with two white stomatiferous bands beneath. Cones sessile, variable in size, cylindric, obtuse, 3—4·5 inches long and 1—1·75 inch in diameter, at first violet-purple changing to dark brown when mature; scales closely imbricated, reniform with a short, cuneiform claw, the entire outer margin incurved; bracts shorter than the scales, spathulate, mucronate with notched margins. Seed wings broadly obovate.

Abies homolepis. Siebold and Zuccarini, Fl. Jap. II. 17, t. 108 (1842). Carrière, Traité Conif. ed. I. 215 (1855); and ed. II. 290 (1867). Masters in Journ. Linn. Soc. XVIII. 518; Gard. Chron. XII. (1879), p. 823, with fig.; and Journ. R. Hort. Soc. XIV. 192. Mayr, Abiet. des Jap. Reiches. 35, Tafel II. fig. 3.

A. brachyphylla, Maximowicz, Mélanges Biolog. Bull. Acad. St. Petersb. X. 488 (1866). Masters in Gard. Chron. XII. (1879), p. 556, with figs.; Journ. Linn. Soc. XVIII. 515, with figs.; and Journ. R. Hort. Soc. XIV. 189. Kent in Veitch's Manual, ed. I. 88, with fig. Beissner, Nadelholzk. 153.

A. Harryana, McNab. in Proceed. R. Irish Acad. II. ser. 2, 689, fig. 16 (1877).

Picea brachyphylla, Gordon. Pinet. ed. II. 201.

Pinus homolepis, Endlicher. Synops. Conif. 101.

P. brachyphylla, Parlatore, D. C. Prodr. XVI. 424.

Eng. Nikko Silver Fir. Germ. Nikko-Tanne. Jap. Take-momi (Mountain-Fir), Ura-shiro Momi (White beneath).

Abies homolepis is a native of the cooler temperate region of Japan lying between the thirty-sixth and thirty-eighth parallels of north latitude. It is abundant on the central mountains in Nikko, ascending to 5,000 feet, in places forming small stretches of pure forest, but mostly "scattered singly or in small groups through the birch and oak woods just below the belt of Hemlock Firs." The wood, which much resembles that of *A. firma*, is not much used on account of the inaccessibility of the places where it grows.

Siebold and Zuccarini's figures of this species, including only two branchlets with foliage and two immature cones, long remained an enigma. By some authors they were referred to *Abies firma*; by others they were held to represent a distinct species; whilst others considered them to belong to the *A. brachyphylla* of Maximowicz. The question was decided in favour of the last named view by Dr. Heinrich Mayr, the author of the excellent "Monographie der Abietineen des Japanischen Reiches," during his residence in Japan, and whose opportunities of observing the trees *in situ* were far better than those of any previous European botanist who visited that country.

Abies homolepis at Castlewellan, Co. Down.

The *brachyphylla* of Maximowicz being the more recent name must therefore sink as a synonym of the older *homolepis*.

Abies homolepis was introduced into European gardens about the year 1870. Both in Great Britain and in the north-eastern States of America it has proved to be one of the hardiest and most rapid growing of Abies, adding annually from 15 to 24 inches to the height of the leader shoot according to locality, and forming in a few years an elegant tree of broadly conical or pyramidal outline. It thrives in many situations not too much exposed to cold winds, and has adapted itself to the British climate better than any other Japanese Abies.

Abies lasiocarpa.

A tall tree with an elongated spire-like top 80—100 feet high with a trunk 2—3 feet in diameter; at its greatest development nearly double these dimensions and at its northern and highest vertical limits reduced to a low bush or prostrate shrub. Bark of trunk of young trees, smooth silvery grey; of old trees, divided by shallow fissures and roughened by thick closely appressed scales which are light reddish brown or nearly white on the surface. Branches short, crowded, the lower ones slightly pendulous, but on old trees the trunk is bare for nearly half the height. Branchlets distichous and mostly opposite with pale brown rugose bark. Buds small, globose-conic, with reddish brown perular scales. Leaves linear, crowded, nearly erect by a twist at their base, 0·5—1·75 inch long, rounded or emarginate at the apex, on the fertile branchlets with a short callous tip; with a median groove on the upper and two whitish stomatiferous bands on the under side. Staminate flowers cylindric, 0·5—0·75 inch long with dark indigo-blue anthers. Cones oblong-cylindric, rounded, truncate or depressed at the narrowed apex, 2·5—4 inches long and 1—1·5 inch in diameter. Scales gradually narrowed from a broad rounded apex to a short cuneate base, usually longer than broad; bracts oblong-obovate, about one-third the

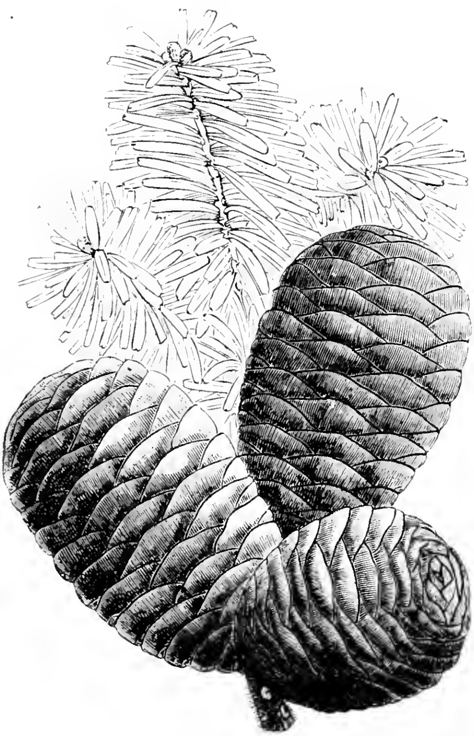


Fig. 134.
A cluster of young cones of *Abies lasiocarpa*.
(From the *Gardeners' Chronicle*.)

length of the scale, abruptly contracted at the apex into a long slender tip. Seed wings nearly half as large as the scale.—Sargent, *Silva of North America*, XII. 113, t. 611.

Abies lasiocarpa, Nuttall, Sylva III. 138 (1849). McNab in Proceed. R. Irish Acad. II. ser. 2, 682, fig. 7. Masters in Gard. Chron. V. ser. 3 (1889), p. 172, with figs.: Journ. Bot. XXVII. 129, with the same figs.; and Journ. R. Hort. Soc. XIV. 192.

A. bifolia, Murray in Proceed. R. Hort. Soc. III. 320, with fig (1863).

A. subalpina, Engelmann, American Naturalist, X. 555 (1876). Masters in Journ. Linn. Soc. XXII. 183, with figs. Sargent, Forest Trees N. Amer. 10th Census. U.S.A. IX. 211. Beissner, Nadelholzk. 466. Macoun, Cat. Canad. Plants, 474.

Pinus lasiocarpa, Hooker, W., Fl. Bor. Amer. II. 163 (1840). Endlicher, Synops. Conif. 105.

Abies balsamea, Torrey, Pacific Ry. Rep. IV. part V. 141 (in part).

A. grandis, Carrière, Traité Conif. ed. II. 296 (in part).

Pinus amabilis, Parlatore, D. C. Prodr. XVI. 426 (in part).

And many others.*

Although the most widely distributed of the Silver Firs of western America, *Abies lasiocarpa* is practically the least known of any of them in Great Britain. The following sketch of its geographical distribution is derived from the same authoritative source as the description given above.

"*Abies lasiocarpa* is an inhabitant of high mountain slopes and summits and is distributed from at least lat. 61° N. in Alaska southwards along the coast ranges to the Olympic mountains of Washington and over all the high ranges of British Columbia and Alberta: it extends along the Cascade mountains of Washington and Oregon; over the mountain ranges of Idaho, Montana, Wyoming, Colorado and Utah; and finds its southerly home on the San Francisco peaks of Northern Arizona.† Its vertical range in different parts of the great region over which it is spread varies from 2,000 feet elevation near its northern to 11,000 feet at its southern limit. The wood is light and soft but not strong nor durable: it is probably little used except for fuel."

Abies lasiocarpa has been sparingly in cultivation in British gardens under Engelmann's name of *A. subalpina* for some years past, but by whom or when it was introduced no record is to be found. Healthy young trees in different parts of Great Britain should suggest a more extended trial of it, especially in exposed places. It is perfectly hardy but grows somewhat slowly, and such too is the experience of it in the north-eastern States of North America.

Abies magnifica.

A gigantic tree 150—250 or more feet high, the trunk 8—10 feet in diameter near the ground and covered with thick deeply fissured red-brown bark and usually free of branches for 100 or more feet

* Probably no species of Abies has been involved in more confusion as regards its identification and nomenclature than the subject of the present notice. It would now be superfluous to enter into any examination of the causes of the confusion, for the clearing up of which science and horticulture are mainly indebted to Dr. Maxwell Masters in whose elaborate articles in the "Gardeners' Chronicle" and "Journal of Botany" quoted above, the question is fully discussed and finally set at rest.

† That is to say a meridional range of nearly 30°.

from the base. In Great Britain a formal tree of rather slow growth, the trunk covered with smooth ash-brown bark. Branches short in comparison with height of trunk, rigidly horizontal and ramified laterally only; branchlets opposite, rarely alternate, and inclined forwards at an angle varying from 45° to 60° to their primaries, short, rigid and covered with reddish brown bark. Buds small, ovate, acute, reddish brown. Leaves persistent eight — ten years, obscurely four-angled, obtuse or sub-acute, 0·5 — 1·5 inch long, greyish or glaucous green with two pale stomatiferous lines on the lower side, spirally crowded around the branchlets, the longer ones on the under side of sterile branchlets pseudo-distichous in three—four ranks; the shorter ones on the upper side either erect or pointing in the direction of the axis at a greater or less angle to it; on the fertile branchlets all upturned and more or less falcately curved. Staminate flowers cylindric, 0·5—0·75 inch long, with reddish crimson anthers. Cones among the largest in the genus, cylindric, obtuse, 6—9 inches long and 3—5 inches in diameter, at first violet-purple changing to dark sepia-brown at maturity; scales triangular-cuneate with the longer exposed margin rounded and incurved; bracts lanceolate with a small mucro at the apex about three-fourths as long as the scale. Seeds angulate with a broad sub-obovate wing.

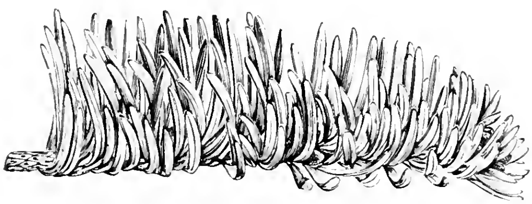


Fig. 135. Foliage of fertile branchlet of *Abies magnifica*.

Abies magnifica, Murray in Proceed. R. Hort. Soc. III. 318, with figs. (1863). Engelmann in Gard. Chron. XII (1879), p. 685; and Brewer and Watson's Bot. Califor. II. 119. Masters in Gard. Chron. XXIV. (1885), p. 652 with figs.; and Journ. R. Hort. Soc. XIV. 193. Beissner, Nadelholzk. 482, with fig. Sargent, Silva N. Amer. XII. 137, tt. 618, 619.

A. nobilis var. robusta, Carrière, Traité Conif. ed. II. 269 (1867).

A. nobilis var. magnifica, Masters in Journ. Linn. Soc. XXII. 189, with figs. (1886).

Picea magnifica, Gordon, Pinet. ed. II. 219 (1875).

Pinus amabilis, Parlatore, D. C. Prodr. XVI. 426 (in part).

Pseudotsuga magnifica, McNab in Proceed. R. Irish Acad. II. ser. 2. 700, fig. 30.

Amer. Red Fir. Germ. Prachtige Weisstanne.

var.—shastensis.

A smaller tree with more slender foliage and usually ellipsoid (not cylindric) shorter cones the bracts of which, 0·5—1 inch long, protrude from between the scales, reflexed and suddenly contracted to an acuminate point; "the large purple cones thus decked out with tasselled fringes are most beautiful objects."

A. magnifica var. shastensis, Lemmon, N. W. Amer. Cone-bearers, 62 (1895). Sargent, Silva N. Amer. XII. 138, t. 620. A. shastensis, Lemmon in Garden and Forest, X. 184. A. nobilis robusta, Masters in Gard. Chron. XXIV. (1885), p. 652, fig. 147 (not Carrière).

Abies magnifica inhabits chiefly the mountains of Oregon and California. On the Cascade mountains it is common between 5,000 and 7,000 feet elevation and also on the western slopes of the

Abies magnifica at Murthly Castle, Perthshire.

Sierra Nevada between 6,000 and 9,000 feet, in some places forming pure forests of great extent, in others mixed with *Tsuga Mertensiana* at its higher, and *Pinus ponderosa* and *Abies concolor* at its lower limit. It also forms a large and exclusive forest on the high plateau of lava formerly erupted from Mount Shasta in north California whence it spreads southwards along the western slopes of the Sierra Nevada to Kerr County.

> On the southern slopes of Shasta the trees become a dark, gloomy assemblage of massive black trunks, covered on the north side from the base to the lowest branches with a bright yellow lichen; the lower branches are draped here and there with long, sweeping festoons of black filmy lichen, giving a funereal aspect to the whole scene, scarcely relieved by the twitter of the red squirrel, the long wailing note of the woodpecker or the occasional cry of the bald eagle.*

The forest here described is composed of the variety *shastensis*, distinguished from the typical *Abies magnifica* chiefly by its shorter cones with exserted bracts. This variety, so far as at present known, is but sparingly represented in British gardens.

Abies magnifica was introduced into Great Britain in 1851 by the Scottish Oregon Association through their collector John Jeffrey, who, believing it to be the *A. amabilis* of Douglas, sent home cones and seeds under that name, and the seedlings were subsequently distributed among the members of the Association as *A. amabilis*. In the following year William Lobb collected cones of this tree for the Veitchian firm at Exeter; he also, supposing it to be the *A. amabilis* of Douglas, affixed that name to his collection; the seedling plants not conforming to the true *amabilis* of which there was at that time a good specimen at Bicton with which comparison could be made, and more closely resembling *A. nobilis*, they were distributed as *A. nobilis robusta*, the name adopted by Carrière in the second edition of his "Traité Général des Conifères," published in 1867.

Many fine specimens of *Abies magnifica* are dispersed over the country especially in Scotland in the grounds of former members of the Oregon Association. Our illustration represents a beautiful and characteristic tree at Murthly Castle in Perthshire from a photograph kindly lent for the purpose by Lady Stewart of Grantully.† *Abies magnifica* is hardy in nearly all parts of Great Britain, being rarely injured by spring frosts; its rate of growth, except under very favourable conditions of soil and climate, is rather slow, the leader shoot rarely adding more than 9—12 inches to its height annually; it is one of the best of the Abies for the lawn, not requiring much room, a space with a radius of not more than 10—12 feet being sufficient for it.

* Lemmon, Cone-bearers of North-west America, p. 63.

† Among other fine specimens worthy of note are those at the following places. In England—Orton Hall, Revesby Abbey, Cheswardine, Hewell Grange, Bayfordbury, Digswell Rectory, Warnham Court; in Scotland—Glamis Castle, Durris, Ochtertyre, Rossie Priory, The Cairnies, Haddo House, Castle Kennedy, and many others; in Ireland—Shane's Castle, Powerscourt, Abbey Leix, Castlewellan, etc.

As a species, the nearest affinity of *Abies magnifica* is *A. nobilis* with which it has been often confused. The economic properties of *A. magnifica* are not very favourably reported on: the wood is light and rather coarse-grained, durable in contact with the soil but liable to warp: it is largely used for fuel and for coarse timber constructions.

Abies Mariesii.

A medium-sized tree 40—50 feet high but at its southern limit 60—75 feet high with close-set, relatively short spreading branches forming a compact pyramid. Branches stoutish, covered with brown bark marked with circular scars of fallen leaves. Branchlets distichous and opposite, given off from their primaries at an angle of about 45°, the young shoots with a dense brown pubescence. Buds small, globose with dark brown closely appressed perulæ. Leaves 0·25—0·75 inch long, narrowly linear, obtuse or emarginate, tapering at the base into a very short petiole; the midrib depressed on the upper and prominent on the lower side, dark green above, paler with two whitish stomatiferous bands below, the longer leaves on the lower side of the branchlets pseudo-distichous in three—four ranks, the shorter ones on the upper side pointing forwards and upwards and loosely imbricated. Staminate flowers not seen. Cones broadly fusiform or sub-cylindric, narrowed at the base and apex, deep violet-blue changing to dark brown when mature; scales suborbicular, somewhat broader than long, with a cuneate base and an entire slightly incurved apical margin; bracts half as long as the scales, obovate-oblong, retuse, with a small central mucro. Seed wings broadly wedge-shaped, entire.

Abies Mariesii. Masters in Gard. Chron. XII. (1879), p. 788, with fig.; Journ. Linn. Soc. XVIII. 519,; and Journ. R. Hort. Soc XIV. 193. Kent in Veitch's Manual. ed. I. 100. Mayr, Abiet. des Jap. Reiches, 40, Tafel II. fig 5. Beissner, Nadelholzk. 455.

This very distinct Silver Fir was discovered by Mr. Charles Maries on Mount Hakkoda near Aomori in the extreme north of Hondo in 1878; he also met with it in Nikko on the central mountains, and recently it has been found in two or three localities on the mountains of southern Yeso by Japanese botanists. On Hakkoda it is common at 4,000 to 5,000 feet elevation mixed with deciduous trees; in Nikko it ascends considerably higher but occurs more sparingly. *Abies Mariesii* is thence an alpine tree with a comparatively restricted habitat, occupying a geographical position between that of *A. Veitchii* and *A. sachalinensis*; its nearest affinity is, however, *A. homolepis*. Nothing is known of its economic properties.

Seeds were sent to Messrs. Veitch by Maries in 1879 but very few plants were raised from them, and from these as well as from the younger seedlings raised from a consignment received ten years later, no definite statement respecting the suitableness of the species for British arboriculture can be made further than that it has proved to be quite hardy but of very slow growth. The young plants in this country have a Tsuga-like aspect with the leaves much crowded and shorter than those of any other Abies.

Abies nobilis.

A stately tree attaining a height that varies in individuals according to locality and environment from 100 to 200 or more feet, with a trunk 4—5 feet in diameter near the base, covered with reddish brown bark in its native forests; smooth in the younger trees, deeply fissured into broad ridges in the older ones; in Great Britain the trunk gradually tapering and frequently marked with large resinous blisters. Branches pseudo-whorled, for the most part spreading horizontally, the lowermost usually made decumbent by the weight of their appendages. Branchlets opposite, often crowded, rigid with reddish brown bark and densely clothed with foliage, the herbaceous shoots pubescent. Buds small, globose, almost concealed by the apical leaves, the perular scales thickish and reddish brown. Leaves persistent seven—ten years, close-set, spirally arranged around the stems, 0·5—1·5 inch long, linear, sub-falcate, obtuse or shortly mucronate; with a shallow groove along the mid-rib, and dull bluish green, often glaucous above, with a glaucous

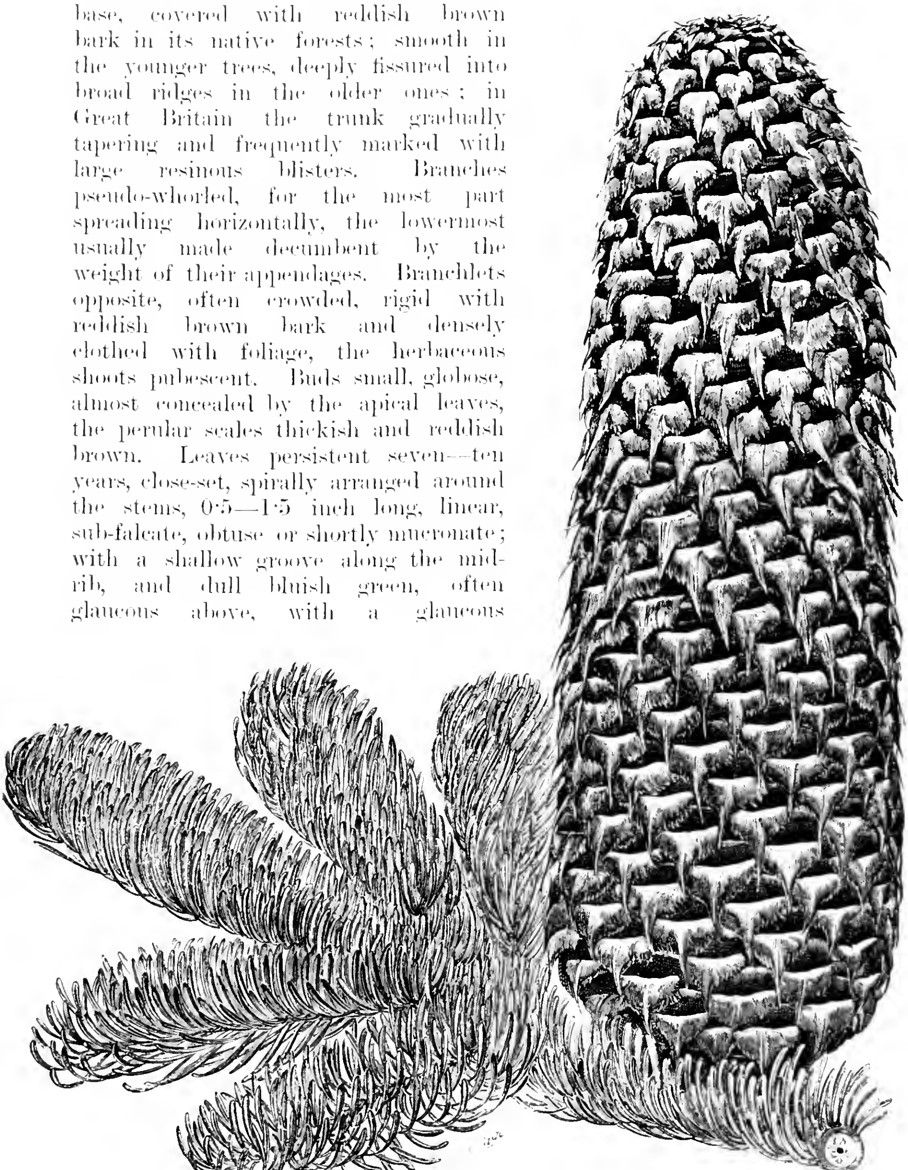


Fig. 136. Fertile branchlet with cone of *Abies nobilis* about one-half nat. size.

stomatiferous band on each side of the midrib below; those on the under side of the shoot pseudo-distichous by a twist at the base to bring them into a horizontal position, those on the upper side curved upwards and inwards. Staminate flowers shortly pedicelled and closely packed mostly on the under side of the branchlets, cylindric, about an inch long and often curved, reddish crimson, surrounded at the base by triangular-ovate involucral bracts in three—four series. Cones among the largest in the genus, cylindric, obtuse, 6—8 inches long and 2—3 inches in diameter.* Scales triangular with an acute awl-shaped claw, about 1 inch long and 1·25 inch broad, the exposed apical margin entire and incurved; bracts longer than the scales, cuneate-spathulate, exserted and bent downwards, with an acuminate flattened mucro 0·5 inch long at the apex. Seed wings broadly wedge-shaped, irregularly truncate at the apex.

Abies nobilis, Lindley in Penny Cyclop. I. 30 (1833). Forbes, Pinet. Woburn. 115, t. 40. Link in Linnaea, XV. 532. Carrière, Traité Conif. ed. II. 268. Engelmann in Gard. Chron. IX. (1878), p. 334; XII. (1879), p. 684, in part; and Brewer and Watson's Bot. Califor. II. 119. Masters in Journ. Linn. Soc. XXII. 188, t. 4 (excl. hab. Mt. Shasta and var. magnifica); Gard. Chron. XXIV. (1885), p. 652, with fig.; and Journ. R. Hort. Soc. XIV. 193. Beissner, Nadelholzk. 484, with figs. Sargent. Silva N. Amer. XII. 133, t. 617.

Picea nobilis, Loudon, Arb. et Frut. Brit. IV. 2342, with figs. Lawson, Pinet. Brit. II. 181, tt. 28, 29, and figs. Gordon, Pinet. ed. II. 207.

Pseudotsuga nobilis, McNab in Proceed. R. Irish Acad. II. ser. 2, 699, fig. 29.

Pinus nobilis, Douglas in Comp. Bot. Mag. II. 147. Endlicher, Synops. Conif. 90. Parlatore, D. C. Prodr. XVI 419.

Eng. Noble Fir. Amer. Red Fir, Larch Fir of Oregon. Germ. Edle-Weisstanne. Ital. Abete nobile.

Abies nobilis forms large forests along the slopes of the Cascade mountains of Oregon from the Upper Rogue river to the Columbia with a vertical range of between 2,500 and 5,000 feet elevation; it also occurs along the coast range of Oregon in much fewer numbers but where it attains its greatest individual development; it has also recently been found on Mount Ranier in Washington up to 5,000 feet elevation but nowhere wild in California. It was originally discovered by David Douglas during his first mission to north-west America near the Grand Rapids of the Columbia river in 1825, but it was not till his second mission and during his excursion up the Columbia in 1830 that he was able to collect seeds and send them to England.

At that time the great forests which covered the Cascade mountains had probably not been penetrated by the white man; half a century later, a railway traversed the country; saw-mills have been established on the principal streams, and the once great forest of *Abies nobilis* which made so vivid an impression on David Douglas and others who subsequently visited it, is fast disappearing under the axe of the lumberer. It is by no means rash to surmise what its fate will be within the next half century unless the State intervenes to arrest its total destruction.

As an ornamental tree for the lawn, park and landscape, *Abies nobilis* ranks among the best of the Silver Firs; its outline is regular

* Usually smaller in the forests of Oregon.

Abies nobilis 60 feet high.

without being too formal; it is dense with branchlets and foliage without being sombre; its dark green foliage with a soft glaucous hue, often heightened to silvery whiteness under certain conditions of soil and environment, is most distinct whether looked at alone or in contrast to that of other trees; its large handsome cones which are produced freely even on comparatively young trees are a striking ornament of this species. Numerous fine specimens scattered over well nigh the whole of Great Britain and Ireland, attest its adaptability to the British climate; the average yearly increase in height of the leader shoot varies from climatic and other causes from 15 to 25 inches and even more in localities particularly favourable for its development. As the lowermost branches of the largest trees growing in this country rarely exceed 25 feet in length, a space with a radius a little more than this should be allowed for it when planted for ornamental purposes.*

One of the most remarkable arboreal effects produced by *Abies nobilis* to be seen in this country is an avenue formed of it at Madresfield Court, the seat of Earl Beauchamp, in Worcestershire. This avenue was planted in 1868 and the height of the trees composing it now range from 50–60 feet; the soil in which they are growing is a strong loam approaching clay in consistency. The trees are arranged in two rows, each row including twenty-five trees placed 45 feet apart; the interval between the rows is also 45 feet, a distance sufficient to allow a distinct view of the whole from either end. The rate of growth of the leaders and the spread of branches is remarkably uniform throughout; the foliage of the youngest growths is highly glaucous, contrasting strongly and effectively with the dark green of the older leaves. Both staminate and ovuliferous flowers are produced in great quantities which lend an additional feature to the trees during the early summer. This great fertility of the trees is doubtless owing, at least in part, to the fact that they are all grafted on *A. pectinata*, for as regards age, they may still be considered to be in their infancy for *Abies nobilis*.†

The wood of *Abies nobilis* is light, hard, strong and rather close grained, and coloured light brown streaked with red.‡ It is durable when well seasoned and suited for architraves, panelling and framing, also for doors, windows, and the interior finish of dwelling houses generally.

* Among the finest indvidual trees worthy of especial mention, all of them over 70 feet high, are the following:– In England at Monk Coniston, Lancashire; Penrhyn Castle, Linton Park, Tortworth Court and Highnam Court, Gloucestershire. In Scotland at Haddo House, Coul House, Ross-shire; Dupplin Castle, Keir House, Murthly Castle, Ochtertyre and Scone Palace in Perthshire. In Ireland at Fota Island, Birr Castle, Curraghmore.

† It will be useful to place on record the following additional facts respecting this remarkable avenue. The present condition of the trees, as the illustration shows, is most satisfactory. Mr. Crump, the gardener to Earl Beauchamp, informed the author that towards the end of the "eighties" a very troublesome fungus came up thickly and persistently in a circle around each tree; to destroy this, a good coating of lime was first applied, followed by a dressing of ground bones with two cart-loads of strong loam to each tree with the result that the fungus was destroyed and the trees were invigorated. Further care is taken in their preservation by the removal of many of the cones as they appear.

‡ Silva of North America, XII. 135.

The *Abies nobilis* Avenue at Madresfield Court.

Abies Nordmanniana.

A stately tree attaining a height of 75—150 or more feet with a tapering trunk 3—4 feet in diameter near the ground; the bark of the oldest trees growing in Great Britain greyish brown, smooth or marked with shallow fissures. Branches spreading, the lowermost depressed, those above horizontal or ascending. Branchlets distichous and opposite with light brown striated bark. Buds globose-conic, about 0·25 inch long, with reddish brown, broadly ovate, perular scales. Leaves persistent seven—ten years, narrowly linear, obtuse or emarginate, 0·75—1 inch long, bright grass-green with a narrow median groove above, paler with two whitish stomatiferous bands below; those on the under side of the shoot pseudo-distichous in two—three ranks; those on the upper side pointing forwards and loosely imbricated. Staminate flowers crowded on the under side of the branchlets, ovoid-cylindric, about 0·4 inch long; the involucral bracts at the base of each, scale-like in three series and closely imbricated. Cones ovoid-cylindric, sub-acute, 6 inches long and 1·5 inch in diameter, dark brown; scales sub-reniform with a short cuneate claw, and with the outer edge entire or minutely denticulate; bracts oblong spathulate, cuspidate, longer than the scale and exserted, reflexed at the apex, the exposed margin notched.

Abies Nordmanniana, Spach. Hist. Veg. Phan. XI. 418 (1842). Carrière, Traité Conif. ed. I. 203 (1855); and ed. II. 276 (1867). Regel, Gartenfl. XXII. 259, with fig. McNab in Proceed. R. Irish Acad. II. ser. 2, 694, fig. 22. Boissier, Fl. orient. V. 703. Hooker fil. Bot. Mag. t. 6992. Masters in Gard. Chron. XXV. (1886). p. 142, with fig.; and Journ. R. Hort. Soc. XIV. 194. Beissner, Nadelholzk. 434, with fig.

A. Eichleri, Lauch in Gartenzeit. 1882, p. 63. Hemsley in Gard. Chron. XVII. (1882), p. 145.

Picea Nordmanniana, Loudon, Encycl. of Trees, 1042, with fig. (1842). Gordon, Pinet. ed II. 208.

Pinus Nordmanniana, Steven, Bull. Soc. Nat. Mosc. (1838), p. 45, fig. 2. Endlicher, Synops. Conif. 93.

P. Abies. Pallas, Fl. Ross. 6. t. 1. fig. c. (not Duroi). 1784. Parlatore, D. C. Prodr XVI. 412. in part.

Eng. Nordmann's Fir. Germ. Nordmann's Tanne. Ital. Abete di Nordmann.

Abies Nordmanniana was first recognised as a distinct species by the Finnish botanist Alexander Nordmann who met with it in 1837 near one of the sources of the Kur river on the Adschur or Atskur range of mountains in the Caucasian province of Imeritia where it is very abundant. There is, however, sufficient evidence to show that Nordmann was not the original discoverer of it, since the region over which it is spread had been previously partially explored by Pallas in the latter part of the eighteenth century and more fully by Bieberstein in the early part of the nineteenth century, both of whom record a Silver Fir* but refer it to the common European species which is nowhere found in the Trans-Caucasian provinces. Since Nordmann's journey, the region has been frequently visited both by Russian and German botanists, and the geographical range of *Abies Nordmanniana* can be defined with approximate accuracy:—

* Pallas, Flora Rossica, p. 6, t. 1, fig. G. (1784). Bieberstein, Flora Taurico-Caucasica, Vol. II. p. 409 (1808).

Abies Nordmanniana at Castlewellan, Co. Down.

It has not been met with east of the meridian of Tiflis, its further spread in that direction being prevented by the arid climate of the steppes of eastern Georgia and the plain of Shirvan; it does not occur north of the lofty chain of Caucasus proper, nor is it known to occur south of the boundary line separating the Russian from the Persian provinces. In the central Caucasus it covers the greater part of the mountain valleys from 3,500—6,000 feet elevation, almost constantly associated with *Picea orientalis*. It also occurs under similar conditions in Pontish Armenia and Lazistan and more sparingly on the mountains around Trebizond, its western limit. The statement by Gordon and others and inadvertently repeated in the former edition of this Manual that *Abies Nordmanniana* is common on the Crimean mountains is without foundation.

In the wild state *Abies Nordmanniana* does not possess the elegant and compact outline for which it is so much valued as an ornamental tree in European gardens. In the damp coast region of Pontus it is more or less rigidly pyramidal or even Cypress-like, but never shows that luxuriant dark green as is seen in young plants under cultivation. In the central Caucasus it gives the same general impression as the common Silver Fir, the difference consisting only in the more slender outline and in the presence of an abundance of gigantic specimens.* The timber is said to be superior to that of the common Silver Fir; it is used for building purposes generally throughout the Russian Trans-Caucasian provinces.

Abies Nordmanniana was introduced into European gardens about the year 1848 or a little earlier, and is now well known as one of the handsomest of Conifers for ornamental planting. Its merits as a landscape tree and the conditions under which it thrives in this country are tersely summarised by a correspondent of the "Gardeners' Chronicle" in the following paragraph:—

As an ornamental tree for landscape gardening, few can compare with it for beauty of outline, symmetry, and the rich contrast produced in summer by the dark glossy green of the old and the light lively tints of the young foliage: and whether planted on the lawn or mixed with other trees, it never fails to attract attention and to produce the most pleasing effect. This tree is also capable of accommodating itself to a great variety of soils and situations, though, like other species of Abies, it prefers a strong deep loam rich in organic matter, not apt to dry up in summer nor retain too much moisture in winter. It thrives remarkably well in peat bogs and in hollow places where the common Silver Fir suffers from late spring frosts; in such situations it stands unscathed. Cold stiff clays, poor in inorganic accumulations are inimical to its growth.†

One great advantage from a cultural standpoint, possessed by *Abies Nordmanniana* is, that it does not commence its annual growth till summer has fairly set in, when it pushes rapidly for about eight weeks, completing its growth in time for the young shoots to become sufficiently mature before the approach of winter to enable them to endure without injury the severest frosts known in this country. To

* Dr. G. Dieck in Gartenflora, 1891, p. 233.

† Emergo in the Gardeners' Chronicle, Vol. XVIII. (1882), p. 492.

secure good specimens a space with a radius of not less than 25 feet should be provided for them.

Under cultivation *Abies Nordmanniana* sports into many varieties in the seed bed, the deviations from the common type being observable chiefly in the habit or foliage of the plant. In continental nurseries some of these seminal forms have been distinguished by name as *aurea*, *brevifolia*, *glauca*, *pendula*, *refracta*, *robusta*, etc.

Abies numidica.

A slender tree of moderate dimensions, the trunk rarely exceeding 50—60 feet in height and 10—18 inches in diameter near the base and with a dense pyramidal crown. Bark of trunk ash or greyish brown, slightly rugose. Branches in pseudo-whorls, spreading or ascending. Branchlets distichous and opposite, covered with light reddish brown bark; on the younger shoots marked with shallow oblique ridges. Buds globose-conic, sub-acute, about 0·5 inch long, light chestnut-brown with ovate, obtuse, closely imbricated and minutely fringed perular scales. Leaves spirally crowded, persistent seven—nine years, linear, obtuse or emarginate, slightly narrowed at the base, bright grass-green with a narrow median groove above, with thickened midrib and margins and two white stomatiferous bands beneath, 0·5—1 inch long, the longer ones on the under side pseudo-distichous in two—three ranks, the shorter ones on the upper side erect or sub-erect. Cones solitary or in clusters of three—five, sub-cylindric, slightly tapering at the base and apex, 5—6 inches long and 2 inches in diameter. Scales reniform, contracted to a short claw, closely imbricated, the outer exposed margin entire and incurved; bracts shorter than the scale, narrowly spathulate, mucronate. Seed wings oblong, truncate, nearly as long as the scale.

Abies numidica. De Lannoy ex Carrière, Rev. Hort. 1866, pp. 106, 203; Traité Conif. ed. II. 305; and Van Houtte's Flore des Serres, XVII. 9. t. 1717. Masters in Gard. Chron. III. ser. 3 (1888), p. 140 (in part and excl. figs.); and Journ. R. Hort. Soc. XIV. 194. Beissner, Nadelholzk. 447.

A. Pinsapo var. baborensis, Cosson in Bull. Soc. Bot. de France. VIII. 607 (*nomen nudum* 1861). Willkomm, Forstl. Fl. ed. II. 111.

A. baborensis, McNab in Proceed. R. Irish Acad. II. ser. 2. 697. fig. 27 (1877).

Picea numidica. Gordon, Pinet. ed. II. 220.

Pinus Pinsapo, Parlatore, D. C. Prodr. XVI. 423 (not Boissier).

Eng. Algerian Fir. Fr. Sapin d'Algèrie. Germ. Numidische Weisstanne. Ital. Abete d'Algeria.

The Algerian Fir, so far as at present known, has a very restricted habitat on a part of the Atlas mountains lying within the province of Kabylia (the ancient Numidia), known as Babor and Thababor, at an altitude of 4,000 to 6,000 feet; it occurs chiefly on the northern and eastern slopes of these mountains associated with *Cedrus atlantica* and *Taxus baccata*, growing on limestone rocks with a scanty covering of soil, but nowhere abundant. At this altitude, snow falls in enormous quantities from December to April, and which in the more exposed ravines is scarcely ever absent. The following account of its discovery and introduction into European gardens is derived from Carrière's "Traité Général des Conifères," *loc. cit. supra.*

Abies numidica was discovered by Captain Guibert in 1861. Shortly afterwards MM. Letourneux and Perrandière gathered branches of it which they brought to M. Cosson, a well-known botanist of that time, who took the tree to be a variety of the Spanish Fir, *A. Pinsapo*. It was M. de Lannoy, Superintendent of roads and bridges for the province, who first recognised it as a species distinct from *A. Pinsapo*, and who gave it the name of *A. numidica*. The first seeds were sent to France about the year 1862 by M. Davout, Conservator-General of the Algerine forests, and a little later, in 1864, by M. de Lannoy.

From France the species has found its way into Great Britain but in numbers so restricted that up to the present time it has been too sparsely distributed to admit of any general statement being made respecting its usefulness as an ornamental tree, the only purpose for which it should be planted. Its hardiness equals that of *Cedrus atlantica*, and the specimens upwards of 20 feet high, growing at Pampesford near Cambridge, at Bicton in Devonshire, at Streatham Hall, Exeter, and in the Royal Botanic Garden at Glasnevin, Dublin, give a favourable impression of its beauty and distinctness.

Abies pectinata.

A lofty tree varying in height from 100 to 180 feet with a straight, erect, slightly tapering trunk 6—8 feet in diameter near the base, regularly furnished with tiers of branches from the ground upwards during the first thirty to forty years, in favourable localities much longer, and covered with smooth greyish brown bark. In old age the bark rugged and more or less fissured longitudinally, the trunk free of branches for a great part of the height, and the persistent branches forming the crown, of unequal length and spreading horizontally. Ramification distichous and opposite: bark of branchlets pale brown with longitudinal striations. Buds cylindric-conic, chestnut-brown. Leaves persistent five—seven or more years, linear, obtuse or emarginate, 0·5—1·25 inch long, pseudo-distichous in two—three ranks; on fertile branchlets all more or less upturned; grooved along the midrib and dark lustrous green above, with two silvery grey stomatiferous bands below. Staminate flowers crowded among the leaves, cylindric, 0·75 inch long, greenish yellow, surrounded at the base by imbricated involucral bracts in two—three series. Cones cylindric, obtuse, 6—8 inches long and 1·5—2 inches in diameter. Scales nearly as long as broad, with a rounded exposed margin and cuneate base; bracts linear-spathulate, prolonged beyond the scale into a sharp reflexed mucro. Seeds angular with a rhombic wing twice as long as the seed.

Abies pectinata, De Candolle, Flore Franc. III. 276 (1805). Richard, Mém. sur les Conif. 73 (1826). Forbes, Pinet. Woburn. 105. Link in Linnæa, XV. 526. Carrière, Traité Conif. ed. II. 276. Hoopes, Evergreens, 205. McNab in Proceed. R. Irish Acad. II. ser. 2, 693, figs. 20—21. Boissier, Fl. orient. V. 701. Beissner, Nadelholzk. 428, with figs. Masters in Journ. R. Hort. Soc. XIV. 194.

Picea pectinata, Loudon, Arb. et Frut. Brit. IV. 2329, with figs. Gordon, Pinet. ed. II. 209.

Pinus Abies, Duroi, Observ. Bot. 39 (1771) (not Linnæus). Endlicher, Synops. Conif. 95. Parlatore, D. C. Prodr. XVI. 420.

P. Picea, Linnæus, Sp. Plant. II. 1001 (1753). Lambert, Genus Pinus, I. t. 30 (1803).

Eng. Common Silver Fir. Fr. Sapin des Vosges, Sapin de Lorraine. Germ. Weisstanne, Silbertanne. Ital. Abete argentato. Abete bianco.

var. Equi Trojani.

Leaves acute and spine-tipped as in *Abies cephalonica*. Cones shorter and broader, with the bracts more prominently exserted than in *A. pectinata*.

A. pectinata var. Equi Trojani. Boissier. Fl. orient. V. 701. Beissner. Nadelholzk. 431.

The common Silver Fir has an extensive geographical range in central and southern Europe, but at the present time its indigenous growth is confined chiefly to the mountain districts. Its distribution in Central Europe may be said in general terms to extend from the Pyrenees to the Carpathian mountains, and from the Vosges and Hartz mountains to the Alps. In the Mediterranean region east of the Pyrenees, it occurs on the mountains of Corsica; it follows the trend of the Apennines through Italy; it appears again on the mountains of Thrace and Macedonia and beyond the European limits, on Perindagh and Olympus in Bithynia. On the Carpathian mountains it ascends to 3,000 feet above sea-level, on the Vosges to 4,000 feet, on the Jura to nearly 5,000 feet, on the Alps of Lombardy to 6,000 feet, and on the Pyrenees to 6,500 feet. The largest pure forests of *A. pectinata* still remaining are on the French slopes of the Pyrenees, on the Vosges and on the Jura; in other parts of its range it is more scattered and associated with other trees. It attains its greatest development in the humid mountain tracts of central Europe; individual trees nearly 200 feet high have been observed in south Germany.*

The common Silver Fir was one of the first exotic coniferous trees introduced into Great Britain, but the precise date of introduction is unknown. Loudon, quoting Evelyn, states that a Silver Fir two years old was planted at Harefield Park in Middlesex in 1603, and this was the first planted in England. In this country its growth during the first few years from the seed is very slow, only attaining the height of a few inches, but after it has become established its progress is more rapid. About the twentieth year and during its full vigour for some years afterwards, the leader shoot will increase from two to three feet annually. Unless planted in a sheltered situation the Silver Fir is liable to injury by spring frosts in its first stages of growth, as the young shoots throw off their perular covering early in the season; but when older, the spring frosts are less injurious, and under ordinary circumstances the Silver Fir has attained dimensions scarcely yet surpassed by any other introduced coniferous tree. Willkomm states that it completes its upward growth between one hundred and eighty and two hundred years when the top becomes flattened but the tree lives on for several hundred years more. Numbers of fine specimens of great size dispersed over Great Britain and Ireland bear witness to its suitableness as a park and landscape tree as well

* The geographical distribution of the common Silver Fir has been carefully investigated by Willkomm, and the limits of its indigenous growth traced out in his "Forstliche Flora von Deutschland und Oesterreich," from which the particulars given above are chiefly derived.

as for the many purposes in rural economy for which it is planted.* Among the most noteworthy of these is one at Lynedoch near Perth over 104 feet high, 14 feet in girth at five feet from the ground, and estimated to contain 417 cubic feet of timber.† In the grounds at Dunkeld House in the same county is one of the finest groups of Silver Firs in Great Britain; this group consists of fifteen trees ranging from 95 to 110 feet in height, and from 10 to 14 feet in girth at five feet from the ground.‡ At Carton in Kildare, the seat of the Duke of Leinster, are several lofty specimens which form a conspicuous feature of the place, the largest of which is 112 feet high and 15 feet in girth at five feet from the ground; and at Curraghmore, near Waterford, the seat of the Marquis of Waterford, are several superb specimens over 100 feet high.

The timber of the common Silver Fir is inferior to that of the Spruce Fir; the wood is strong and elastic but the grain is irregular; it is soft and porous and soon decays on exposure; it is, however, recommended for roofing, partitions in the interior of houses, posts for fencing; also for troughs, cisterns, and for any purpose connected with sluices and embankments, as it does not warp or twist. In the mountain regions of Europe where the Silver Fir is abundant, its timber is used for carpentry of every description, and it is also burnt into charcoal. In the forests of the Vosges, the resinous secretions are collected in great quantity, from which is prepared the Strasburg turpentine of commerce.

Many varieties of the Silver Fir have from time to time been brought under the notice of horticulturists, showing a greater or less deviation in habit from the common type. They are mostly of French and German origin, and have received the following names among others:—*brevifolia*, *columnaris*, *pendula*, *pyramidalis*, *stricta*, *tortuosa*, *tenuifolia*, *variegata* — names sufficiently indicative of the most obvious characteristic of the varieties to which they have been applied. Probably not one of them is to be found in British gardens except perhaps *pendula* which occurs wild on the Vosges and in east Friesland. Of far greater interest than any of them is that described by Boissier under the name of *Equi Trojani* which was discovered by the Greek botanist Sintenis on the summit of Kas Dagh (Mount Ida) in north-west Anatolia, not far from the site of the ancient Troy.§ In its spine-tipped leaves it approaches *Abies cephalonica* and in its broader cones *A. Nordmanniana*; it is thence an intermediate form connecting these two Abies with each other and with the more widely distributed *A. pectinata*, a significant fact showing how nugatory the technical circumscriptions of species often prove.

* It should be borne in mind that when the Silver Fir is felled, the stump, if left in the ground, retains its vitality and even increases in size for many years afterwards; it is thence advisable to remove it if the ground on which the tree stood, is required for other purposes.

† Dimensions communicated by Mr. Pitcaithley, Forester to the Earl of Mansfield.

‡ Communicated by Mr. David Keir, Forester to the Duke of Atholl.

§ "Instar montis equum, divina Palladis arte
Ædificant, sectaque intexunt *abiete* costas."—*Æneid*, II. 15.
Assisted by the divine skill of Pallas, they build a horse to the size of a mountain and interweave its ribs with planks of fir.

Abies Pindrow.

A lofty tree 80—100 feet high with a trunk 4—5·5 feet in diameter near the ground. In Great Britain an elegant tree of moderate growth, the trunk covered with ash-brown bark, smooth or slightly rugose. Branches more or less deflexed, with distichous ramification. Branchlets opposite with whitish brown bark, obscurely fluted by cortical outgrowths decurrent from the pulvini of the leaves. Buds conic-cylindric, 0·25—0·4 inch long, with ovate, reddish brown, closely imbricated perular scales. Leaves persistent five—seven or more years, narrowly linear, acute or bidentate at the apex, 1·25—3·5 inches long, dark lustrous green with a shallow median groove above; much paler with a shallow keel at the midrib, and with but faint traces of a stomatiferous band on each side of it; the longer ones on the under side pseudo-distichous in three—four ranks and inclined forwards at an angle of about 45° to the shoot; the shorter ones on the upper side all pointing forwards and loosely imbricated. Staminate flowers crowded on the under side of the branchlets, fusiform-cylindric, 0·75 inch long. Cones cylindric, obtuse, 4—5 inches long and 2 inches in diameter, violet-purple changing to dark brown when mature. Scales sub-rhomboidal with a small wedge-shaped claw, the exposed margin entire and slightly incurved; bracts about one-third as long as the scale.

Abies Pindrow, Spach. Hist. Veg. Phan. XI. 423 (1842). Carrière. Traité Conif. ed. II. 299. McNab in Proceed. R. Irish Acad. II. ser. 2, 690, fig. 17. Kent in Veitch's Manual, ed. I. 110.

A. Webbiana var. Pindrow, Brandis, Forest Flora N.W. India, 528. Hooker fil, Fl. Brit. Ind. V. 625. Beissner. Nadelholzk. 481. Masters in Journ. R. Hort. Soc. XIV. 196.

Picea Pindrow, Loudon, Arb. et Frut. Brit. IV. 2346, with figs. Madden in Journ. Hort. Soc. Lond. V. 246. Gordon, Pinet. ed. II. 222.

Pinus Pindrow, Royle, Illus. Him. Plants, 354, t. 86. Lambert, Genus Pinus, ed. III. p. 77, t. 14. Endlicher, Synops. Conif. 106. Parlatore, D. C. Prodr. XVI. 425.

Abies Pindrow forms dark gloomy forests on the great spurs of the Kumaon Himalaya from 7,000 to 9,000 feet elevation, spreading westwards into Kashmir; it was introduced into Great Britain in 1837 by Dr. Royle. On the Kumaon Himalaya the annual rainfall exceeds 100 inches, and the mean temperature at the elevation of the Pindrow forests about 10°—12° C. (50°—55° F.); where these climatic conditions are most nearly approached in Great Britain *Abies Pindrow* thrives when protected from piercing winds; thus, in the south-west of England, in parts of Wales and Scotland and in Ireland are to be seen healthy trees of great beauty;*

* In the grounds of Mr. Victor Marshall at Monk Coniston are two remarkable specimens of *Abies Pindrow* over 60 feet high. At Conan House, Ross-shire, is a beautiful specimen over 50 feet high, on a bank raised about 36 feet above the swampy ground near it and surrounded by other trees taller than itself by which it is protected from cold winds. At Kilburne Castle in Ayrshire is a vigorous specimen over 50 feet high, of which the leader shoot has increased in height about 15 inches annually. Other fine trees are to be seen at Cultoquhey in Perthshire; at Castle Kennedy in Wigtownshire; in Ireland at Powerscourt, Charleville (probably the largest in the British Islands) and Kilmacurragh in Co. Wicklow; at Cahermoyle, Co. Limerick; and in the Royal Botanic Gardens at Glasnevin, Dublin. Also at Menabilly, Cornwall; Tortworth Court, Gloucestershire; and Penrhyn Castle in Wales. Most of the trees in this enumeration have been seen by the author, and there are doubtless others which it would be useful to place on record.

in the relatively dry climate of England with the exceptions noted, and in the eastern counties of Scotland it does not grow satisfactorily.

The claim of *Abies Pindrow* to specific rank has occasionally been doubted; Sir Dietrich Brandis, the author of the "Forest Flora of North-west India," has declared against it, and following him Sir J. D. Hooker reduced it to a variety of *A. Webbiana* in the "Flora of British India." As seen in Great Britain, scarcely any two species of Abies are to be found more easily distinguishable the one from the other than *A. Pindrow* and *A. Webbiana* even on superficial inspection. In *A. Pindrow* the branches are much shorter in proportion to height of trunk than in *A. Webbiana*, and are bent downwards, not spreading or ascending; the branchlets are slender, lax and sub-pendulous, not stout and rigid; the leaves are longer and narrower, not glaucous on the under side, and of a different shade of green; the cones are much smaller, and when young paler in colour than those of *A. Webbiana.*

Abies Pinsapo.

A much-branched tree 60—80 feet high with a gradually tapering trunk 2—3 feet in diameter near the base, covered with greyish brown bark that is smooth in some of the largest trees growing in Great Britain, rugged and much fissured in others. Branches in rather close-set pseudo-whorls, short in proportion to height of trunk, the lowermost depressed, those above spreading horizontally or ascending. Branchlets distichous or in whorls of three—four; bark light reddish brown. Buds broadly conic, obtuse, 0·35—0·45 inch long, light fulvous brown, usually covered with a film of translucent resin, the apical bud with a circlet of three—four smaller ones. Leaves persistent seven—nine years, spirally crowded, erect, 0·25—0·75 inch long; on the sterile branches sub-acicular, obscurely four-angled and compressed, mucronate and sometimes falcately curved; on the fertile branches linear, flattened and obtuse, dull green with two pale stomatiferous lines on the under side. Staminate flowers numerous, chiefly on the under side and towards the distal end of the branchlets, fusiform-cylindric, 0·5 inch long, violet-crimson and surrounded at the base by broadly ovate, obtuse involucral bracts in two series. Cones sessile, solitary or in pairs, sub-cylindric, obtuse, 4—5 inches long and 1·5—2 inches in diameter; scales triangular-cuneate, clawed, with entire rounded and slightly reflexed outer margin; bracts from a narrowed base, ovate, mucronate, much shorter than the scales. Seed wing obcuneate-oblong.

Abies Pinsapo. Boissier in Biblioth. Univ. Geneva. 1838; and Voyage Bot. en Espagne, I. tt. 167—168; and II. 584 (1845). Carrière. Traité Conif. ed. II. 303. McNab in Proceed R. Irish Acad. II. ser. 2. fig. 26. Beissner, Nadelholzk. 444 with fig. Masters in Gard. Chron. XXIV. (1885), p 468, with fig.; and Journ. R. Hort. Soc. XIV. 195.

Picea Pinsapo. Loudon, Encycl. of Trees. 1041 (1842). Gordon, Pinet. ed. II. 224.

Pinus Pinsapo. Endlicher, Synops. Conif. 109 (1847). Parlatore. D. C. Prodr. XVI. 423 (excl. African habitat).

Eng. Spanish Fir. Fr. Sapin d'Espagne. Germ. Spanische Weisstanne. Ital. Abete di Spagna. Span. Pinsapo.

Although abundant on the Sierras in the south of Spain *Abies Pinsapo* was unknown to science till discovered by the eminent Swiss botanist, Edmond Boissier, during his excursion to Andalusia in 1837, and afterwards fully described by him in his "Voyages Botaniques" quoted above. Even at the present time the limits and area of its distribution are but imperfectly known: it forms extensive forests

Fig. 137. *Abies Pinsapo.* Branchlet with staminate flowers. (From the *Gardeners' Chronicle.*)

on the Sierra Nevada at elevations ranging from 3,500 to 6,000 feet from Ronda eastwards into the province of Murcia; it is also said to occur on the Sierra Morena and other mountains in central Spain, but no localities are quoted.*

Abies Pinsapo was introduced into Great Britain about the year 1839 by Captain Widdrington to whom Endlicher afterwards dedicated the South African genus of Coniferæ allied to Callitris and Frenela

* The African habitat given by Parlatore refers to *Abies numidica*.

under the name of Widdringtonia. It has now become one of the most generally cultivated of the European Abies, as it is also one of the most ornamental: the oldest trees up to the present time have for the most part retained their lowermost branches in health and vigour where sufficient space has been allowed for their development, which should not be less than a radius of 20 feet. It is quite hardy, and thrives in almost any soil not too wet and cold: it is especially suitable for chalk land on which it grows into a fine landscape tree; it is also one of the best of the Abies for the lawn and pleasure ground: it is rarely if ever subject to injury by late spring frosts owing to its being late in starting into growth. Several varieties have been noted, but none of them are of sufficient merit to require description. The variety *glauca* is attractive: the glaucescence, however, appears to be an accident caused by the soil in which the plant is growing: *Hammondi* described in the former edition is an abnormity due to the loss or removal of the leader shoot in the young state of the plant. Nothing is authentically recorded of the quality of the timber of *Abies Pinsapo*.

Abies religiosa.

A lofty tree 100—150 feet high with a trunk 5—6 feet in diameter, covered with ash or greyish brown bark broken into oblong plates by broad longitudinal and narrow transverse fissures which expose a reddish brown inner cortex. Branches spreading, slender in proportion to trunk and ramified distichously. Branchlets with light reddish brown bark, the herbaceous shoots hairy (hirtellous) and striated longitudinally. Buds sub-globose, about 0·35 inch in diameter, with light brown perular scales. Leaves persistent five—six years, linear, obtuse or sub-acute, often curved, 0·75—1·5 inch long, spirally arranged, those on the under side of the shoot pseudo-distichous in three—four ranks and more or less curved inwards, those on the upper side inclined forwards at a small angle to the axis, grooved along the midrib and dark green above, with two silvery grey stomatiferous bands below. Cones sessile, cylindric-oblong, slightly narrowed towards the apex, 4—6 inches long and 2—2·5 inches in diameter, dark violet-blue changing to dark brown when mature; scales broadly obovate, cuneate; bracts with a triangular, acuminate, recurved tip. Seed wings oblique obovate.*

Abies religiosa, Schlechtendal in Linnæa, V. 77 (1830). Carrière, Traité Conif. ed. II. 273. McNab in Proceed. R. Irish. Acad. II. ser. 2. 676. fig. 2. Hooker fil, Bot. Mag. t. 6753. Masters in Gard. Chron. XXIII. (1885), p. 56, with fig.; IX. ser. 3 (1891), p. 304, with fig.; Journ. Linn. Soc. XXII. 195; and Journ. R. Hort. Soc. XIV. 195. Beissner, Nadelholzk. 495.

A. hirtella, Lindley in Penny Cyclop I. 30 (1833).

Picea religiosa, Loudon, Arb. et Frut. Brit. IV. 2349, with fig. (1838). Gordon, Pinet. ed. II. 212.

Pinus religiosa, Humboldt, Bonpland and Kunth, Nov. Gen. et Sp. II. 5 (1815). Endlicher, Synops. Conif. 92. Parlatore, D. C. Prodr. XVI. 420.

Eng. Sacred Fir. Germ. Heilige Weisstanne. Mex. Oyamel.

Abies religiosa was discovered in 1799 by Humboldt, who saw it in two localities on the mountains near the city of Mexico at

* Branchlet with cone, communicated by Mr. Osborne, Gardener to the Right Hon. A. H. Smith Barry, Fota Island, Co. Cork.

about 4,000 feet altitude. It was afterwards seen in other places by botanical explorers of the country but always at a high elevation, on some of the mountains at the extreme verge of arborescent vegetation where it becomes dwarfed to a flat-headed bush.* It is now known to be widely distributed over the Mexican Cordilleras at altitudes ranging from 7,000 to 10,000 feet, occasionally descending to 4,000 feet, from the Sierra Madre southwards into Guatemala, where it was seen by Mr. G. Ure Skinner and after him by Dr. Seemann. *A. religiosa* is therefore the most southern species of the genus, and the only one found wild within the tropics. The inhabitants of Mexico use branches of it for the decoration of their churches and cemeteries, a custom which suggested the specific name *religiosa*.

The Mexican Sacred Fir was introduced in 1838 by the Horticultural Society of London through their collector, Theodor Hartweg, who met with it at Anganguca (not found on any map to which I have access), and afterwards in the Real del Monte district. The changeable climate of Great Britain is, however, unsuitable for it; the recurrence at intervals of exceptionally severe winters has proved fatal to it. In a few localities where the extremes of our climate are not experienced, as in Cornwall, the south of Ireland and some other places, *Abies religiosa* grows more or less vigorously, and at Fota Island near Cork it has attained the dimensions of a large tree.†

Abies sachalinensis.

A tree 100—125 feet high with a cylindric or slightly tapering trunk 2·5—3·5 feet in diameter covered with greyish bark, and at its best development of pyramidal outline with spreading or slightly ascending branches ramified distichously. Branchlets opposite, rarely alternate, with an occasional adventitious weaker shoot beneath the normal pair, the youngest shoots pubescent. Buds small, cylindric-conic with reddish brown perular scales. Leaves persistent five—seven years, narrowly linear, obtuse or emarginate, 0·5—1·5 inch long, spirally inserted, the longer ones on the under side of the branches and branchlets pseudo-distichous in three—four ranks; the shorter ones on the upper side pointing forwards at a small angle to the axis; on the fertile branchlets all more or less falcately curved upwards; bright lustrous green with a depressed median line above, with a glaucous stomatiferous band on each side of the thickened midrib beneath. Cones cylindric, slightly tapering towards the obtuse apex, 3 inches long and 1·25 inch in diameter; scales transversely oblong with an inflexed denticulate outer margin and attached to the axis by a broad cuneate claw; bracts longer than the scale, obovate acuminate, the acumen with the exserted part of the blade reflexed. Seed wings obovate truncate.

* By Deppe and Schiede on the mountains of Orizaba.

† The only specimens of *Abies religiosa* known to the author, besides the Fota Island tree, are at Kilmacurragh, Co. Wicklow; Menabilly, Cornwall; Castle Kennedy in Wigtownshire; and Ballamoor, Isle of Man (if still living), but there may be more. One of the finest specimens in the country, growing at Fota Island, was blown down by the fierce gale that occurred in the night of September 25th, 1896; it had attained a height of 70 feet.

Abies sachalinensis. Masters in Gard. Chron XII. (1879), p. 588 with fig.; Journ. Linn. Soc. XVIII. 517, with same fig.; and Journ. R. Hort. Soc. XIV. 195. Kent in Veitch's Manual, ed. I. 106, with fig. Mayr, Abiet. des Jap. Reiches, 42, Tafel III. fig. 6.

A. Veitchii var sachalinensis. Schmidt in Mém Acad St. Petersb. XII. ser. 7 176, t. 4, figs 13—17 (1868). Beissner, Nadelholzk. 461, with fig.

Eng. Saghalien Fir. Germ Sachalin Weistanne. Jap. Todo-matsu.

Abies sachalinensis was discovered by the German botanical traveller, Friedrich Schmidt, on the island of Saghalien in 1866, and subsequently described by him in the "Mémoires" of the Imperial

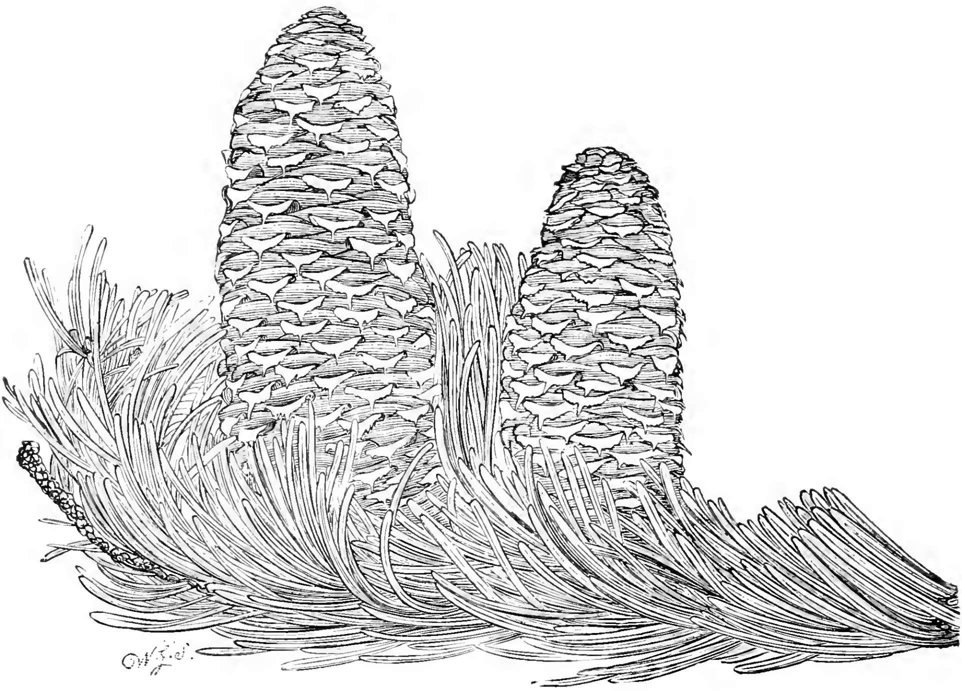


Fig. 138. Fertile branchlet with cones of *Abies sachalinensis*.
(From the *Gardeners' Chronicle*.)

Academy of Science of St. Petersburg as a variety of *Abies Veitchii*. Nothing further was known of it till it was re-discovered by Maries in 1878 in Yeso, the northern island of Japan, and by whom it was introduced in the following year. In northern Yeso it is believed to form pure forests of considerable extent; on the central mountains it occurs mixed with *Picea ajanensis* and *P. Glehnii*; and in the south which is much better known botanically, it is more or less scattered, but abundant and often mixed with deciduous trees. *A. sachalinensis* is thence a northern tree, enduring annually winters with which the most severe experienced in Great Britain will scarcely bear comparison. The wood is of fair quality, but only used locally for building and out-of-door carpentry.

Transplanted into the milder climate of Great Britain *Abies sachalinensis* has proved disappointing. In the south of England it begins to grow too early in the season, and the young shoots are occasionally destroyed by late spring frosts, an injury which the tree is unable to repair during the ensuing season, and after being crippled in this way a few times, it becomes a twiggy unshapely bush. Further north as at Scone Palace, Murthly Castle, and Ochtertyre in Perthshire, it is better acclimatised and the young trees have the handsome appearance they are reported to have in their native country; it also grows freely in Massachusetts, U.S.A. The nearest affinity of *A. sachalinensis* is *A. Veitchii*; so nearly related indeed are they that the claim of the first named to separate specific rank has been questioned; as seen in this country the distinctness of the one from the other is evident even on superficial inspection. The most obvious characters in which they differ may be thus noted:—*A. sachalinensis* is a larger tree with a denser habit and broader outline; the leaves are longer, narrower, less crowded and of a different shade of green than those of *A. Veitchii*; the cones are larger, less strictly cylindric, with the bracts more prominently exserted, and while growing, of a different colour. These differences seem, however, to be broken through in a variety discovered by Dr. Mayr in eastern Yeso (Osthokkaido), which has shorter and broader leaves and smaller cones with the bracts less prominently exserted than in the typical *A. sachalinensis*.* Professor Sargent mentions another variety with red bark, red wood and red cone-bracts discovered by Professor Miyabe near Sapporo.†

Abies sibirica.

A medium-sized tree, varying in height from 30 to 75 feet, usually with a pyramidal or spire-like crown. Trunk slender and covered with smooth greyish brown bark. Branches close-set and spreading horizontally, the lowermost often depressed; ramification lateral or pseudo-distichous.‡ Branchlets numerous, with smooth pale brown bark and densely clothed with foliage. Buds small, globose, with broadly ovate perular scale and usually covered with a film of whitish resin. Leaves persistent five—seven years, narrowly linear, obtuse or emarginate, 0·5—1 inch long, bright grass-green with a narrow median groove above, with a relatively broad keel and a narrow stomatiferous band on each side of it beneath; those on the upper side of the shoot erect or falcately curved forwards, those on the under side pseudo-distichous in three—four ranks; the leaves on the fertile branchlets stouter and more acute. Staminate flowers§ crowded near the apex of the shoots, globose-cylindric, 0·125 inch long, bright yellow tinged with red at the top and surrounded at the base by broadly oval involucral bracts in two series. Cones solitary or in approximate pairs, 2—3 inches

* Abietineen des Japanischen Reiches, 12. Tafel III.

† Forest Flora of Japan, 83.

‡ In the branchlets examined.

§ Communicated by Mr. Croucher from Ochtertyre, and Mr. McLagan from The Cairnies, Perthshire.

long and 1·25 inch in diameter, deep violet-blue changing to cinnamon-brown when mature; scales subtrapeziform, clawed, rounded and obscurely denticulate at the exposed margin: bracts half as long as the scales.

Abies sibirica. Ledebour. Fl. alt. IV. 202 (1833). Carrière, Traité Conif. ed. II. 302. McNab in Proceed. R. Irish Acad. II. ser. 2, 685. fig. 12. Beissner, Nadelholzk. 455. Masters in Journ. R. Hort. Soc. XIV. 195

A. pichta. Forbes, Pinet. Woburn, 113. t. 39 (1839). Willkomm, Forstl. Fl. ed. II. 107.

Picea pichta. London, Arb. et Frut. Brit. IV. 2338 (1838). Gordon. Pinet. ed. II. 221.

Pinus sibirica, Parlatore, D. C. Prodr. XVI. 425 (1868).

P. pichta. Endlicher. Synops. Conif. 108 (1847).

Eng. Siberian Silver Fir. Fr. Sapin de la Sibérie. Germ. Sibirische Weisstanne. Ital. Abete della Siberia. Russ. Pichta.

Abies sibirica is the most northern species of the genus, in places spreading as far as the sixty-sixth parallel of north latitude where it is dwarfed to a stunted unshapely bush. It is also distributed over a greater geographical area than any other Abies; from its western limit in north-east Russia, in the Government of Archangel, it spreads eastwards through Siberia to Kamtschatka and the Amur region frequently associated with *Picea obovata*, *Pinus sylvestris* and *Larix dahurica*, and forming with them the most extensive coniferous forest on the eastern continent. On the Altai mountains it ascends to 5,000 feet above sea-level, forming immense forests between 3,000 and 4,000 feet. The climate of this region is one of the coldest known, the thermometer registering many degrees of frost below zero (Fahr.) every winter; the seasons too are sharply defined, there being scarcely any spring or autumn to mark the transition from winter to summer and *vice versâ*. In such a climate the Siberian Silver Fir is of the highest economic value to the inhabitants, not only for fuel but for all kinds of constructive purposes, although in quality its wood is inferior to that of the European species, *A. pectinata*. Those who have seen *A. sibirica* at its best development describe it as a more slender and more graceful tree than the Common Silver Fir, and its foliage of a more pleasing shade of green.

Abies sibirica was introduced into Great Britain about the year 1820, but it has failed to adapt itself to our milder climate, and good specimens south of the highlands of Scotland are unknown. In the colder climate of north and east Germany and Scandinavia it is muc cultivated as an ornamental tree, taking the place of those Silver Firs that cannot withstand the severe winters of northern Europe, but it grows slowly, and takes the form of a slender tree with a narrowly pyramidal outline clothed with foliage of the brightest green. Two varieties have been noted: *alba* (Fischer) from the higher slopes of the Altai mountains, with longer leaves that are more glaucous on the under side; and *elegans* (Beissner) with shorter and stouter leaves and of compact Araucaria-like habit.

Abies Veitchii.

A slender tree with an average height of 60—70 feet, but sometimes attaining a height of upwards of 90 feet. Bark of trunk greyish white and smooth even in old age. Branches spreading or slightly ascending; ramification distichous and opposite with an occasional adventitious weaker shoot above or beneath the normal pair. Buds ovoid-cylindric, 0·2—0·35 inch long, with dark chestnut-brown perular scales. Leaves spirally crowded, persistent four—five years, narrowly linear, emarginate or obtuse, bright grass-green with a median groove on the upper face, with a relatively broad silvery white stomatiferous band on each side of the midrib beneath, 0·5—1·25 inch long; the longer leaves on the under side pseudo-distichous in three—four ranks, the shorter ones on the upper side loosely imbricated and pointing forwards at an angle of about 45° to the axis; on the fertile branches all more or less upturned. Staminate flowers "about 0·25 inch long

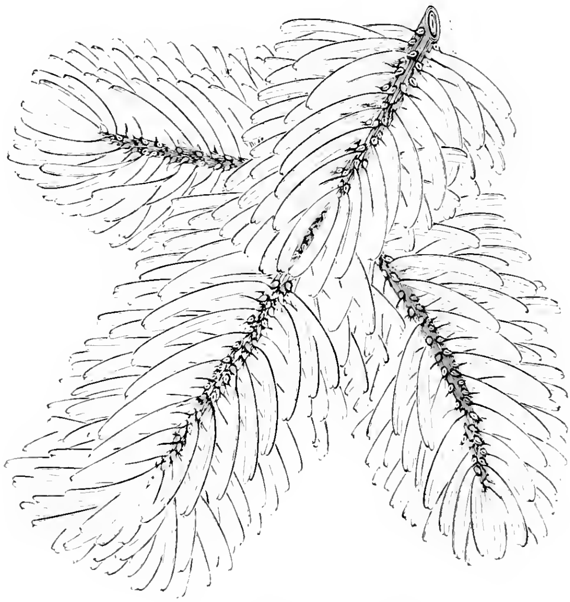


Fig. 139. Foliage of *Abies Veitchii*.

raised on a stipes of equal length emerging from a scaly bud; anthers stalked, connective developed into a saddle-shaped flap from the back of which projects a spur-like process.* Cones sub-cylindric, obtuse, 2·25—2·5 inches long and 0·75—1 inch in diameter, dark violet-blue changing to brown when mature; scales closely imbricated, semilunate, broader than long and attached to the axis by a short cuneate claw; bracts as long as, or a little longer than the scales, wedge-shaped at the base, dilated above into a subquadrate blade truncate at the apex, and with a small mucro that sometimes projects beyond the scale and is bent downwards.

* Masters in Gardeners' Chronicle, XIII. (1880), p. 275.

Abies Veitchii, Lindley in Gard. Chron. 1861, p. 23. Murray, Pines and Firs of Japan, 39, with figs. (1863). Carrière, Traité Conif. ed. II. 307. McNab in Proceed. R. Irish Acad. II. ser. 2., 686, fig. 13. Masters in Gard. Chron. XIII. (1880), p. 275, with fig.; Journ. Linn. Soc. XVIII. 515, t. 20; and Journ. R. Hort. Soc. XIV. 196. Beissner, Nadelholzk. 457, with fig. Mayr, Abiet. des Jap. Reiches, 38, Tafel II. fig. 4.

A. nephrolepis, Maximowicz in Bull. Acad. Imp. St. Petersb. X. 186 (1866).

Picea Veitchii, Gordon, Pinet. ed. II. 226 (1875).

Pinus selenolepis, Parlatore, D. C. Prodr. XVI. 427 (1868).

Eng. Veitch's Silver Fir. Germ. Veitch's Weisstanne. Jap. Shira-biso Riu-sen.

Abies Veitchii is an alpine tree rarely descending below 5,000 feet elevation; it occurs on all the higher mountains of central Japan from Sikoku northwards to about 39° N. lat. north of which it has not been seen; it forms in some places pure forests of considerable extent; in others it is mixed with *Picea ajanensis*, *P. polita*, or *Tsuga diversifolia*. If the *A. nephrolepis* of Maximowicz rightly belongs to this species, it is also common on the mainland of Manchuria in the neighbourhood of the coast.

Dr. Mayr distinguishes two forms of *Abies Veitchii*; the type, in which the apical end of the cone-bract is exserted and bent downwards, and the Nikko variety, a local form with smaller cones, the cone-bracts of which do not protrude beyond the scale.* The typical form was discovered in 1860 on Fuji-yama by the late John Gould Veitch after whom it was named by Dr. Lindley. Dr. Mayr observed that about every third year this Fir produces abundance of cones whilst in the intervening years cones are scarce, which may account for the failure of Mr. Veitch to procure seeds. In 1879 Maries was more successful, and young plants were subsequently widely distributed.

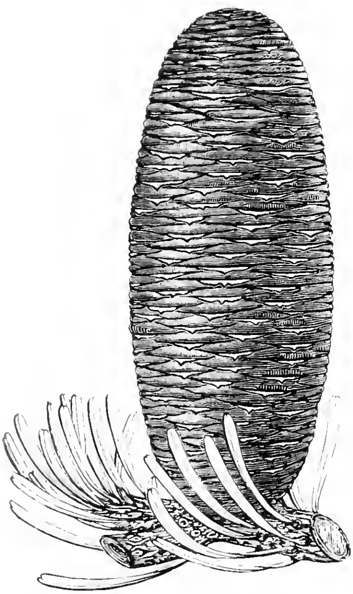


Fig. 140. Cone of *Abies Veitchii*.

In Great Britain *Abies Veitchii* has proved hardy and is growing freely in many soils and situations; its slender habit, its bright green and white foliage, and its beautiful cones which are in this country also produced freely in some years even on young trees,† render it an ornamental tree for the lawn and for places where the larger Abies are unsuitable. It is also hardy in the north-eastern States of America where it was in cultivation under the unpublished name of *Abies japonica* some years previous to its introduction into Europe, and where it is looked upon as "an exceedingly beautiful tree in its young state."‡

* Abietineen des Japanischen Reiches, p. 39.

† Sometimes, indeed, too freely, and if the superabundant cones are not picked off, the tree perishes from excessive fertility.

‡ Garden and Forest, Vol. X. p. 511.

John Gould Veitch (1839—1870) was born at Exeter. He was at an early age initiated in the working of the nursery business, and took an active part in the management of the Veitchian establishment after its removal to Chelsea in 1853, at that time rapidly acquiring celebrity chiefly through the introduction of new plants, a celebrity he was determined to maintain, and if possible to enhance. He had scarcely attained his majority when an opportunity offered itself by the opening of the ports of Japan to foreigners, and in April, 1860, he started on a voyage to the Far East, arriving at Nagasaki in July following. He remained in Japan about a year, collecting plants previously unknown in British gardens. Attached to the suite of Sir Rutherford Alcock, the British Envoy to Japan, he was enabled to make the ascent of Fuji yama; he was therefore one of the first Europeans who reached the summit of the "sacred" mountain of the Japanese. After dispatching his collections to Europe he proceeded to the Philippine Islands on a similar mission, but with the especial object of obtaining plants of the beautiful Phalænopses, natives of the islands, and which were at that period extremely rare in European gardens; a mission which proved successful The result of the voyage to Japan was the enrichment of European gardens with many choice coniferous trees, several beautiful evergreen and deciduous shrubs, and herbaceous and other plants; the first named are sufficiently noticed in the preceding pages; among the latter especial mention should be made of several beautiful varieties of *Acer palmatum*, *Ampelopsis tricuspidata* (syn. *A. Veitchii*), *Lilium auratum*, *Primula japonica* and *P. cortusoides*. The spirit of enterprise and the desire of making further discoveries induced him again to undertake a long voyage to the East, and in 1864 he set out for Australia and the South Sea Islands, returning to England in February, 1866. Among the most enduring results of the second voyage was the introduction of many richly coloured Crotons and Dracænas (varieties of Codiæum and Cordyline), the forerunners of the handsome races now so constantly in request for decorative purposes; also the beautiful *Pandanus Veitchii*, the elegant *Aralia Veitchii* and other stove plants of great merit In the early part of 1867 he was taken seriously ill with an affection of the lungs from which, however, under careful treatment he rallied for a time, but in August, 1870, hæmorrhage of the lungs set in, from which he died shortly afterwards at the early age of thirty-one.

Abies Webbiana.

A large tree 120—150 feet high, the trunk having a girth of 9—15 feet near the ground. Bark of old trees dark or brownish grey fissured into long narrow scales by deep grooves often running in spirals around the trunk and anastomosing at right angles. Branches short, spreading nearly horizontally and forming a tall, narrow, cylindric crown.* In Great Britain, at its best development, a stately tree with a rather broadly conical outline, the trunk four or more feet in diameter near the ground, gradually tapering upwards and covered with rugged, irregularly fissured, greyish bark, often with a concavity immediately below the insertion of the primary branches which are stout, spreading or slightly ascending. Branchlets distichous and opposite with reddish brown bark, the latest formed hairy (sub-hirsute) and fluted obliquely by cortical outgrowth decurrent from the pulvini of the leaves. Buds ovoid-conic with orange-brown perulæ. Leaves persistent seven—nine years, spirally arranged around their axes, linear, emarginate; bidendate at the apex on the fertile branches, 1—2·5 inches long, decurved or straight; dark lustrous green with a narrow median groove above; with thickened midrib and margins, and with two silvery stomatiferous bands beneath; the longer leaves on the under side pseudo-distichous in three—four ranks, the shorter ones on the upper side erect or inclined forwards. Staminate flowers globose-cylindric, 0·75 inch long, surrounded at the base by broadly

* Brandis, Forest Flora of North-west India, p. 529.

oval-oblong involucral bracts in three series. Cones among the largest and handsomest in the genus, shortly stalked cylindric, obtuse, 6–8 inches long and 2–3 inches in diameter, deep violet-blue changing to dark brown when mature; scales obovoid-rhombic suddenly contracted to a short claw, the outer margin entire or obscurely crenulate; bracts linear-spathulate, mucronate, three-fourths as long as the scale. Seed wings obliquely oblong, truncate, nearly as long as the scale. Wood whitish, inodorous, open-grained and soft, and not durable when exposed to the weather.*

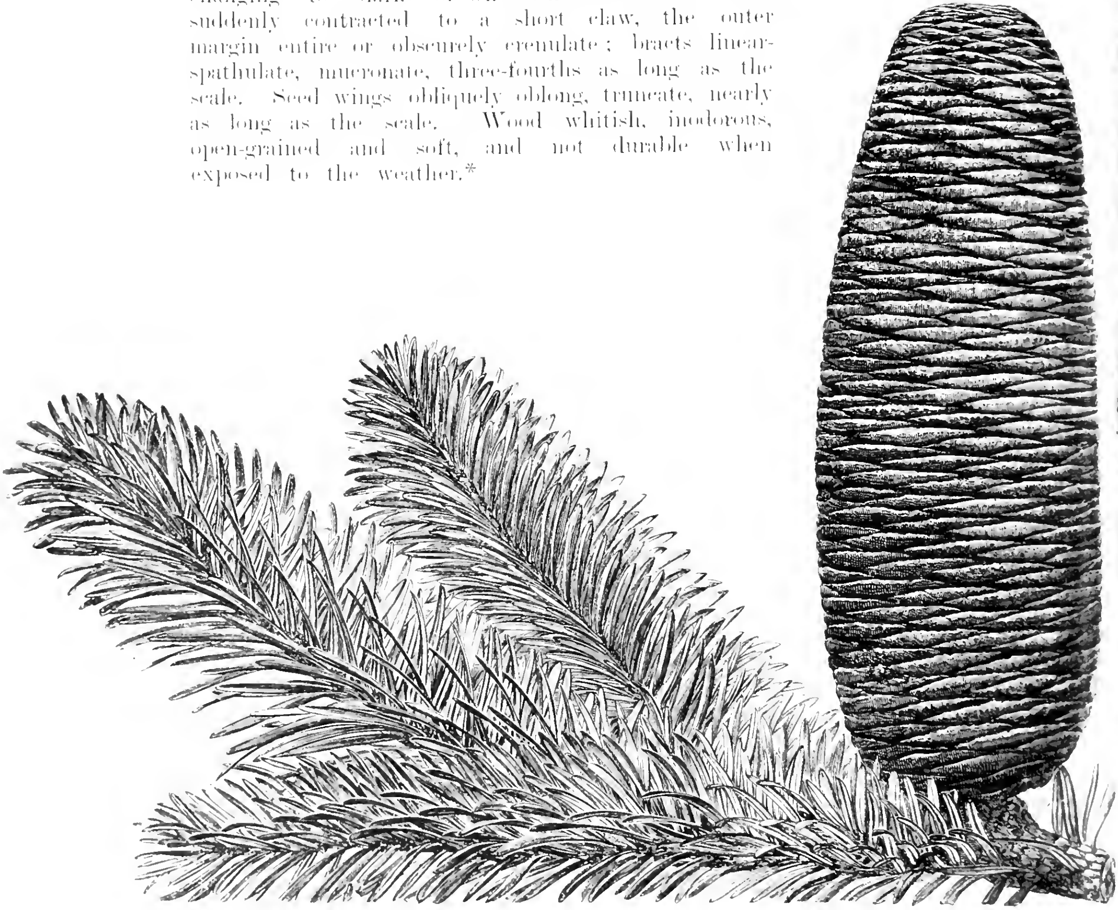


Fig. 141. Fertile branchlet with cone of *Abies Webbiana* (reduced).

Abies Webbiana, Lindley in Penny Cycl. I. 30 (1833). Forbes, Pinet. Woburn, 117. t. 41. (1839). Link in Linnæa, XV. 532 (1841). Carrière, Traité Conif. ed. II. 300. Brandis, Forest Fl. N.W. India, 528. McNab in Proceed. R. Irish Acad. II. ser. 2. fig. 18. Aitchison in Journ. Linn. Soc. XVIII. 98. Hooker fil. Fl. Brit. Ind. V. 654. Beissner, Nadelholzk. 179. with fig. Masters in Gard. Chron. XXII. (1884), p. 167. with fig.; and Journ. R. Hort. Soc. XIV. 196.

Picea Webbiana, Loudon, Arb. et Frut. Brit. IV. 2341, with figs. (1838). Madden in Journ. Hort. Soc. Lond. V. 251 (1850). Gordon, Pinet. ed. II. 226.

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Eng. Indian Silver Fir. Fr. Sapin d'Himalaya. Germ. Webb's Weisstanne.

* Brandis, "Forest Flora of North-west India," *loc. cit.*

Abies Webbiana is one of the most widely distributed of the Himalayan Abietineae; its western limit is in north Afghanistan, whence it spreads eastwards to the upper Indus and through Nepal to Bhotan. Its vertical range in Afghanistan and Kafristan is between 7,000 and 9,000 feet; further eastwards on the central Himalaya it ascends to 12,000 feet, and occasionally descends to 5,000 feet; in the north-west it forms extensive pure forests; east of the Indus it is commonly mixed with Acers and other broad-leaved trees; in places it is associated with *Pinus excelsa* and *Picea Smithiana*, and in Sikkim with *Tsuga Brunoniana* and Rhododendrons. As seen at a distance, the foliage looks almost black whence the name of Black Forest has been locally given to large stretches of this Fir, just as the common Silver Fir has given rise to the same name to a district in southern Germany formerly covered with it. The economic value of *Abies Webbiana* is by no means inconsiderable to the inhabitants of the higher Himalaya although the wood is of inferior quality.

Abies Webbiana was introduced into Great Britain by Dr. Wallich, for many years Director of the Botanic Garden at Calcutta; he repeatedly sent seeds to Mr. Lambert and others, but none appear to have germinated till about the year 1822 when some plants were raised in the nursery of Messrs. Whitley and Osborne at Fulham.* Although *Abies Webbiana* occurs at a higher elevation with a colder climate than *A. Pindrow*, its cultivation in this country has not been attended with any better results. On the Himalaya at the altitude at which *A. Webbiana* attains its greatest development the climate is constant; the winter snows fall upon the forests with a regularity unknown in Great Britain and have the same duration year after year. To this cause may probably be assigned the frequent failure of *Abies Webbiana*: it begins to grow early in spring, and this early growth is often cut off by frosts later in the season—an injury the tree is unable to repair in the same season. Where sufficiently protected from these late frosts, it is one of the most beautiful of the Abies, evidence of which is afforded by specimens dispersed throughout the country, notably at Bicton and Upcott in Devonshire; Tandridge Court in Surrey; Hewell Grange, Worcestershire; Howick Hall, Northumberland; Castle Kennedy, Wigtownshire; Whittinghame in East Lothian; Keir House in Perthshire; Torloisk in the Isle of Mull; at Fota Island near Cork; Powerscourt, Wicklow; and Courtown, Wexford.

The species was named in compliment to Captain W. S. Webb, an officer in the service of the East India Company, "a distinguished traveller and zealous investigator of Natural History," who first discovered it in the early part of the nineteenth century.

* Loudon, Arboretum et Fruticetum Britannicum, IV. 2345.

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INDEX I.

MISCELLANEOUS SUBJECTS.

INDEX II.

GENERA AND SPECIES
(Nomina systematica).

Names in italics are synonyms.

INDEX III.

VERNACULAR AND COMMON NAMES
(Nomina trivialia).

CORRIGENDA.

Page 46	In line	14 from bottom	—For Figs. 30 and 31, read Figs. 32 and 33.
,, 143	,,	17 from top	For Wildenow,
,, 172	,,	13 from top	read
,, 343	,,	12 from bottom	Willdenow.
,, 275	,,	23 from bottom	—For Seeman read Seemann.
,, 425	,,	24 from top	—For Fisher, read Fischer.

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