# TREES

AND THEIR LIFE HISTORIES

SILVER BIRCH—*BETULA ALBA:* SUMMER.

# TREES AND THEIR LIFE HISTORIES

BY

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# PREFACE

In this book I have endeavoured to consider the tree, not as a mere object to be identified, but as a living being whose struggling life is to be watched, whose wants are to be studied, and whose changing lineaments are to be observed. And I have sought rather to guide the interested observer of Nature than to attract the book-lover, and rather to concentrate the reader's attention on the tree itself than to lure him from the woodland to his book-room.

The explanatory Introduction will be found useful to those unacquainted with botany, but superfluous to others. Every pursuit must have its own technology to ensure accuracy, but throughout this work I have reduced technical terms to a minimum.

Analytical tables, diagnoses of families, and numerous illustrations will enable the reader to identify the various trees, and certainty in this respect is quickly ensured by the brief mention of distinctive features that is prefixed to the account of every tree described.

But the accounts of the various trees are not mere descriptions of the forms of these, nor are they alike in nature and scope. Particular trees have been selected for more detailed discussion, so as to serve as types by which to demonstrate certain structural features or general phenomena observable in tree-life. For example, branching of the tree is specially illustrated by the Scots Pine, Larch, Yew, Horse Chestnut, and others; branching of a shrub and weeping tree, by the Elder and Laburnum; the repair of injuries, by the Scots Pine; the attacks of Bark Beetles, by the Elm; the deformation of diseased shoots, by the Spruce and Birch; the habits and behaviour of a shade-enduring tree, by the Beech; the shape and conduct of a light-demanding tree, by the Larch and Birch; the degeneration of flowers, by the Sweet Chestnut and Ash; the evolution of sexuality, by the Maples, Horse Chestnut, and Ash; the part played by insects in fertilisation, by the Horse Chestnut, Laburnum, Guelder Rose, and others; versatility is exemplified by the Juniper and Mountain Ash; variability of form and action, by the Common Spruce; and so forth. By this analytical method I have attempted, not only to add interest to the study of each tree, but also to enable the reader ultimately to combine all the different points of view in connection with any particular tree that he may wish to study. If the reader, then, have only a solitary tree available for constant examination, he will find in it sufficient material for years of observation, interest, and—discovery.

That this book will thus incite some of its readers to enrich our knowledge of tree-life is the hope of the author.

PERCY GROOM.

CHELSEA PHYSIC GARDEN.

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# TREES AND THEIR LIFE HISTORIES

Fig. 1.—Under the Beeches.

## INTRODUCTION

### I.—ACTIVITY OF THE TREE

So gradual is the growth and so hidden from casual inspection are the various forms of activity of the tree, either in its summer garb of foliage or in its winter nudity, that one is apt to forget the rapid unfolding of the leaves in spring, the sudden outburst of blossom, or the sprouting of countless seedlings, and thus to regard the tree as akin to an inert stone rather than to an active animal. Yet the tree is a living being which breathes, feeds, grows, moves spontaneously, reproduces its kind, and provides protection as well as nourishment for its offspring. Its seeming quiescence or dull, slow working is illusory, and masks unceasing activity.

But in other respects the tree presents a deceptive appearance. Lashed by wind and bereft of its branches, or uprooted by storm; robbed of its foliage by countless insect foes, by frost, or by drought; sickening under insidious fungal attack that is

Fig. 2.—Young Beeches.

revealed in rotting boughs or disease-infested twigs, the tree seems but a helpless victim doomed to fall at the relentless hands of animate or inanimate Nature. Yet its apparent helplessness conceals a faculty of defence that, within limits, is as unerring as it is unconscious. The tree has a policy to pursue in reference to its surroundings, and to these it has a marvellous power of adjusting itself either during the life-time of one individual, or in the course of ages. The nature of its struggles will be recounted in connection with the life-histories of the different trees described, but here we may illustrate the point by mere allusion to the modes in which a tree rooted in sand pushes the main root rapidly down to the depths where water lies, but on rock or ruin spreads out shallow lateral roots which penetrate crevices, and perhaps cleave rock or ruin asunder; or to the manner in which a tree whose stem-tip is injured repairs the damage by forcing its upmost branch or bud to grow erect, and thus stretches towards the light that it needs; or how the tree sacrifices and sheds the old branches, when once they have become too overshadowed to be of service; and conversely how it shoots forth numerous branches from old parts of the stem, when these are exposed to stronger light, or when new branches are required to replace old ones that have been

**Faculty of Defence.**

Fig. 3.—Young Beeches.

Fig. 4.—IVY ON SCOTS PINE.

Fig. 5.—Drooping Wych Elm.

destroyed by mishap; or finally how the tree ravaged by foe, or perhaps nearly dying of thirst, may burst into a marvellous blaze of blossom as if in one despairing effort to preserve the race by the sacrifice of its own life. All these illustrations convey the truth that the individual tree has a remarkable power of adjusting itself to the outside world, and that, within the limits of its powers, it seems to possess the still more remarkable faculty of inevitably doing the right thing — a faculty of which man's reasoning power has robbed him.

**Hostile Forces.**

But the powers of a tree are not infinite; frost, heat, or drought may cause leaves and buds to wither, or stems to crack and thus admit deadly fungal foes; animals or fungi injure the roots; or shade may destroy the whole plant. To these and other hostile forces different kinds of trees show different powers of resistance, and have become adapted in the course of ages to live in diverse situations. In every forest may be seen examples of the truth of these statements, especially in reference to one external agent, light, to obtain which forest-plants are engaged in unending warfare in which millions of humble herbs, infant trees, or tall striplings, perish under the lethal shade of more successful rivals. Some trees have fitted themselves for the warfare by acquiring the faculty of successfully withstanding a considerable amount of shade, and are said to be *shade-enduring*. And it is instructive to observe how the shade-enduring young Beech-tree grows upwards slowly, but spreads its deadly shade over its young rivals (*see* p. 2; Figs. 2 and 3). Certain other trees cannot withstand much shade, and are therefore described as *light-demanding*.

These when young often shoot swiftly upwards, produce but little shade, and soon cast off their lower branches.*

**Degeneration.** Trees have not only advanced in complexity and developed elaborate structural devices fitting them for existence in special situations, but they have in some cases retrograded by reducing certain of their parts that have become useless or a source of danger; such reduced parts are said to be *degenerate*. Large leaves possessed by the ancestral tree may dwindle to scales in the descendant; long, leafy branches to short scaly spines; gay blossom to dingy inconspicuous flowers; or winged seeds to wingless seeds.

**Regularity of Growth.** Irregular as may be the shape of a tree, its form is determined by growth as ordered and orderly as that of any animal; but its regularity of design is obscured or obliterated by two circumstances. First, the tree grows year after year throughout life, and preserves certain of its parts in a permanently juvenile condition: a British tree, in the strict sense, is never full grown. Secondly, the tree has the power of bringing into activity some of these perennially young parts, and of thus replacing missing members or creating new limbs. Its irregular shape is not the result of disordered growth, but of irregular experiences and demands. The tree is like a warrior who has been maimed and scarred in many a battle, but has the magic power of replacing lost limbs by others springing from different predestined parts of his body.

* It must not be forgotten that all trees demand a certain amount of light, that each flourishes in a given situation only between certain limits of darkness and light, and finally that increased shade often involves more moisture while increased light often implies greater expenditure of water. Hence the terms *light-demanding* and *shade-enduring* are vague and partly misleading; but practical forestry in Europe justifies their use.


Fig. 6.—Holm Oak.

Very simple, probably degenerate, male (♂) and female (♀) flowers and inflorescences.

Fig. 7.—Common Elm: shoot.

Fig. 8.—Wych Elm: shoot.

## II.—NOURISHMENT OF THE TREE

An animal compared with a green plant is an epicure demanding elaborate food in the form of starch, sugar, or fat, and albuminous substance; the tree is an ascetic, for, although ultimately needing these same elaborate substances, it can obtain and manufacture them from simple ingredients contained in the soil, water, and atmosphere.

**Nature of Forest Soil.**

Forest soil in which the roots lie is not, however, simple in composition, nor is it a mere cumulus of corpses and mineral matter, but is rather a world seething with life. It is permeated by countless fungal threads, occupied by inconceivable myriads of micro-organisms, and burrowed by many subterranean animals, including earthworms. All these play a part in building up forests which, indeed, cannot exist in their absence. Under their influence dead fallen leaves and stems, and animal products, are converted into food-material for the trees, while the soil is rendered permeable so that air can penetrate and moisture percolate without stagnating. Were merely the earthworms to be removed the forest would vanish, and in its place stunted heath would reign. Or were the air to be driven out of the soil by permanent inundation, then the forest would give way to mossy, reedy, or grassy bog and fen.

**Absorption of Water.**

The *roots* not only fix and support the tree firmly, but they also *absorb from the soil water and substances dissolved in it.* When the soil is cold this absorption is retarded or stopped, and such is the condition of affairs during our winter.

The raw sap thus obtained is carried up the outer wood of the stem to the growing parts and green leaves. From these a small part of the water exudes in the form of drops, but a vastly greater part is exhaled as water-vapour.

This latter process of evaporation is termed *transpiration;* and it is important to note that *the greatest loss of water takes place through the green leaves*, so that when these are shed, the tree is not expending much water. Loss of water by transpiration is increased by larger number or size of leaves, by heat, dryness of air, wind, and by light. Yet transpiration can continue, however cold the weather or climate, even when the roots are not absorbing. And it is, at least, partly for this reason that our trees shed their foliage before winter; or if the leaves be retained as in Firs, they are thick-skinned and tough, and transpire slowly.

**Transpiration.**

But *green leaves* have another duty to fulfil. In the presence of light they *absorb carbonic acid gas* from the atmosphere, and split this into oxygen and carbon. The oxygen is released as a gas, and goes to enrich the atmosphere; but the carbon is retained, and combines with the water and raw material obtained through the roots. In this way *elaborate food is manufactured by the green leaves*, whence it is transported to growing twigs, flowers, and fruits, to thickening stems and subterranean roots, in all of which it is utilised in building up the tree, or is stored for future consumption. Destruction of the leaves of a tree, therefore, involves a loss of power to produce appropriate food-material, and threatens the

**Green Leaves as Factories of Food.**

Fig. 9.—Knee-roots of Marsh Cypress.

tree with starvation. How this danger is averted will be seen in the sequel.

The greater number of green leaves that a tree acquires, the more food does it manufacture, and the more water does it expend. Consequently increase in the foliage and branches demands a corresponding increase in the size of the root-system to supply the larger demand for water and raw material, as well as to support the additional weight, and to withstand the force of the wind now acting on a larger and taller surface.

But the tree accomplishes yet another gaseous interchange with the atmosphere:

**Respiration.**

it breathes, taking in oxygen and giving out carbonic acid. This process of *respiration* proceeds in light and darkness, by day or night, and not only in the green leaves but in all living parts of the tree. Just like a human being, the tree requires oxygen. This is well brought out when we note the behaviour of the Marsh Cypress whose roots are sunk in a water-logged soil from which the free air has been expelled. Such roots would seem to be exposed to the danger of suffocation. But the tree sends up from shallow horizontal roots knee-like roots (Figs. 9, 146–7, and 149), which act as lungs by taking in air (with oxygen), and conveying it to the parts lying in the mud.

A tree, therefore, requires air, water, food-material in the soil, sunlight, and—it may be added—an appropriate temperature. Excesses of heat or cold, of drought or humidity, of shade or sunlight, or over-abundance of certain substances (common salt, lime) injure or kill the tree.

## III.—ROOT SYSTEM

The root of the infant plant inside a seed is usually represented by a single short rod —the *main root*—which subsequently elongates solely by growth at its tip, and tends to descend vertically. From its sides, not far behind the tip, spring root-branches—the *lateral roots*—which grow and branch in like manner, but tend to spread out horizontally or descend obliquely. All these roots thicken in their older parts, but are thin at their constantly young ends. The thin parts alone absorb water.

Some kinds of trees are *deep-rooted* and

**Deep and Shallow Roots.**

even unable to adapt themselves to shallow soils, or, if compelled to grow on these, are readily uprooted by wind and may develop feebly for lack of water. Other kinds of trees are *shallow-rooted*, emitting long, horizontal, lateral roots which enable them to thrive even on rocky soil. But each individual tree more or less adjusts the form of its root-system to the nature and depth of soil in which it finds itself.

The stems of some trees, such as the Sweet Chestnut and Spruce, have the power of emitting roots; indeed certain trees, including Willows and the Lombardy Poplar (Figs. 10 and 11), are mainly propagated by shoots in the form of cuttings.

Conversely the roots of the Black Poplar, Common Elm, and some other trees, manufacture and send out of the soil erect leaf-bearing shoots which are known as *suckers*. Such trees may be propagated by root-cuttings.

## IV.—SHOOT SYSTEM

A simple *shoot* consists of a *stem* and lateral appendages, known as *leaves*. The stem, like the root, elongates by growth at its tip, where it produces new leaves; it therefore ends in a *bud* which consists of a short young stem bearing crowded young leaves.

In most cases a stem (Figs. 12 and 13) shows leafless bare parts—the *internodes*—

Fig. 10.—Lombardy Poplar, in Winter.

Fig. 11. Lombardy Poplar, in Summer.

**Fig. 12. Common Maple.**
**Shoot with opposite leaves.**

connecting the leaf-bearing parts—the *nodes*—which are sometimes joint-like or swollen (Fig. 488). But in many Firs the leaves succeed one another at such short distances that there are no distinct internodes (Figs. 119 and 120).

**Leaf Arrangement.**

Green leaves are not arranged irregularly round the stem. This is very evident if we examine a Maple (Fig. 12), which has two leaves at each node. These are on directly opposite sides of the stem, and are succeeded (above or below) at the next node by two leaves standing at right angles above (or below) the middle of the gaps between them. Such a *leaf-arrangement* is described as *opposite*, and the leaves at the successive nodes are said to alternate with one another. It will be noted that with two leaves at a node there are four ranks of leaves along the stem (*e.g.*, Maples, Ash, Horse Chestnut). The two (or more) leaves inserted at one node constitute a *whorl*, and when more than two leaves occur at a node, the arrangement is said to be *whorled*. Even when there is only one leaf at each node the leaves are not arranged irregularly, but form a spiral, so that there may be two, three, five, or more ranks of leaves along the stem; this *leaf-arrangement* is said to be *alternate* or *spiral* (*e.g.*, Hazel, Willow, Oak, Apple). Observations on the leaf-arrangement often aid us in distinguishing between trees of somewhat similar foliage; the Plane (Fig. 326) and Mountain Ash (Fig. 454), with alternate leaves, are thus respectively distinguished from the Sycamore (Fig. 349), or Maples (Figs. 12 and 354), and Ash (Fig. 494), with opposite leaves.

**Lateral Buds.**

The stem, in addition to ending in a bud, which is the *terminal* in position, also bears *lateral* buds. Each ordinary lateral bud stands in the upper angle between the stem and leaf; this upper angle is termed the *axil* of the leaf, and the lateral bud is said to be

**Fig. 13.—Lombardy Poplar.**
**Shoot, showing alternate leaves and axillary buds.**

*axillary*. In broad-leaved (dicotylous) trees in the axil of most of the foliage-leaves stands a bud; and, as such a bud may remain attached and living for many years, though in a resting condition, the tree possesses numerous buds capable of shooting out when occasion arises. In most conifers a considerable number of the green leaves have no buds in their axils, and it is partly for this reason that coniferous trees usually exhibit a smaller power of replacing leaves or shoots which have been destroyed. But many trees are endowed with the power of producing new buds on old stems or roots, and of thus atoning for any lack of long-lived axillary buds: in this respect, too, conifers are generally less capable than broad-leaved (dicotylous) trees.

## V.—LEAVES

### I.—FOLIAGE-LEAVES

A complete green leaf has three distinct parts: (1) Leaf-base, (2) Leaf-stalk, (3) Leaf-blade.

**Leaf-base and Stipules.**

The *leaf-base* attaches the leaf to the stem, and often bears at its sides two flat outgrowths known as *stipules* (Figs. 14 and 24–6). As the stipules often serve merely to protect the delicate young parts of the bud, they usually shrivel or fall off shortly after the leaf bearing them has expanded (Fig. 15). Hence, in examining a leaf to see if it be really stipule-bearing, one must always remember to be prepared for the presence of scars left by fallen stipules. Sheathing tubular stipules embracing the stem are possessed by the Plane, which also completely conceals its lateral buds within the hollowed base of the leaf-stalk (Fig. 325). Protection of another kind is provided by the stipules of *Robinia*, which are converted into hard woody spines (Fig. 410) that persist, and apparently serve as weapons of defence against browsing animals. The large green leaf-like stipules of the Hawthorn (Fig. 479) persist for an entirely different reason, namely because they perform the offices of green leaf-blades. In some cases the leaf has neither leaf-stalk nor leaf-blade, but is reduced to its two stipules, which then

Fig. 14.—Tulip-tree.
Opening buds, showing the separation of the stipules.

Fig. 15.—Tulip-tree.
Bud protected by stipules; the stipules of the expanded leaves have fallen.

form paired scales protecting the resting-buds.

On the contrary, the leaves of some trees (Sycamore, Ash), in place of being *stipulate* (stipule-bearing) never produce stipules. The presence or lack of stipules often enables us to distinguish between trees whose foliage is more or less alike—for instance, between the Plane and Maples, or the Ash and Mountain Ash.

In some cases the stem is raised up into a ridge or swelling (*leaf-cushion*) where each leaf is attached, *e.g.*, Ash, Spruce.

**Leaf-stalk.**

The *leaf-stalk* merely serves to thrust the leaf-blade into its correct position and pose in relation to the light, so that it is sometimes wanting. The mode in which the leaf-stalk regulates the exact pose of the leaf by adjusting its length, direction, or by executing a twist, can be fully realised only by examining the leaves on the tree itself. But in this connection attention may be drawn to one special case, that of many conifers whose spirally-arranged, flat, narrow leaves are twisted on the branches so as to assume a double comb-like arrangement (Figs. 61 and 118).

**Leaf-blade.**

The *leaf-blade* is the part that is mainly responsible for the absorbing and manufacturing activity of the leaf. Its skin is perforated by many microscopic pores—the *stomata*—whose position is sometimes visible to the naked eye, because white wax coats the stoma-bearing part of the leaf, and that part only (Figs. 61 and 118).

The leaf-blade is usually flattened, and more or less broad in dicotylous (broad-leaved) trees, but is needle-like, or only slightly broader (*linear*), in Fir-trees and most other conifers (Figs. 61 and 62).

In the former type of blade the veining is net-like, as the finest veins unite to form a network. The chief veins, however, vary

Fig. 16.—Pinnately-veined Leaves of the Medlar-tree.

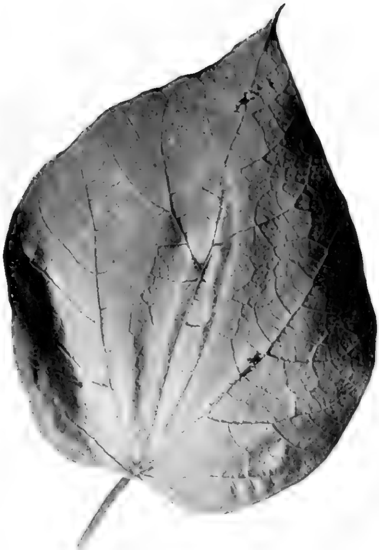


Fig. 17.—Palmately-veined Leaf of the *Catalpa bignonioides* (Walt.).

in their arrangement. In most cases only a single median vein or nerve—the *mid-rib*—runs from the base to the tip of the blade, and from its sides lateral veins are given off right and left (Figs. 15 and 16); such veining is *pinnate*. But the leaf-blade of the Sycamore, Maples, or Plane, shows several chief veins radiating from its base, and the veining is *palmate* (Fig. 17).

**Veining.**

The margin of the leaf-blade may be *toothed* in various ways, or the indentations may be larger and deeper, so as to divide the blade into *lobes* or *segments;* in this way a palmately-veined leaf becomes *palmately-lobed* (*e.g.*, Sycamore, Plane: Figs. 349 and 326), while a pinnately-veined leaf becomes *pinnately-lobed* (*e.g.*, Oak: Fig. 235). Sometimes the blade is divided completely into separate *leaflets*, and the leaf is said to be *compound* in contradistinction to a *simple* leaf with a single leaf-blade. Such a leaf may be *pinnately compound* (*e.g.*, Elder, Ash, Mountain Ash: Figs. 18 and 454) or *palmately compound* (*e.g.*, Horse Chestnut: Fig. 381).

**Division of the Leaf.**

As the delicate, soft, young leaf-blade is specially liable to be attacked by parasitic fungi or by noxious insects, and to be dried up by excessive transpiration, it is developed as far as possible under protection of older parts of the bud. For this reason it is tucked inside the bud so as to occupy as little space as possible, by being *folded* or *rolled* in various ways. When the blade is thrust out of the bud by sudden elongation of the leaf-stalk, it is often more or less folded or rolled, and coated with glistening balsam or slime, or clothed with hairs which persist or are shed after the blade has fully unfurled. Even protected as they are, the young parts of the buds of Oaks, Spruces, and other trees, are pierced by gall-insects, and consequently give rise to galls (*see* pp. 195 and 196, Figs. 19, 20).

**Protection of the young Leaf-blade.**

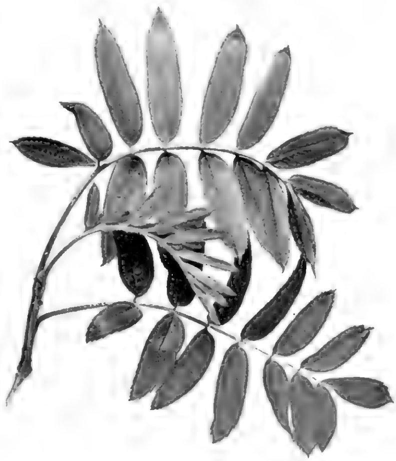


Fig. 18.—*Pyrus Sorbus.*
Twig with pinnately compound leaves.

Fig. 19.—Currant Galls on Oak.

characters in our woodlands, causing them to differ from evergreen forests. In the first place, the bare or thinly foliaged branches and trunks in early spring allow much light to reach the ground; to this light we owe the gay carpet of primroses, bluebells, and the like, haunted by many insects which would not enter the gloom of a perennially foliaged forest. Secondly, many trees burst into blossom in spring before the leaves shoot forth; the consequence is that there is no mass of foliage to conceal flowers from the vision of insects, or to obstruct the powdery pollen that requires to be blown from flower to flower.

## II.—SCALES

A tree possesses in addition to foliage several other kinds of leaves, which are fitted to perform different kinds of work,

The green leaves of most of our trees change their tints in autumn to yellow, brown, or red, and fall before winter arrives. But the Holly, Ivy, and Box, as well as nearly all coniferous trees, retain their foliage through the winter, and are therefore described as being *evergreen*, in contradistinction to trees which shed their foliage annually, and are therefore referred to as *deciduous* trees. Even in the evergreen trees each foliage-leaf lives and remains attached only for a limited number of years; the longevity of the leaves varying with the kind of tree and the situation, from two to twelve or more years.

**Fall of the Leaf.**

The habit of casting the leaves each year not only brings in its train the beauty of our autumns, when poverty in blossom is atoned for by glory of leaf-tint, but is also associated with certain

Fig. 20.—Artichoke and Marble Galls on Oak.

and therefore assume different shapes, but are arranged spirally or in whorls. Some of these are small, broad-based, stalkless, simple in outline, and not green. Such *scales* are produced in place

Fig. 21.—Holm Oak.
Shoot with evergreen leaves.

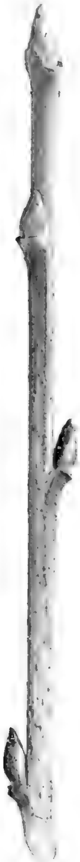


Fig. 22.—Pyrus Sorbus.
Twig in winter, with resting-buds.

Fig. 23.—Acer Negundo.
Twig in winter, with resting-buds and showing scars of fallen leaves.

of foliage-leaves towards the conclusion of the growing season in summer, so that the terminal bud of a shoot is encased in *bud-scales*, which serve to protect it for years, or at least during the succeeding winter (Figs. 22 and 23). In the following spring, when a *resting-bud* of this kind sprouts, the scales do not develop into green foliage-leaves, nor does the part of the stem bearing them elongate appreciably; the consequence is that, as the scales fall soon, they leave behind them a number of closely clustered scars, which thus clearly mark the conclusion of a year's growth of the twig (Fig. 23). It is therefore evident that the piece of stem lying between two of such rosettes of scars represents one year's growth; it is therefore termed the *year's-shoot*. Other kinds of scales apart from bud-scales are met with in Pine-trees (*see* p. 50). Scales are mainly protective in function, and therefore require neither green colouring matter nor a leaf-stalk.

## III.—COTYLEDONS

The first two leaves borne on the seedling of a broad-leaved (dicotylous) tree are always opposite, and are usually simpler

**Fig. 24.—Lime.**
**Opening buds, first stages.**

than, or differ in form from, the foliage-leaves subsequently produced (Fig 27). These two leaves are termed *cotyledons*; and *dicotyledons* or *dicotylous* plants are so-called because they possess two cotyledons in their infancy. The coniferous seedling has a whorl of two or more narrow cotyledons. Cotyledons may serve merely to store food for the infant plant, or may absorb food stored outside the latter and thus render it available to the seedling; they may or may not subsequently emerge from the soil, become green, and perform the office of foliage-leaves.

The foliage-leaves succeeding the cotyledons often differ markedly from those produced later on, and are then referred to as *primary leaves* (*see* pp. 56 and 283).

**Fig. 25.—Lime.**
**Opening bud, second stage.**

IV.—BRACTS

Near the flowers foliage-leaves are usually replaced by simpler, smaller, often scale-like leaves, which are known as *bracts* (Figs. 264 and 271). These leaves usually protect the young flowers, and are apt to be feebly developed when protection is otherwise provided. But they also may take on other functions, such as that of assisting in the scattering of the seeds (*e.g.*, Lime, Hornbeam).

V.—FLORAL LEAVES

The leaves entering into the composition of the flowers are termed *floral leaves*, and will be discussed on pages 24–31.

**Fig. 26.—Lime.**
**Opening bud, third stage.**

Fig. 27.—Seedling Beeches.

## VI.—STEM

The infant plant within the seed or the seedling itself has a short stem—the *main stem*—which is unbranched. This grows in length by means of its terminal bud, and produces lateral buds in the manner already described. In the Scots Pine and other firs the terminal bud grows year after year, naturally with intervening periods of quiescence, so that the successive year's-shoots together build up a true stem in the form of the tall main trunk. But in the majority of dicotylous trees the terminal bud dies at the conclusion of the growing season, and in the following spring its place is usurped by the topmost lateral bud on the year's-shoot, which thus provides a substitute to continue the growth of the leading shoot. The main trunk of such a tree therefore consists of a series of branches strung end to end to form a *false stem*.

The rate at which the main stem grows upwards during the youth of the tree varies in different trees; it is usually greater in those trees which demand much light and in this way seek to obtain it quickly, but is less in those trees that are not easily harmed by shade.

Before going on to discuss the production of branches it is necessary to point out the difference between an *active bud*, which is in process of vigorous growth and is not scale-clad, and a relatively quiescent *resting-bud*, which, with few exceptions, has an external coating of scales. If we follow the growth of the main stem (or of a branch) of a tree during one season, we note that the lateral buds produced on it are resting-buds which do not as a rule grow out before some subsequent season. Thus the year's-shoot in its first season, or, as it is termed, the *current year's-shoot*, bears leaves but produces no branches. In the second year this shoot sends forth branches, though it is now devoid of leaves if it belong not to an evergreen tree. The branches grow in length in the same manner as the main stem, and their stems are consequently true (in most firs) or false (in most dicotylous trees). But the growth of a stem is sometimes arrested by the utilisation of the end to produce flowers, as in the Horse Chestnut (Fig. 380), Elder (Fig. 501), Mistletoe (Figs. 28 and 29), and many trees (Fig. 45). It will now be evident that, except in the case of conifers, it is rare for a true stem to grow in length for more than a limited period.

**Active Buds and Resting-buds.**

Fig. 28.—Mistletoe.
Flowers at the end of the stems.

**Long-shoots and Dwarf-shoots.**

A tree often shows at least two different kinds of vegetative shoots: (1) *Long-shoots*, which have more or less elongated internodes, and are themselves of comparatively considerable length. (2) *Dwarf-shoots*, which are shorter and have shorter internodes, so that the leaves are apt to be tufted. Very clearly marked dwarf-shoots are possessed by Pines (Figs. 68 and 94), Larch (Fig. 106), Cedars (Fig. 111), Beech (Fig. 255), and Ash (Fig. 489).

**Trees and Shrubs.**

If we watch the fate of the various buds borne on a year's-shoot, we find that not all of them develop with equal vigour nor at the same time. In the case of a *tree* the resting-buds nearest the tip of the year's-shoot grow out most vigorously into long-shoots, while the lower buds on this develop into dwarf-branches, inflorescences, or flowers, or remain dormant. As a result the tree preserves a main trunk, the boughs become long, and the finer twigs show stronger branches occupying positions near the tips of the successive year's-shoots. This latter feature is particularly obvious in Pine-trees, in the Silver Fir (Fig. 118), and Spruce (Fig. 135). A *shrub*, in contrast with a tree, has in place of a single main trunk a number of more or less equal-sized stems rising from its base. The shape of the shrub is due to several peculiarities in its behaviour. First, no stem, false or true, continues to increase greatly in length for more than a very limited number of years; secondly, it is usually the buds near the base of the year's-shoot that grow out most strongly;

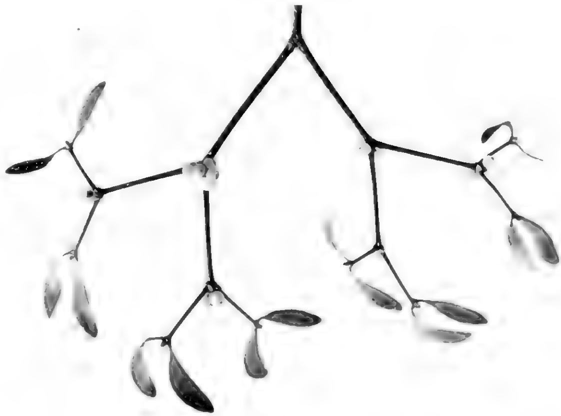


Fig. 29.—Mistletoe.
Fruit at the end of the stems.

Fig. 30.—WEEPING WILLOW *SALIX BABYLONICA.*

Fig. 31.—Wind-clipped Oaks.

thirdly, new erect shoots readily spring from old stems (or roots) near the ground.

A peculiar fountain-like mode of growth, intermediate between those of trees and shrubs, is exhibited by "weeping-trees," such as the Elder (p. 292), Laburnum (p. 322), and Weeping Elm (Fig. 5). Moreover, a shrub can be made to assume a tree-like form if all the lower buds be annually removed; and, conversely, a tree can be reduced to a bush by removing the higher buds or clipping the higher shoots. This interchange between tree and shrub is often accomplished by natural agencies. For instance, far north, or high up mountains, or on bleak sour moors, trees are dwarfed so as to be pygmies only a few inches or feet in height (*see* p. 106). Again, in windy exposed places the tree suffers greater deformation than the shrub or herb because the force of the wind increases with a rise above the ground. Hence on wind-swept hills or near the sea the wind causes the leaves on the upper parts of the developing tree to transpire with such rapidity that the highest shoots are dried up; moreover the leading shoot at its summit and the adjoining branches are bent away to leeward, so that a wind-clipped tree assumes a characteristic, dwarfed, more or less flattish-topped, lop-sided form (Fig. 31), and may be bush-like in stature.

**Sprouting of Buds.**

The buds do not all shoot forth simultaneously, either on different kinds of trees or on the same tree. The date of sprouting of the buds is not without influence on the form or even distribution of trees. For example, in our temperate climate, buds that sprout early in spring are in danger of being nipped off by late frosts, so that certain kinds of trees which thrive in the milder climate of England are absolutely excluded from frosty parts of Central Europe.

The sprouting of buds is promoted not

only by heat and moisture, but also by light, as may be seen when numerous little branches shoot out from an old tree-trunk that has been suddenly exposed to stronger light (say by the fall of adjoining trees).

Shade does more than arrest the sprouting of buds, for it actually kills branches already in existence. Thus it comes that in forest, and to a less extent in open country, the lower branches given off from a tree-trunk die and drop off as they become overshadowed by higher branches or other trees. The bare, branchless portion of the old trunk thus denuded is termed the *bole;* while the portion of the trunk, together with the mass of boughs, branches, and foliage, surmounting it compose the *crown* of the tree.

The bole may subsequently send forth younger branches at different heights (Fig. 336); and new branches—*stool-shoots*—may spring up from the very base of the trunk, or from the stump of a felled tree. All these new branches springing from old parts arise either from axillary resting-buds that have remained dormant for years, or from entirely new buds which are first brought into existence on these old stems.

**Bark.**

As the stem thickens the original skin (perforated by stomata) becomes too small to cover it, and a new covering, dead *bark*, replaces it. The dead bark is a protective layer guarding the tree against the attacks of animals, the entrance of parasitic fungi, excessive loss of water, frost, and perhaps against the burning sun's rays. And it is instructive to note how carefully the tree seals up artificial or natural wounds; the scar left by branch or leaf that is naturally cast off is a "clean" one, not ragged, and is closed by cork; while the wound made by mechanical injury is, in the course of time, covered by cork or bark. The importance of this closing of the wounds will be more fully appreciated when it is remembered that many parasitic fungi attacking stems and roots can gain entrance only through a wound. The bark therefore is impermeable to water and to gases except at certain spots or along certain lines, which usually take the form of *lenticels*.

Lenticels permit the free entrance of oxygen and exit of carbonic acid gas, and thus enable old stems and roots to obtain the oxygen they require for respiration. Lenticels on twigs are usually noticeable as little lumps differing in colour from the rest of the surface (Figs. 497 and 498), and are still more obvious as long transverse lines marking the bark of the Birch and Cherry trees (Figs. 274 and 418).

Each year the tree adds to its bark from within. If this production is balanced by the outer bark being regularly shed in the form of scales, sheets, or strips, then the bark remains thin and relatively smooth, as in the Plane (Fig. 319) and Strawberry-tree (Fig. 32). If the outermost bark does not flake off at frequent intervals it may become thick and furrowed, as in the Oak, Elm, and Ash. But even rough-barked trees shed scales at longer or shorter intervals, and in one and the same tree the rate of the shedding may differ at different heights up the trunk, as in the Scots Pine and Birch (*see* pp. 50 and 225). The nature of the bark frequently gives some clue to the habit of the tree. Trees with thin, smooth, often dark-coloured, bark usually are shade-enduring species (and often live in moist woodlands), as is the case with Beech, Hornbeam, and Silver Fir; whereas trees that soon acquire a thick, rough bark are usually light-demanding (and often capable of living in drier places).

**Thickening of the Stem.**

So far we have considered only the *dead bark*, but lying within this and encircling the wood, from which it is separated by the thinnest of films, is the *living bark*.* This serves to transport elaborate substances

* The definition of "bark" here implied conforms with ordinary English usage, and does not agree with the technical one given by most English and American botanists.

Fig. 32.—Smooth Bark of a Strawberry-tree (*Arbutus Andrachne*, Linn.), with thin, peeling scales.

(such as sugar) manufactured in the leaves to growing or storing parts of the tree, and stores them itself; moreover, it acts as a receptacle for useless excretions, which may subsequently be thrown off with the dead bark. The bark as a whole is added to, thanks to the activity of two or more delicate, thin, *creative layers*, one of which runs as a permanent film-like sheet round the stem immediately outside the wood. This particular creative layer, year after year, produces new living bark on its outer face, and new wood on its inner face. Each year, in the case of British trees, it thus manufactures one clearly recognisable ring of wood, which is deposited outside the pre-existing wood and is termed an *annual ring*. By counting the annual rings of wood in any part of the stem we learn the exact (or, in exceptional cases, the approximate) age of that part. The outer, and therefore younger, annual rings of wood alone carry up the raw sap. As the inner rings become older and die, they may change in tint, become heavier, more resistant to decay, and cease to be capable of conducting water. Such central coloured wood is termed *heart-wood*, as opposed to the lighter-coloured surrounding *sap-wood*. (In popular parlance the heart-wood and sap-wood are often loosely referred to as "heart" and "sap" respectively.)

**Adaptive Faculty.**

It is remarkable that the direct effect of the surroundings—soil, weather, and climate—upon the individual tree is generally such as to fit the latter for existence in the spot where it happens to be. The tree, in fact, seems to *adapt* itself to the outside world, and to behave in a manner that the exercise of full reasoning powers could not better. Thus one and the same kind of tree if planted in a more northern situation or higher up a mountain tends to put into action its various vital processes, such as the sprouting of buds and possibly the production of flowers, at a later date in the season, but to complete them at an earlier one ; it thus avoids extremes of the more rigorous climate and rapidly utilises the shorter favourable season. Again, in the presence of sufficient light, in moist air there is a tendency for numerous buds to shoot forth, and for the leaves to be large as well as numerous, so that the tree can throw off a large amount of water despite the humid air ; but in dry air more numerous buds remain dormant, and the leaves tend to be fewer and smaller, so that there is less danger of expending an excess of water. Again, in the moist shade of forest the protective bark is thinner than in the drier, well-lighted, open country where the danger of desiccation is greater. In the open country the branches remain attached lower down the trunk, for they receive plenty of light ; but in the forest the lower branches, being soon overshadowed, become useless and are sacrificed. Furthermore the dwarfed form assumed by trees in windy places, and in Arctic or sub-Alpine situations, enables the bush-like plants to withstand the danger of drying up. Many other examples of this apparent *direct adaptation* will be encountered.

As the various kinds of trees differ in their wants and powers of accommodation, there may be considerable variety in the vegetation of a small area. Here may stretch a heath mainly occupied by heather and gorse, dotted with isolated Scots Pines, able to absorb sufficient water from the soil. At a little distance, fringing a stream may be Willows or Poplars, which demand light, but possess roots capable of resisting suffocation in periodically soaking soil. A little farther, the soil may be occupied by forest, in which light-demanding and shade-enduring trees, shrubs, and herbs do battle.

Fig. 33.—Rough, Scaly Bark of the Medlar-tree.


**Fig. 34.—Male Flowers (♂) and One-year-old Cone (♀) of Scots Pine.**

## VII.—FLOWERS

The function of a flower is to bear seed, in whose production only two kinds of floral leaves—carpels and stamens — participate. The simplest flowers consist, therefore, of either carpels or stamens, or of both.

The little cone-like flower of a Pine (Fig. 35), or a Spruce (Fig. 131, ♀), that gives rise to the familiar woody cone-fruit, consists solely of a stem—the *receptacle*—and a number of spirally arranged scale-like leaves. To the upper face of each leaf are attached two egg-shaped bodies, the *ovules*, which are capable of developing into seeds. A leaf that bears ovules is termed a *carpel.**

But the Scots Pine has other yellow cone-like flowers (Fig. 34) each consisting of a stem—the *receptacle*—and many spirally arranged scale-like leaves—the *stamens*. On the lower face of each scale-like stamen are two closed little bags containing numerous microscopic yellow grains

* The exact structure of this cone is described on page 54, where it will be seen that the scales are double, and that there is some doubt as to interpretation of the cone.


**Fig. 35.—Female Flowers of Scots Pine.**

—the *pollen-grains;* the bags are therefore known as *pollen-sacs.* A floral leaf that produces pollen is termed a *stamen.* The part of the scale projecting outwards and upwards beyond the pollen-sacs is the *connective.*

Each pollen-sac splits open, and the pollen is transported (in this case, it is blown by the wind) to the carpels, and reaches the ovules. This act of transference is known as *pollination.* A pollen-grain thereupon sends a tube into the ovule and brings about the act of *fertilisation,* one consequence of which is the change of the ovule into a *seed* containing an infant plant—the *embryo.*

A flower containing carpels but having no stamens is a *female* (♀) flower; one possessing stamens but no carpels is a *male* (♂) flower; both kinds of flowers are described as *unisexual,* in contradistinction to flowers possessing both carpels and stamens which are said to be *bisexual* (⚥).

**Gymnospermæ.**

It is important to note that neither the ovules nor the seeds of the Scots Pine are contained in a closed chamber. Plants like Pines, Firs, Cedars, Cypresses, and others having naked seeds are grouped together to form the great class *Gymnospermæ.*

**Angiospermæ.**

Opposed to the simpler Gymnospermæ are the vast majority of Flowering Plants which form the more advanced *Angiospermæ,* and are so-called because their ovules and seeds are contained within a closed chamber—the *ovary.* If, for instance, we examine the flower of a Pea or Laburnum, we find in the centre a pod-like body containing within its single chamber a number of ovules attached in a double line down the one side. This ovule-containing part is like a miniature pea-pod, and is the *ovary.* Rising from its summit is a stalk-like structure—the *style*—which is capped by a broader part—the *stigma.* The whole structure, composed of ovary, style, and stigma, is termed a *pistil,* and is produced by the folding of one leaf—the *carpel*—whose margins unite and so produce the closed ovary. The stigma is the part intended to receive and retain pollen-grains, which send tubes down the style, and thence to the ovules.

But a flower may include a number of *separate* closed *carpels* or pistils, as is the case with the Magnolia (Figs. 36 and 37). Still more frequently the flower contains two or more *carpels* that are *united* to produce a single pistil; in such a case the ovary often has as many chambers as there are carpels, and sometimes there is the same number of

Fig. 36.—Magnolia.
Flowers showing the separate white petals.


**Fig. 37.—Magnolia.**
Flowers, stripped of sepals and petals, showing many stamens (♂) and separate carpels (♀) attached to the receptacle.

styles, or stigmas or stigma-lobes. For instance, the ovary of the Sycamore is produced by the union of two carpels and is two-chambered; similarly, that of the Horse Chestnut is three-chambered, and that of the Apple five-chambered.

**Stamens.** The *stamens* of Angiospermæ are very different from those of the Scots Pine. Each is usually rod-like, and shows the following parts: (1) a stalk known as the *filament*; (2) the thicker terminal part known as the *anther*, which bears four pollen-sacs. The four pollen-sacs are often grouped in pairs so that the anther is *two-lobed*, and the two halves or lobes are connected by a narrow bridge, the *connective*, which sometimes is prolonged above the anther as a little scale-like crest. In most flowers the stamens are separate from one another, but in the Laburnum the filaments of all ten stamens in the flower are united to form a tube surrounding the central ovary.

**Pollination.** Experience has taught us that, at least in many cases, more or better seed is produced if the pollen conveyed to the carpel is derived from a different individual plant (of the same kind). Such a mode of transference is described as *cross-pollination*, and is opposed to *self-pollination*, which implies the effective transference of pollen on to the carpel of the same flower. In this country pollen is conveyed from one flower of a tree to another either by *wind* or by *insects*.

*Wind-pollinated* trees are exemplified by all conifers, and by the Oak, Poplar, and Ash; all these possess relatively inconspicuous flowers that pour out no honey-producing solution of sugar (*nectar*). Their pollen is powdery, not sticky, and the grains are usually devoid of any marked outgrowths, such as spines. As the wind may blow in

Fig. 38.—Common Elm (*Ulmus campestris*); flowers.

any direction, towards or away from trees of the same kind, a vast amount of pollen is generally produced by wind-pollinated trees, and the stigmas are usually large, being often branched or brush-like. Frequently the anthers are pushed far out of the flowers, or are arranged in dangling inflorescences, and thus are readily caught by the breeze. Moreover, many wind-pollinated plants are *social;* that is to say, numerous individuals of the same kind grow close together to form, so to speak, pure populations or communities: and this is true whether they be herbs like grasses, or trees such as Oaks, Pines, and Firs.

But *insect-pollinated* flowers possess devices which attract the notice of insects, and allure them. They are therefore more showy or scented, and usually include sugar-producing glands known as *nectaries.* The pollen is often sticky or rough at the surface so that it will cling to an insect's body. As the pollinating insect is apt to go from one flower direct to another of the same kind, there is no necessity to produce an overwhelming amount of pollen. Coupled with this economy in pollen is also the smaller size of the stigma. Moreover, in order to ensure that the visiting insect shall transfer pollen to the stigma, there is a certain correspondence between the position of the anthers and stigmas (*see* p. 325), and sometimes the flower is elaborately constructed so that an insect visitor strikes the anthers or stigmas with exactly the same part of its body (*see* p. 303). Thus the filaments and the style are of utility in raising the anthers and stigmas into the correct position.

Showy floral leaves are therefore designed to

Fig. 39. White Poplar (*Populus alba*). Catkins of male flowers.

**Fig. 40.—Regular Flowers of the Medlar-tree.**
**Each showing five separate petals and many stamens.**

attract the notice of insects, and are dispensed with when a plant gives up its habit of insect-pollination and adopts a policy of wind-pollination; such degenerate flowers are possessed by the Common Ash (p. 388).

*Self-pollination*, or even pollination by pollen from the different flowers of one tree, is rendered difficult or impossible by: (1) the male and female flowers being on different trees or branches; (2) the male and female flowers on one tree, or the stamens and carpels of one flower, maturing at different times: (3) the stigma being out of reach of the anthers, or the anthers opening away from the centre of the flower. But if no cross-pollination has taken place, many flowers make provision for subsequent spontaneous self-pollination, as will be described in the sequel.

**Protection of Flowers.**

At least during their youth, flowers require protection, from desiccation, from insect-foes, and from fungi; indeed there are some fungi which can pass certain stages of their lives only in young flowers. Such protection is provided either by the close aggregation of flowers, by bracts, or by special floral leaves. Hence a flower may possess in addition to stamens and carpels two other different kinds of floral leaves :—

(1) An outer envelope of usually green leaves, the *sepals*, which compose the *calyx*. These are protective. The sepals may be separate (*e.g.* Magnolia) or united at their bases (*e.g.* Laburnum).

(2) An inner envelope of showy *petals* composing the *corolla*. The petals may be separate, as in the Magnolia, Plum, and Medlar (Figs. 36 and 40), or united to produce a shorter or longer tube with separate teeth or segments, as in the Strawberry-tree (Fig. 42), Elder, and Guelder Rose.

In some cases there is no distinction into sepals and petals, and the general envelope is termed a *perianth*, which may be green or petal-like. Its floral leaves may be termed perianth-leaves, but in this work they are, for the sake of simplicity, described as sepals. It may be noted that when the flowers are adequately protected by bracts, or by close aggregation, the sepals or perianth-leaves may become reduced and degenerate, or even suppressed, as in the Betulaceæ, Fagaceæ (pp. 215 and 216), and Elder (p. 393).

The floral leaves may be arranged in spirals or in whorls; in the latter case the successive whorls usually alternate with one another. For example, the Holly-flower has four sepals; within these, but opposite to the gaps between them, are four petals; these are succeeded by four stamens, which alternate with them and are therefore opposite to the sepals; while in the centre are placed four carpels, which alternate with the four stamens and are thus opposite to the four petals.

**Arrangement of Floral Leaves.**

The part of the flower-stem actually bearing the floral leaves is termed the *receptacle* (which is shaded black in the accompanying three diagrams). The receptacle may be convex, so that the sepals, petals, stamens, and carpels, are respectively attached at successively higher levels; in such a case the flower is said to be *hypogynous* (Fig. 41*a*), and the ovary is *superior*, as in Magnolia (Fig. 37), the Lime, Sycamore, and Horse Chestnut. But in some flowers the receptacle is concave at its end so as to form a basin or cup, to whose rim are attached sepals, petals, and stamens, and to whose lining or bottom are attached the carpels or a lump bearing these; such a flower is *perigynous* (Fig. 41*b*), and the ovary is superior, as in the Cherry and Plum. Finally, the receptacle may be concave as in the preceding type but also joined by its inner lining to the ovary-wall, so that the ovary cannot be plucked out of the flower but seems to stand below all the other floral parts; such a flower is *epigynous* (Fig. 41*c*), and the ovary is *inferior*, as in the Apple, Pear, Medlar (Fig. 40), Hawthorn, and Elder. In all three of the above types of flowers the stamens may, however, be attached to the petals, as, for instance, in the Elder.

The receptacle sometimes bears a glandular, glistening outgrowth, which is known as the *disk*, and often excretes nectar, *e.g.*, Sycamore, Horse Chestnut, and Cherry.


**Fig. 41.—Three Diagrammatic Flowers, cut down the middle to show the shape of the receptacle.**
(*a*) Hypogynous, (*b*) perigynous, (*c*) epigynous.

**Device for concealing Nectar.**

The production of a tube, either by the union of the sepals or petals, or by the receptacle becoming concave, is frequently a device for concealing the nectar and keeping at bay useless or noxious insect visitors. The plant would reap no advantage from the visits of insects that stole nectar and pollen without effecting cross-pollination. To avoid such waste of material, some flowers have become shaped to entertain certain classes of insects. In order to appreciate the policy pursued by insect-pollinated plants it is necessary to remember that among flower-haunting insects intelligence is generally proportionate to length of tongue.

**Fig. 43.—Bird Cherry (*Prunus Padus*); flowering shoot.**

**Fig. 42. Regular Flowers of the Common Strawberry-tree (*Arbutus Unedo*, Linn.) with united petals.**

Hence, flowers pollinated largely by unintelligent short-tongued flies and beetles have freely-exposed nectar, as in the Elder, and are usually white or yellow. Flowers, such as those of the Cherry, with nectar partially concealed in a tube, are visited by a high percentage of the longer-tongued bees and butterflies or moths. While the Laburnum, with its specially shaped flowers, also its carefully placed and concealed nectar and pollen, is particularly adapted for pollination by the most intelligent insects—bees. Finally, the Honeysuckle and Pink, with very long tubes, are particularly pollinated by moths and butterflies, which have

Fig. 44.—**Irregular Flowers of *Catalpa bignonioides* (Walt.) with united petals.**

irregular, are nevertheless symmetrical, because each can be divided into two exactly equal and similar halves. A flower (or a corolla) is *regular* when the floral leaves composing each whorl are all equal and similar. Regular flowers present much the same appearance when viewed from any side, and their insect visitors can alight with equal convenience on all sides. Such flowers tend to be erect or to hang down vertically (Fig. 42). Irregular flowers present different appearances from the front, back, and sides; and as they are adapted to receive insects that alight in a particular manner, they are directed horizontally or obliquely (Fig. 48).

the longest tongues though not the highest intelligence.

The blossom of the Laburnum illustrates the shaping of a flower so as to exclude all insects excepting certain special kinds that enter in a particular manner, and inevitably effect cross-pollination (*see* p. 325). This is often achieved by unequal growth of the petals of a flower, which is then said to be *irregular* (or, more strictly, is said to have an irregular corolla). Such flowers as those of the Laburnum (Fig. 408), Horse Chestnut (Fig. 380), and *Catalpa* (Fig. 46), though

Fig. 45.—**Wild Service-tree (*Pyrus torminalis*).**
Terminal inflorescence.

## VIII.—INFLORESCENCES AND FLOWERING

**Catkins.**

Flowers are usually grouped together on the tree in time and space. They are frequently arranged to form *inflorescences*, in which the flowers or flowering branches stand in the axils of reduced or modified leaves termed *bracts*. Among the many varieties we may single out one particular kind of inflorescence for mention, namely the *catkin*. This is an elongated unisexual inflorescence consisting of an apparently unbranched stem, bearing on its sides a number of bracts (catkin - scales) in whose axils are inconspicuous stalkless unisexual flowers; as a rule the catkin falls off as a whole. Such catkins are possessed by the Hazel, Oak, Poplar, Birch, and others (Figs. 46 and 39). The precise reasons why flowers are grouped into inflorescences are not fully understood: one advantage gained is that the blossom is rendered more conspicuous; another is that insects can pass more rapidly from flower to flower; a third is that certain buds can be set apart for the production of flowers, while others are left free to produce foliaged shoots. Inflorescences are either terminal, as in the Wild Service-tree (Fig. 45), or lateral, as in the Sloe (Fig. 48).

**Date of Flowering.**

The age at which a tree flowers varies widely in different trees; some kinds of trees flower when only a few years old, whereas others do not blossom until they have reached the ripe age of fifty or more years. A tree in the open country usually flowers at an earlier age than the

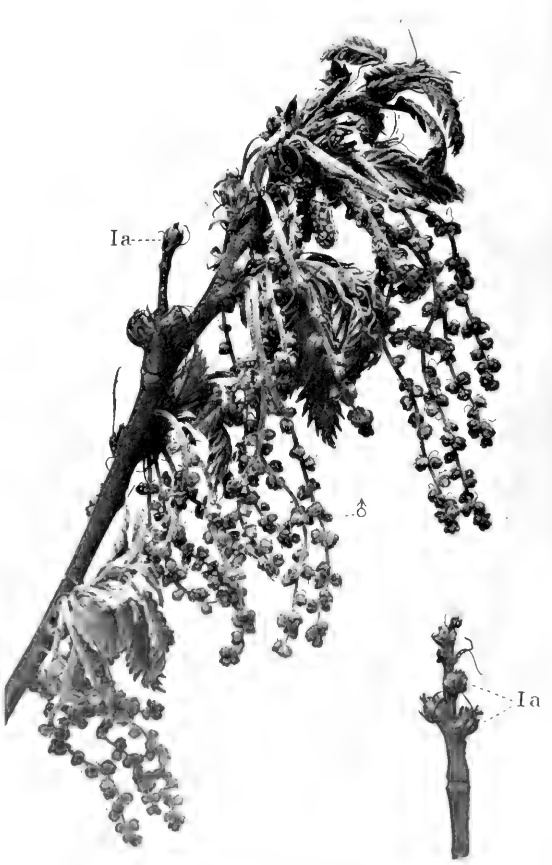



Fig. 46.—Turkey Oak (*Quercus Cerris*).
Catkins of male flowers (♂) and one-year-old young acorns (Ia).

Fig. 47. *CATALPA BIGNONIOIDES* IN BLOOM.

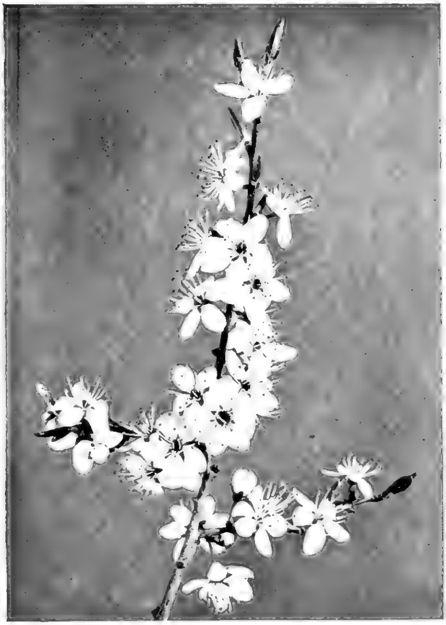


Fig. 48.—Blackthorn (*Prunus spinosa*). Flowering shoot.

Why light should promote flowering, or why various trees should flower at different dates in the year, we do not know. Yet we can suggest some advantages reaped by the confinement of flowers to well-lighted shoots; for, by this means, the flowers and subsequently the fruits may necessarily be freely exposed to animals or breezes that cause pollination or seed-dispersal. There is no close relation between the times of flowering and fruiting, for though some Willows and Poplars blossom and fruit early in the year, the Hazel flowers yet earlier but does not bear ripe nuts until late autumn, and Pines require more than one or two years to mature their woody cones.

same kind of tree in the forest: light promotes flowering. Nor does a single tree flower with equal abundance every year: good crops of blossom and seed follow at intervals of two or more years. Again, each kind of tree has its own flowering season, which usually lasts very few weeks, though exceptions to this rule are met with in the Holly and some other trees. The flowers may emerge before, with, or after the leaves. In the first two cases they are usually prepared during the preceding season, and remain as minute young structures concealed within resting-buds all through the winter, so that under exceptional circumstances they shoot out in autumn instead of waiting until the following spring. These flowering-buds are often distinguishable from the foliage-buds, as in the Elm (Fig. 49); sometimes, indeed, the inflorescences themselves are visible in autumn, but rest naked and closed throughout the winter, as is the case with the male catkins of the Birch (Fig. 279).

Fig. 49.—Wych Elm (*Ulmus glabra*). Pointed vegetative buds, and rounded inflorescence - buds commencing to open.

Fig. 50.—Laburnum; fruits opening.

## IX.—FRUIT

As the ovule changes into a seed the carpel or carpels of the flower grow, and the result is the flower is replaced by a *fruit*. In the Angiospermæ the ovary enlarges and becomes the seed-vessel within which are the seeds. It must be noted that a fruit is the product of one flower, not of several flowers; thus the blackberry-like "mulberry-fruit" (Fig. 306) is not a fruit, because it is formed by a number of flowers. Again, the edible chestnut is a fruit because it is the changed ovary containing one seed; whereas the somewhat similar seed of the Horse Chestnut is a seed because it is a changed ovule.

**Needs of the Infant Plant.**

The infant plant and its store of food inside the seed require protection against injury by drought, heat, or cold, against mechanical violence, and against the attacks of animals and fungi. But at the same time it is necessary for the seeds to be dispersed. Consequently arrangements must be made to cover the contents of the seed with a hard coat, and to provide some means of dissemination. Seeds and fruits of our trees are mainly scattered by wind or by animals.

If we compare an ordinary filbert with a plum, the most obvious distinction between these two fruits is that one has a covering which is *dry* and woody, while

Fig. 51.—Winged Fruits of *Ailanthus glandulosa* (Desf.).

**Fig. 52.—Wych Elm (*Ulmus glabra*); winged fruits.**

the other is encased in an envelope which is *fleshy* and juicy in part. There are two main types of fruits—*dry* and *fleshy*.

**Dry Fruits.**

Commencing with the *dry fruits*, the filbert is a nut containing one seed, and it remains closed until the time of germination. Here the fruit itself is scattered (partly by squirrels), and protection is provided by the hardening of the ovary-wall which becomes the nut-shell, while the seed-shell inside remains thin and papery. The fruits of the Oak, Beech, and Chestnut are likewise nuts. But a Pea-pod (or a Laburnum-fruit), when ripe, splits open spontaneously along two lines, and becomes a two-valved open fruit. In this case the seeds escape from the seed-vessel, and it is they that are scattered and require to produce their own hard shell; hence the seed-shell of the Pea or Laburnum is thick and hard. When dry fruits of trees are dispersed by the wind, they acquire sailing devices for "catching the wind"; often such fruits are flat, and one-winged as in the Ash (Fig. 495), or two-winged as in the Sycamore (Fig. 353) and the Elm (Figs. 52 and 53), while in the Hornbeam (Fig. 273) and Lime (Fig. 343) wings are provided by the bracts. Less commonly wind-dispersed fruits are buoyed up by hairs, as is the case in the Plane-tree (Fig. 323). But when the seeds themselves are freed and scattered by the wind, it is they that acquire similar appendages: for instance,

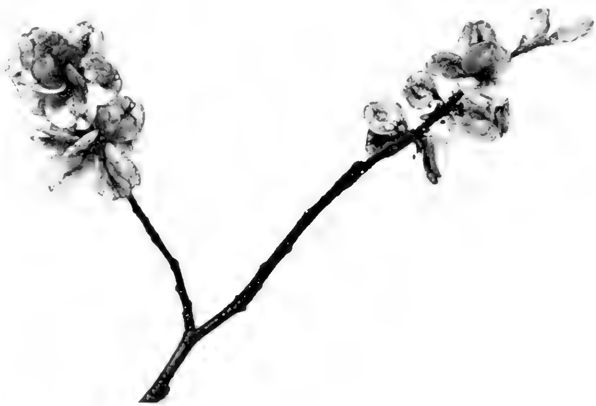


**Fig. 53.—Common Elm (*Ulmus campestris*); winged fruits.**

Fig. 54.—Crack Willow (*Salix fragilis*).
Open fruits shedding the cottony seeds.

the seeds released from the two-valved opening fruits of Poplars and Willows (Figs. 188 and 54) bear tufts of cottony hairs; while the seeds of a large number of naked-seeded plants (Gymnospermæ), including many Pines, are winged (Fig. 65). The modes in which the seeds of the Pines, Larch, Cedars, and Silver Fir are released from the protective investing woody cone-scales are recounted on pages 55, 86, 90, and 99, but here it may be mentioned that in the case of the first two the scales simply gape asunder (Fig. 71), whereas in the last two the scales tumble separately off the axis (receptacle) of the cone, which thus seems to break into pieces (Figs. 125–6).

The seeds of the opening fruits or the naked seeds of conifers are sometimes conveyed from place to place inside birds, which are attracted by the distinctive colouring of the seeds and allured by a fleshy seed-envelope. Thus the fruit of the Spindle-tree splits open and reveals three seeds, each clothed with an orange-coloured fleshy coat which lies outside the true, hard seed-shell. Again, the naked seed of the Yew is surrounded by a red juicy cup which birds eat; while three fleshy carpels of the Juniper combine to form the bluish juniper-berry. In all these cases the seed-contents are protected from injury by a hard seed-shell lying within the fleshy coat.

These examples of seeds dispersed by animals lead on to *fleshy fruits* in which the juicy coat, although it is not a part of the

Fig. 55.—Blackthorn (*Prunus spinosa*); stone-fruits.

Fig. 56.—Service-tree (*Pyrus Sorbus*); fleshy fruits.

requires to manufacture a thick seed-shell in place of the papery one of the stone-fruit. A pear or an apple is intermediate between a stone-fruit and a berry, as the inner parchment-like chamber-walls represent "stones" which are so thin that the seed requires the additional protection of a firm seed-coat. All these fleshy fruits tend to remain green and therefore inconspicuous, also sour and therefore uninviting, until they are ripe, when colour and sugar invite birds or beasts to bite the fruit, and pass the well-protected seeds unharmed through their bodies.

Some fruits are peculiar in type. The walnut, with its green, almost fleshy, outer layer, which spontaneously but irregularly opens, and its nut-like inner layer, is obviously not a nut. Again, the fruit of the Horse Chestnut is partly fleshy yet its spiny wall splits into three valves.

seed but is produced by the original wall of the ovary, yet subserves the same office of attracting animals by its bright colour and its sugary contents.

**Fleshy Fruits.**

One familiar type, the *stone-fruit*, is represented by the cherry and plum. Here the original ovary-wall becomes thick and differentiated into three layers; the firm outer skin, the pulpy middle layer, and the hard, bony, inner, stone-layer which effectively protects the seed, and thus renders any thick seed-shell superfluous. The stone-fruit of some trees includes several stones, each of which is formed round one chamber of the original chambered ovary. The so-called "berries" of the Holly, Hawthorn, and Mountain Ash are in reality stone-fruits. In a true *berry* the original wall of the ovary produces no hard layer, but rather an outer rind and a soft inner pulp, so that the seed

Fig. 57.—Wild Service-tree (*Pyrus torminalis*); fleshy fruits.

## X.—SEED AND GERMINATION

The seed contains an infant plant which is termed the *embryo.* But until the young seedling has manufactured efficient roots and green leaves by which to gain its sustenance, it is dependent upon food stored inside the seed. This food is, broadly speaking, of the same nature as that supplied to the young of animals or to human infants, as it consists of starch (convertible into sugar), or oil and albuminous substance. These substances may be stored inside the cotyledons, which with the tiny main shoot, main root, and a connecting piece between these, constitute the embryo; but they may be stored altogether outside the embryo (as *endosperm*); the former is the case with the Laburnum-seed, which is thus wholly occupied by embryo, while the latter system of storage is adopted by the Pine-seed.

Cotyledons that do not store food usually emerge from the ground, become green, and function as green leaves, for instance in Pine-trees; but those cotyledons which store food may remain below ground as mere reservoirs, for instance in the Oak, Hazel, and Horse Chestnut; or may force their way into the light, and become green, as in the Beech and Sycamore.

## XI.—CLASSIFICATION AND NOMENCLATURE

Plants are grouped together according to their "blood"-relationships. All the plants dealt with in this book belong to the great group of Flowering Plants (*Phanerogamia*), which is subdivided into two main classes :—

1. *Gymnospermæ*, with ovules and seeds naked, usually with narrow or needle-like evergreen leaves, and with two or more cotyledons to the seedling (*see* p. 41).

2. *Angiospermæ*, with ovules and seeds enclosed in an ovary, and usually with broader leaves, showing a different type of veining. The Angiospermæ are again subdivided into: (*a*) *Monocotyledones*, including Palms, in which the seedling has only one cotyledon. (*b*) *Dicotyledones*, in which the seedling has two cotyledons, and the leaves are net-veined (*see* p. 146).

These larger groups are again distinguishable into smaller ones. In regard to the Gymnospermæ we may at once refer the reader to page 41. But in the *Dicotyledones* three not entirely natural subdivisions stand out :—

(1) Families with *no petals* (*see* pp. 147–269).

(2) Families with *separate petals* (*see* pp. 269–383).

(3) Families with *joined petals* (*see* pp. 384–404).

Among still smaller groups are *families.* In one *family* are included all those plants that possess a sufficient number of characters in common. For example, the Oak, Sweet Chestnut, and Beech are included in the family *Fagaceæ.* The family in turn is composed of various *genera;* for instance, the Oak belongs to the genus *Quercus*, and the Beech to the genus *Fagus.* A genus includes a number of *species* which exhibit differences slighter than those between genera. For example, the genus *Quercus* includes *Q. Cerris* (Turkey Oak), *Q. Suber* (Cork Oak), *Q. Ilex* (Holm Oak), and many other species. Each plant, then, is known by a double name, its *generic* name (genus) preceding its *specific* name (species). Sometimes a species is divided into two or more *sub-species*, but it is often difficult to decide whether to term two different kinds of trees sub-species or species; for instance, some

**Fig. 58.—Variety of *Acer Negundo*; variegated leaves.**

authorities include under the name *Quercus Robur* our two British Oaks, and distinguish two sub-species, *sessiliflora* and *pedunculata*, but other authorities at once distinguish these as different species. Again, species or sub-species may be divided into a number of *varieties* which show and preserve in their progeny certain slight, but constant, differences. Finally, each variety, sub-species, or species is composed of the separate *individuals* which are so alike as to deserve the same name.

**Hybrids.**

Sometimes by pollinating one species with pollen from another species of the same genus there results a new kind of plant, which is known as a *hybrid*. The name given to the hybrid is that of the parents; for instance the Grey Poplar is known as *Populus canescens*, but, if it be true, as is generally supposed, that this tree is a hybrid between the White Poplar (*P. alba*) and Aspen (*P. tremula*), its name is in reality a double one, *P. alba* × *P. tremula*. Similar "*crosses*" or bastards between different *varieties* or even different *genera* have been obtained.

The foregoing remarks make it clear that in seeking to identify a particular tree, the reader will first have to decide whether the tree be a gymnosperm or a dicotyledon; and secondly, will turn to page 41 or page 146 in order to ascertain the family to which it belongs; and thirdly, by consulting the opening pages dealing with the family arrived at, will learn its genus, and thereafter its species.

# CLASS I

# GYMNOSPERMÆ

THE great class of plants characterised by the possession of ovules and seeds that are not enclosed in an ovary, is represented in this country by such trees as Pines, Firs, Cypresses, Juniper, Monkey-puzzle, Yew, and Maidenhair-tree. Even these, though not all natives of this country, only incompletely represent the Gymnospermæ, which in other lands or in our hothouses include the Cycadaceæ—woody plants often presenting an appearance between that of a tree-fern and a palm—and Gnetaceæ, one member (*Ephedra*) of which is occasionally met with in gardens in the form of a shrub with switch-like shoots and tiny leaves. Excluding the Cycadaceæ and Gnetaceæ, the remaining Gymnospermæ were formerly all grouped together in one class under the name of Coniferæ—conifers.

This term refers to the fruit, which usually assumes the form of a *scaly cone*. But such is not always the case, for the Juniper has a berry-like fleshy fruit, while the Yew fruit consists of a solitary seed lying within the familiar pink or red cup, nor has the Maidenhair-tree (*Ginkgo*) a cone. In the cone the seeds are directly exposed on the surface of the scales, or in the axils of these.

**Flowers.**

The flowers * are nearly always unisexual; they are devoid of any calyx or corolla, but the colour of their scales or pollen may cause them to be distinguishable at a distance. The stamens vary in form, and are usually more scale-like than those of angiosperms. As the pollen can gain direct access to the ovule in the female flower, there is no necessity for the carpel to have a stigma or style, so that these, as well as the ovary, are undeveloped.

**Fig. 59.**—***Araucaria imbricata*; female flower.**

**Leaves.**

The leaves are nearly always needle-like or very narrow (*linear*); but the *Ginkgo* has broad leaves shaped somewhat like the ultimate segments of a Maidenhair-fern (Fig. 174), hence its popular name; and the Monkey-puzzle (*Araucaria*

* The male and female cones are throughout described as flowers, and not as inflorescences, because such a course more readily lends itself to brevity and clearness of description. But it is quite possible that these cones represent inflorescences.

Fig. 60.—*Araucaria imbricata;* male flowers.

thus easily distinguished from all other conifers. It is interesting to note that the dwarf-shoots of the Pines and *Taxodium* have become so closely identified in function with the leaves they bear that they are shed periodically at the times when the green leaves alone would be expected to fall; thus, as each autumn comes, *Taxodium* casts its foliage-bearing dwarf-shoots which, in fact, resemble pinnately compound leaves (Fig. 148).

The true arrangement of the leaves is frequently obscured by torsions, especially in connection with shoots that are not erect; but to understand the object of these we must consider the distribution of the stomata on the leaf. This can often be studied with the naked eye or by the aid of a simple magnifying glass, because those parts of the leaf surface which are dotted with stomata are also incrusted with white wax. Examining, for instance, the Common Silver Fir, we note that the white lines are confined to the lower face of the leaf (Fig. 118); this tree has flat leaves with stomata solely on their lower faces. Now the leaves of the Silver Fir are spirally arranged on the horizontal branches, and were they to point in their natural directions the stomata would, on the different leaves, face upwards, downwards, and in intermediate directions. But it is important that the stomata should be on the face away from the sunlight; and to achieve this pose the leaves twist so that they are approximately horizontal, and the stomata-bearing lower faces directed towards the

**Stomata.**

*imbricata*) has broad, sharp-pointed leaves. In some species of Cypress and Arbor-Vitæ the leaves are reduced to small green scale-like structures; while in Pines all the leaves on the long-shoots are scales, the needles being confined to dwarf-shoots.

Another important character of these trees is that the overwhelming majority of them are evergreen, their leaves remaining attached for several years. To this rule there are three exceptions: *Ginkgo*, the Larch (*Larix*), and the Marsh Cypress (*Taxodium distichum*), all of which shed the whole of their green foliage in autumn. And we note that the leaves of these plants are of a lighter green colour, and generally less rigid than other coniferous leaves.

In most species the leaves are arranged spirally, but in one group, including the Juniper and Cypress, they are opposite or whorled. In some cases there is a sharp distinction between dwarf-shoots and long-shoots, as in *Ginkgo*, *Taxodium*, Pines, Larch, and Cedars (Figs. 68, 106, 110). The last three have needles arranged in clusters or tufts on the dwarf-shoots, and are soil; consequently the leaves seem at first glance to be arranged on the two sides of the branches, like the prongs of a double comb (*see* Fig. 118). The same comb-like arrangement may be seen in the Douglas Fir (Fig. 61) and in the Yew. Another species of Silver Fir (*Abies Pinsapo*) has stomata on both faces of its thick, flattish leaves, which therefore retain their obvious spiral arrangement and point in various directions. The Common Spruce (*Picea excelsa*) possesses slender four-sided needles with stomata on the four flat faces; its needles therefore do not assume the perfect comb-like arrangement, though those on the lower faces of the twigs twist to some extent, in order to avoid being concealed from the light. In Pines the stomata are on all the faces of the tufted needles, which therefore point in various directions. But in some Spruces the stomata are solely on the upper faces of the flat leaves, which therefore twist and range themselves somewhat in the same manner as in the Common Silver Fir. Finally, the sharp slender leaves of the Juniper have their stomata solely on the upper white waxy face; but frequently this surface is shaded by being more or less closely pressed against the stem. The distribution of the wax (and the stomata) on the leaves of conifers we shall find hereafter to be of assistance in the identification of various trees.

**Fig. 61.—Douglas Fir (*Pseudotsuga Douglasii*).**
**Branch seen from above (right-hand) and below (left-hand).**

The seedlings have two or more cotyledons.

We may range the gymnosperms described in this work in three groups, as indicated by the subjacent table:

*A.* No True Cone

| | |
|---|---|
| I. Leaves broad and falling in autumn . . . | *Ginkgo.* |
| II. Leaves narrow, linear, and evergreen; the projecting seed surrounded by a fleshy red cup . . . . | *Taxus* (Yew). |

*B.* A True Cone

| | |
|---|---|
| III. Leaves narrow, often needle-like (except *Araucaria*); seeds concealed among the cone-scales (*Juniperus* has a berry-like cone) . | Pinaceæ. |

**Distribution.**

The present and past distribution of gymnosperms is of deep interest. The existing representatives scattered over the earth from the Arctic to Equatorial regions, living on icy plains, high up mountains, in arid desert, dripping tropical forest, wet marsh, or forming vast forests in our climes, are but a feeble and scattered remnant of the gymnosperms that flourished in past ages. Some of the ancient groups have been exterminated, another reduced to one solitary representative, and still others broken up and their members banished to isolated spots. For instance, the *Ginkgo* family is now represented by a solitary species found wild only in Western China, though in past ages it was represented by many species of very wide distribution. The family (Taxaceæ) to which the

Yew (*Taxus*) belongs is mainly sub-tropical in distribution, though *Taxus* itself is a temperate genus. The Pinaceæ, which includes Pines, Spruces, Firs, Larches, Cedars, Monkey-puzzle, Cypresses, Junipers, and others, is, on the other hand, a family mainly occupying the temperate zones or the mountains of warmer countries. The representatives growing in the Northern Hemisphere (Pines, Spruces, and others) are replaced by entirely different genera (*Araucaria* and others) in the Southern. But even among Pinaceæ there is evidence of the extinction of species and their limitation to narrow areas. *Sequoia*, a genus including the American giant-trees, is now represented solely by two species which are confined to California; but in the Tertiary epoch it had many species distributed widely over North America, Europe, and Asia. Again, in their local distribution conifers often show that they are defeated combatants driven by competition to unfavourable sites; *Taxodium distichum* (the Marsh Cypress), for instance, occupies swamps.

**Defeat of the Gymnospermæ.**

How are we to account for this story of the defeat and partial massacre of the gymnosperms? So far as I am aware, no satisfactory suggestion has been made in way of a reply. To some extent the triumph of dicotylous trees over gymnosperms may be due to the superiority of insect-pollination to wind-pollination which prevails among the latter. The superiority of insect-pollination, however, is least when plants are social; that is to say, when many individuals belonging to one species live close together. Now, in temperate regions the coniferous, as well as the dicotylous trees, are largely social in the forest; but this is rarely the case in tropical countries, where a bewildering profusion of species is shown. I am of opinion, however, that the main reasons for the downfall of the gymnosperms must be sought in other directions. And as one cause I suggest their relatively small power of repairing injuries. Our knowledge of this matter is, however, nearly limited to north-temperate conifers. An injury of any kind to one of these has much more serious results than the same injury would have on a dicotylous tree: this is true, whether the damage be due to physical or chemical agencies, to animals, or to fungi. For instance, the Spruce (*Picea*) succumbs to poisoning by sulphurous acid (in smoke) more speedily than do broad-leaved trees that are more sensitive to this chemical body. A conifer badly attacked by bark-beetles perishes within a very few years, yet an Ash or an Elm may live for sixty or more years under a similar attack. A conifer completely defoliated by fungi or by animals for several successive years will perish or at least be more vitally weakened than a dicotylous tree. Again, though this may, in part, be but putting the proposition in a different manner, if we compare the number of serious insect or fungal foes attacking coniferous and broad-leaved forest trees, the lists relating to the former trees are considerably longer. But the question arises: "Why do the conifers succumb more easily?" Some reasons for this can be seen at once. In the first place, conifers have a smaller power of replacing destroyed leaves and shoots, which are the food-manufacturing organs, because their axillary buds are more limited in number, and they have less faculty of throwing out new shoots from older parts of the stem and roots. In the second place, supposing all the leaves of an ordinary deciduous broad-leaved tree to be destroyed during the growing season, not only can the tree set into activity many buds, but it has lost only the leaves of one season (and the temporary benefit of their activity); but with the same complete loss of foliage an evergreen conifer is deprived of that which required several years for its production. In this connection it is of interest to note that the solitary deciduous conifer growing as a forest-tree in Europe, the Larch, with its deciduous habit, also has a greater power of resisting serious injury than any other European conifers grown as forest trees. But it is possible that other more obscure characters cause conifers to fall easy victims to disaster—and we know that in transferring them from one climate to another they apparently exhibit smaller powers of acclimatisation than do their more successful rivals, the dicotyledons. There are some exceptions to the rules given above. The Yew has a great power of repairing injuries, and the Juniper an extraordinary capacity for enduring different climates and soils.

# PINACEÆ

This family has cones consisting of a number of scales, among which the seeds are hidden; so that its members are Coniferæ in the strict sense. The cone-scales are nearly always more or less woody when the fruit is ripe; but the fruit of the Juniper is like a berry, and is formed by the union of three fleshy seeds.

The foliage-leaves are almost without exception narrow, but are broad and pointed in *Araucaria*; their arrangement is spiral, opposite, or whorled.

The subdivision of the family and the recognition of the genera described in this work depend largely upon the structure of the flowers and fruits, and can be understood only after a study of these; but here we may give a preliminary Table that will render possible the recognition of the different genera:—

I. Leaves broad and pointed. Cone-scales not double, with one seed above each . . . . . . . . . . . . . . . . . *Araucaria.*

II. Leaves narrow, spirally arranged (except on the dwarf-shoots of *Pinus*). Cone-scales double, with two seeds on each:

- A. Some of the needles in tufts or clusters:
  - (*a*) Each tuft consisting of two to five needles (all the leaves on the long-shoots are scales): evergreen. Ripe cones pendent and falling as a whole . . . *Pinus* (Pines).
  - (*b*) Each tuft consisting of many needles:
    1. Evergreen: Needles stiff. Cone erect, and with scales falling off separately . . . . . *Cedrus* (Cedars).
    2. Deciduous: Needles soft and lighter green. Cone falling off as a whole . . . . . . *Larix* (Larch).
- B. Needles solitary, not in tufts:
  - (*a*) Scars left by fallen leaves flat or basin-like; leaves flat with white lines on the lower face. Ripe cone erect, with scales falling off separately . . . *Abies pectinata* (Silver Fir).
  - (*b*) Scars of fallen leaves mounted on projecting lumps Ripe cones pendent and falling as a whole with the cone-scales persistent:
    1. Leaves flat with white lines on the lower face. Cone showing woody scales and three-pronged thin scales . . . . . . . . *Pseudotsuga Douglasii* (Douglas Fir).

2. Leaves four-sided, with white lines on the sides. Leaf-scars mounted on conspicuous projections. Only one kind of cone-scale visible from the outside . . . . . . . . . *Picea excelsa* (Spruce).

III. Needles narrow, spirally arranged. Ovules more than two on each cone-scale, or two in the axil of each cone-scale:

A. Evergreen leaves. Cone-scales shaped like thick, short nails, with five seeds on each . . . . . . . . *Sequoia* (Wellingtonia).

B. Leaves deciduous, light green, arranged in two ranks on the dwarf-shoots, but spirally on the long-shoots. Cone-scales overlapping, with two ovules in the axil of each fertile scale *Taxodium distichum* (Marsh Cypress).

IV. Leaves opposite or whorled, narrow and elongated, or characteristic, small, green, and scale-like:

A. Fruit berry-like. Leaves white on the upper face, and awl-shaped in outline . . . . . . . . . *Juniperus communis* (Common Juniper).

B. Fruit a scaly cone:

(*a*) Cone-scales nail-like, not overlapping . . . . *Cupressus* (Cypresses).

(*b*) Cone-scales not nail-like, but overlapping . . . *Thuya* (Arbor-Vitæ).

## PINUS.—Pines (*Pinaceæ*)*

**Distinctive Characters.**

Pines are distinguished from all other needle-leaved conifers in that the spirally-arranged leaves on the long-shoots all assume the form of scales, while the needles are confined to dwarf-shoots, on which they are borne in tufts of two, three, or five. Cedars and Larches likewise have needles in tufts on dwarf-shoots, but each tuft includes many needles; furthermore, the leaves, spirally arranged on their long-shoots, take the form of needles (*see* Figs. 110–1, 106).

The Pine-fruits are likewise distinctive. Of each double-scale only the upper (seed-bearing) one grows to any considerable extent; it forms the woody cone-scale, and has on its exposed surface or *apophysis* an outgrowth or patch—the *umbo*. This umbo at once distinguishes the cone from the more or less similar ones of the Spruce and Larch. The cone-scales do not become detached from the cone, which falls off as a whole; whereas the fruits of the Cedar and Silver Fir have cone-scales that are shed separately while the erect cone is still on the tree (Fig. 125).

It is not easy to distinguish critically among all the species of *Pinus* without microscopical examination. But here we may give indications of the chief external characters that facilitate identification.

**Number of Needles.**

The number of needles on the dwarf-shoot is the first important aid in this respect. Some species are characterised by two, others by three, and still others by five needles on each dwarf-shoot, and are briefly described as two-needled, three-needled, or five-needled Pines. The Pines described in this book are all two-needled, with the exception of the Weymouth Pine, which is five-needled. It must be noted, however, that vigorous shoots of a two-needled species

* Those unacquainted with the construction of a Pine may not be able to follow this general account until they have read the special description of the Scots Pine, which immediately follows.

Fig. 62.—Stone-Pine (*Pinus Pinea*).
First and second year cone-fruits, and terminal resting-bud.

we may first note the general form of the tree, as represented by the deep-branched Weymouth Pine, the relatively bare-trunked Scots Pine, and, in this country, the compact Stone-Pine, almost resembling an overgrown bush. The bark, too, aids recognition, especially in the case of the Scots Pine, in which its coppery-orange tint on the upper part of the trunk is very distinctive.

**Needles.**

The needles differ in length, thickness, colour, transverse section, duration, and tufting. We can contrast the long needles of the Cluster Pine with the short ones of the Scots Pine, the thick ones of the former with the thin ones of the Weymouth Pine, and their marked blue-green tint in the Scots Pine with the

Fig. 63.—Stone-Pine (*Pinus Pinea*).
Second and third year cone-fruits.

may assume a three-needled character, while feeble shoots of the Weymouth Pine may have only four needles in each tuft.

**Position of Umbo.**

The next main character to be noted is the position of the umbo on the cone-scale. In the two-needled (and three-needled) species the umbo stands in the centre of that part of the surface of the scale that is exposed while the cone is closed; moreover, the scale is greatly thickened under its exposed surface. In other words, the *umbo* is *central* on a thickened *apophysis*. But in the Weymouth Pine (and other five-needled Pines) the woody scales are relatively thin, and have the umbo at the tip of each; the *umbo* is *terminal*.

Among other more detailed differences

pure green of the Austrian Pine, their short duration in the Weymouth Pine with their longer life in the Austrian Pine, and their tufted grouping in the Cluster and Weymouth Pines with their regular succession in the Scots and Austrian Pines.

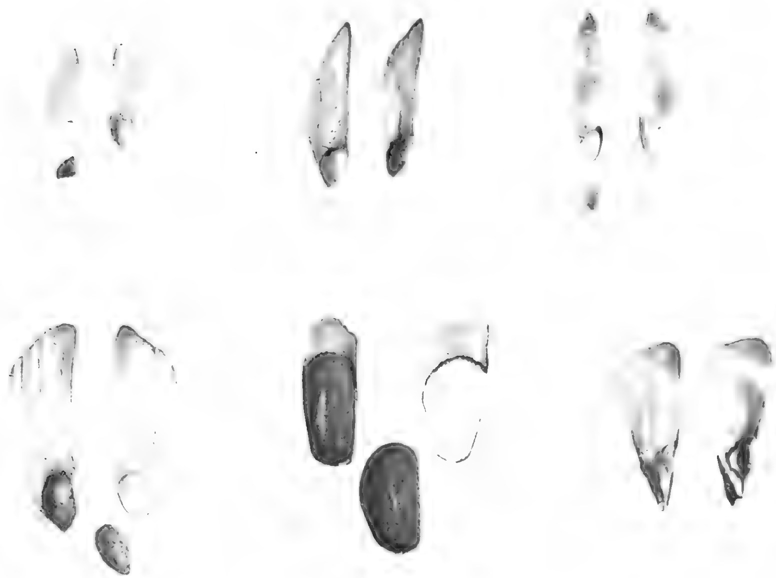
**Resting-buds.** The resting-buds vary in shape, size, colour, and surface. The significance of these distinctions may be seen by comparing the large buds of the Cluster Pine with outwardly curved scales, the small resin-coated ones of the Scots Pine, and the sharp-pointed buds of the Austrian Pine which are intermediate in type between those of the two preceding species.

**Male Flowers.** The shape and size of the male inflorescences show considerable differences, as instanced by the long, cylindrical, many-flowered ones of the Bishop's Pine, the small ones of the Scots Pine, and the few-flowered ones of the Weymouth Pine. The individual flowers likewise vary in size, but one critical feature to note in them is the size and shape of the connective-crest of each stamen.

**Female Flowers.** In the female flowers and cones the first distinction to note is the difference in position between the *sub-terminal* and *lateral* ones, the latter being well-represented by the Bishop's Pine with its false whorls of fruits.

Fig. 64. Stone-Pine (*Pinus Pinea*).
Open male flowers, and, at the tip, sprouting dwarf-shoots.

**Fruit Cone.** The mature fruit-cone shows its characteristic form to the best advantage when closed. In shape the large, rounded cones of the Stone-Pine contrast with all the other species, which taper at least at their ends, and vary in form from the cylindrical spindle-shape of the Weymouth Pine to the conical egg-shape of the Scots Pine. In length the cones vary from the long ones of the Weymouth and Cluster Pines to the short ones of the Scots and Bishop's Pines. In colour and lustre distinctions exist; the dull-surfaced dingy-coloured cones of the Scots and Weymouth Pines contrast with the brighter, lustrous ones of the other species. The outline of the apophysis and its general or partial elevation into ridges should be noted, as should the shape and tint of the umbo and the absence or presence of hooks, spines, or prickles. In yet another respect the Stone-Pine differs from the remaining species described: its cone requires three seasons to ripen, whereas theirs only need two seasons. The length of time that the ripe cones remain attached



1. Pinus sylvestris.
2. P. Pinaster.
3. P. strobus.
4. P. Pinea.
5. P. Laricio.
6. Abies pectinata.

Fig. 65.—Winged Seeds of Pines and Silver Fir.

affords a slight aid to identification: the Bishop's Pine retains its false whorls of prickly *closed* cones for a number of years; the Weymouth Pine allows its old empty cones to hang on for several seasons; but the majority of species retain their ripe, closed or open, cones only for the whole or part of one year.

**Seeds.** Finally, the seeds are grouped into two classes. That of the Stone Pine is very large, and possesses a useless little wing which becomes detached before the seed leaves the cone; those of the remaining species have a well-developed wing, but show differences in the size and colouring of both seed and wing.

## PINUS SYLVESTRIS (*Linn.*).—Scots Pine (*Pinaceæ*)

The Scots Pine is usually distinguishable from other Pines by the bluish-green needles, which are arranged in pairs, also by the bark, which is light copper or orange-copper in tint, except near the base of the trunk, where it is thicker and darker in colour; the fruit is a more or less conical cone with a dull (not polished) surface.

The main root descends deep, and gives off wide-spreading lateral roots, so that the Scots Pine can live on dry, sandy soil, and is not easily uprooted; but when the soil is shallow and rocky the main root is short and deformed, so that the tree is easily blown over.

The tree can attain a height of 150 feet, but usually does not exceed 90 feet, and at its base may be one yard in diameter. When in forest it displays a tall branchless trunk, capped by an umbrella-like crown, but like many other trees in the open it may retain its branches low down on the trunk for many years.

The bark is very characteristic. Excepting near the ground, it peels off regularly in thin scales, leaving a fresh orange-coloured to copper-coloured surface exposed, but low down the trunk the scales remain attached for a much longer time, so that the bark is thicker, darker, rougher, and marked with longitudinal and oblique fissures (Fig. 67).

**The Needles.**

The stiff, resinous, needle-shaped leaves are arranged in pairs exclusively on dwarf-shoots (Fig. 68). Each pointed needle is slightly bent, has minute marginal teeth, and is semicircular in cross-section. The stomata are arranged all round it, but wax is more abundant on the upper flat face, which is therefore bluish-green in colour, than on the rounded surface, which is of a dark green tint. The length of the needle is usually one and a half inches or two inches, but varies from half an inch to four inches. The needles usually live for three years; but in slow-growing specimens they may persist for five years, or, on the other hand, in old trees may perish in their second year of existence. Their span of life is probably largely determined by the amount of light reaching them.

It is of great interest to note that when the needles are dead or dying it is not they alone that are cast off, but the whole dwarf-shoot which bears them. In this case the sole office of the dwarf-shoot is to produce the two foliage-leaves, and when these have done their manufacturing work the shoot on which they are fixed is dispensed with.

**The Sheath.**

The stem of each dwarf-shoot bears at its base about ten thin scales, which constitute the so-called sheath (Fig. 68), and, above these, the two opposite needles between which is the minute terminal growing point. This last, in ordinary circumstances, remains inactive, but when the tree has been robbed of its needles (by the attacks of insects, for instance) the microscopic growing point can awaken into activity and produce long needle-like green leaves, which aid in atoning for the injury done. The sheath of scales plays its active part while the two needles are inside and emerging from the bud, and is undoubtedly devised to protect the young growing needles, round and over which it forms a silvery envelope (Fig. 35). As the bud of the dwarf-shoot is developing, the sheath at first keeps pace in growth with the young enclosed needles, but is finally ruptured at the tip, after which, having become useless, it shrivels and becomes brown. This brown sheath does not fall off as it does in the Weymouth Pine (*see* page 74).

**The Branches.**

The arrangement of the branches may best be understood if we examine the end of a twig in early spring, before it has commenced to grow (*see* Fig. 68). There we see a terminal scale-clad resting-bud, and close beneath it, ranged round the stem, a circle (false whorl) of similar lateral ones. When the growing season arrives the terminal bud sprouts forth a pallid long-shoot, on which are spirally arranged scales, but not a single needle. In the axil of nearly all of these, except a few near the summit of the year's growth, arise buds of the dwarf-shoots, which differ from ordinary buds on trees in that they grow out in the same season as the mother-shoot of which they are branches, and do not remain for even one year as resting-buds. But as the long-

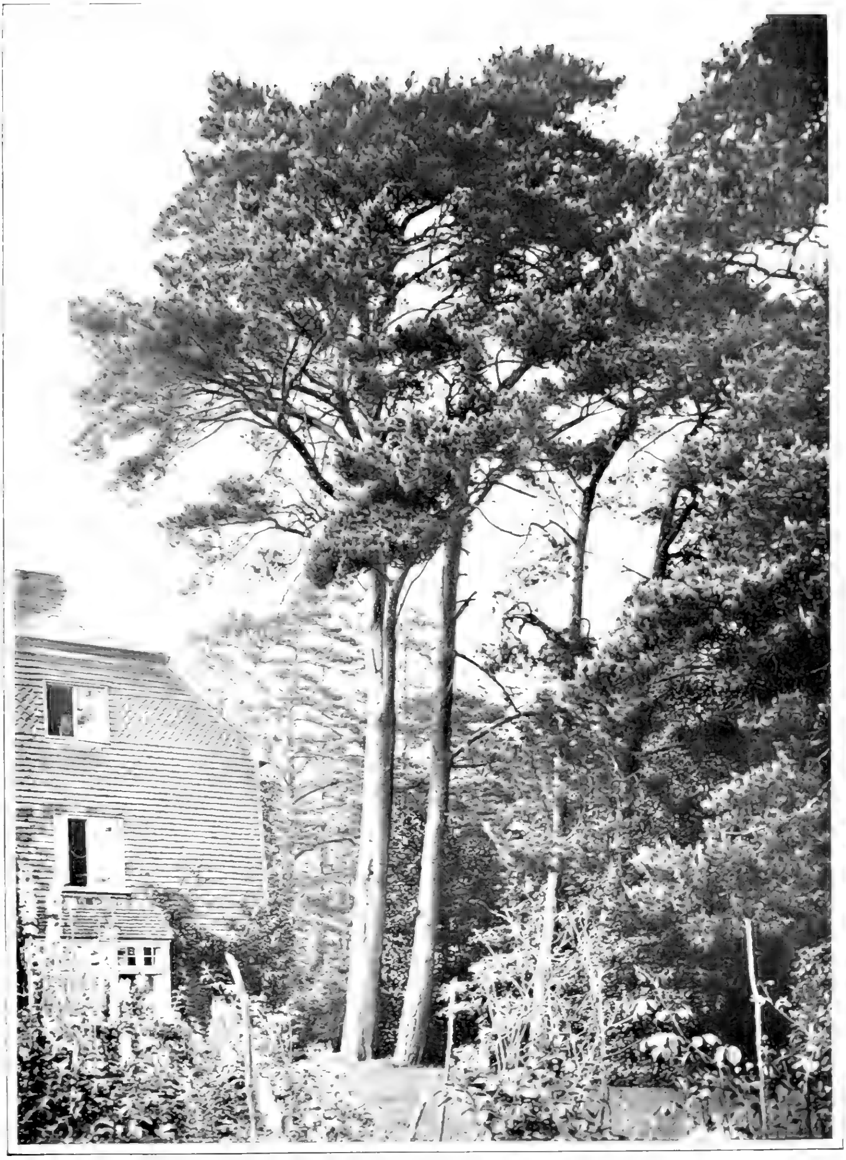


Fig. 66.—SCOTS PINE—*PINUS SYLVESTRIS.*

shoot ceases to elongate we see produced at its tip a resting-bud, and just beneath this, in the axils of a few scales, a circle of similar large resting-buds, which will not develop until the following year. These lateral resting-buds, immediately beneath the terminal one, behave just like the latter, even growing out in the same direction parallel to the main stem (Fig. 35), and only subsequently bending down so as to stand out nearly at right angles. It will thus be seen that each year a false whorl of long-branches is produced, so that the age of a stem agrees with the number of these false whorls or their remains, so long as these are visible (with one exception to be described in the sequel). Only rarely do long-branches shoot out from positions normally occupied by dwarf-shoots. It is worthy of note that when the terminal shoot or bud is injured, one or more of the lateral long-shoots replace it by growing upward in the direc-

Fig. 67.—Bark of Scots Pine.

**Fig. 68.—Twig and Buds of Scots Pine.**

tion that would have been followed by the injured shoot. As a rule, one of the lateral buds in the false whorl does not shoot out with the others, but remains as a kind of reserve bud for future emergencies. Again, in cases of serious injury, a dwarf-shoot may develop and behave like a true terminal long-shoot, or even the colourless scales on both kinds of shoots may endeavour to repair the loss of green needles by becoming themselves green. Thus, by very varied devices the Scots Pine strives to substitute new leaves or shoots for those that have been destroyed; and its powers in this direction are often called into play, because of the multiplicity of its serious foes. On the other hand, in specially favourable circumstances the tree can take advantage of the opportunity offered, not only by more vigorous general growth, but also, when it is a young plant growing on good soil in open country, by sending forth additional long-shoots in place of certain of the dwarf-shoots. In such a case additional long-branches are inserted between the ordinary annual false whorls of long-branches. [The Larch normally (*see* page 84), and the Douglas Fir often, produce long-branches in similar positions.]

The resting-buds (Fig. 68) are of an elongated egg-shape, clothed with many tawny, reddish or greyish scales, on and among which resin is deposited. The upper narrow triangular part of each scale is frayed out into fringe.

The Scots Pine in the open begins to produce flowers at the age of fifteen years; but in close forest does not bear any considerable crop of seed until it is from thirty to forty years old; or on moist soil, not before it has reached the ripe age of seventy to eighty years. Though bearing flowers every year, its good seed-years are separated by intervals of from two to four years. The flowers open in May or June.

The flowers are unisexual, male and female flowers nearly always occurring on the same tree.

**Male Flowers.**

The male flowers are yellow, egg-shaped, and small (only about a quarter of an inch long). They occupy the position of dwarf-shoots, and are confined to the base of the year's-shoots, where a number of them are grouped together to form an inflorescence (Fig. 34). Each male flower arises in the axil of a scale on a long-shoot: it has at the base about four scales, and above these many spirally arranged scale-like stamens which constitute the male cone. Each stamen has a very short stalk, a scale-like anther terminating in a shallow connective-crest, and bearing on its lower face two pollen-sacs. These open by longitudinal splits, and allow the sulphur-like pollen to escape. With the aid of a microscope it can be seen that each pollen-grain possesses two wing-like air-bladders which render it more buoyant. As the male flowers fall off soon after they shed their pollen, it follows that in the succeeding year or years the regions where the male flowers were clustered will be marked out by patches of stem devoid of long-shoots or dwarf-shoots, so that if, year after year, the same stem produces male flowers, the needle-bearing dwarf-shoots will present the appearance of being arranged in rosettes at intervals (this is shown in Fig. 34). On such twigs the life of a needle may be prolonged to eight or nine years.

**Female Flowers.**

The female flowers are lateral, but arise near the tip of the shoot produced during one season; they occupy the positions usually taken by lateral buds destined to produce long-shoots. The bud of the female flower, unlike that growing out into a long-shoot, develops actively in the first year of its appearance. As the little cone-like flower is upwardly directed and attached so close to the summit of the young twig it presents the false appearance of being terminal (Fig. 35); so that the female cones are in such a case often described as being "terminal," but we will more accurately refer to these as being "*sub-terminal.*" Each stalked female flower is a globular scaly cone, about one-fifth of an inch long, and varies in colour from green to red: it is rendered more easily visible by the circumstance that it develops before the subjacent dwarf-shoots have sprouted, and thus stands out at the top of the silvery twig. The axis of the flower bears at the base some scales, and above these the spirally arranged scale-like carpels. Each carpel is characteristic in form and double, for it consists of a lower scale bearing on its upper face another scale, which in turn carries two ovules at the base of its upper face: the lower is the *carpellary scale*, and the upper the *placental, ovule-bearing*, or *seed-bearing scale.*

**Pollination.**

The Scots Pine is wind-pollinated. Enormous quantities of pollen are produced and blown by the wind. At the same time the axis of the erect female flower has slightly elongated, so that the scales are somewhat separated. A pollen-grain, alighting in one of the gaps between the scales, rolls down a central ridge on the upper face of the ovule-bearing scale, and, in a manner that cannot be described here, reaches the ovule, into which it thrusts a tube.

**Ripening of the Fruit.**

The process of ripening of the fruit is a long one, requiring two seasons to accomplish. After pollination the stalk of the cone bends down; the seed-bearing scales grow in length and thickness, becoming tightly packed, and in August have assumed a grey-brown colour. In the meanwhile the carpellary scales have not increased materially in size, nor do they ever do so. In this

Fig. 69.—Ripe Cones of Scots Pine.

condition the young fruit remains during its first winter, so that in the following spring it may be seen in the same stage as is shown in Fig. 34. All the second season is taken up in the further growth of the cone, so that in autumn it is an egg-shaped or conical body, one to two and a half inches in length (*see* Fig. 69). Sometimes in the October of their second year the brown cones open and shed a few seeds, but usually no seeds are liberated until the following spring, that is in the third season after the appearance of the female flowers.

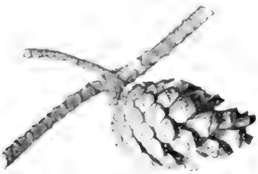


**Fig. 70.—Opening Cone of Scots Pine.**

**The Mature Cone.**

The mature cone requires special description, as Pine-cones afford important means of identification. First it is necessary to notice that the woody cone-scales visible are the enlarged seed-bearing scales. The portion of each scale which is exposed on the outer face of the closed cone is greatly thickened, and is termed the *apophysis;* the possession of this thickened apophysis is characteristic of Pines, and distinguishes them at once from Spruces, Silver Firs, the Larch, Cedars, and others. The shape of the apophysis varies in the same cone, and very greatly in different specimens of this tree; it may be flat, or may project like a pyramid or even as a prominent hook. One feature to be noted is that the apophysis (and hence the cone) is dull, not polished, and varies in tint from greyish to reddish brown. In the centre of each exposed surface (apophysis) of the cone-scale is a lump, or boss, described as the *umbo*, which is continued into an evident transverse ridge, and often into a less obvious vertical ridge. The point to notice is that the umbo is *central, i.e.* in the centre of the apophysis; in this respect the cone differs from that of a Weymouth Pine, as will be explained later. As the cone dries its scales gape asunder, commencing at the top (Fig. 70), and permit the escape of the fertile seeds which are confined to the middle portion (Fig. 71). It should be noted: first, that the cone-scales do not fall off, but that the empty cone as a whole is detached later in the year (in October usually); secondly, that the cone is pendent: in both respects the cone agrees with those of the Spruce, Douglas Fir, and Larch, but contrasts with those of the Silver Fir and Cedar, which are erect and shed their scales separately. The Pine, then, has *persistent* cone-scales, but the Silver Fir and Cedars have *deciduous* cone-scales.

Two winged seeds (Fig. 65, 1) lie on the upper face of each fertile seed-bearing scale.

**Dissemination.**

The length of the brown seed is about $\frac{1}{4}$ in., and that of its wing about $\frac{2}{3}$ in. The seeds are distributed by the wind. But incidentally they are conveyed by water, and by woodpeckers. After falling to the ground the wing is detached so that it largely loses its power of transport through the air.

**Germination.**

The seed includes a little embryo, with about six cotyledons, embedded in food-material (*endosperm*). On germination the root emerges and grows rapidly into the soil; the tips of the cotyledons remain for a time within the seed, sucking food from the endosperm. The structure of the main shoot of the resultant seedling is quite different from that of shoots produced in later life. The seedling at first produces solitary long spirally arranged needles ("primary leaves"), directly on its main stem. During its second year the little plant continues to produce these peculiar solitary leaves, which, however, gradually give way above to scale-leaves, the upper ones of which have in their axils the ordinary two-needled dwarf-shoots: and near the tip of this year's-shoot arises the first false whorl of resting-buds. In the third year these last produce the first false whorl of branches (so that in estimating the age of a young plant by counting the false whorls, two years must always be added). For the remainder of its life the Pine produces on the long-shoots only scale-leaves.

**The Timber.**

The timber of the Scots Pine is resinous and has a red heart-wood. The tree may attain a great age, in fact one specimen has been estimated as being nearly six hundred years old.

Fig. 71.—Fully-open Cones of Scots Pine.

The Scots Pine finds itself at home over a very wide area in Europe and North Asia, and at 70° N. extends to the limit of coniferous forest. It is essentially a lowland form, though in the Caucasus, in stunted and malformed shape, it ascends up to considerably over 8,000 feet, and to lower altitudes farther north. In our country, though liking a good soil, it can grow in dry sandy heaths or on wet peaty moors; for its wax-coated leaves, its relatively slow transpiration, and its well-developed root-system enable the tree to live in these places where all roots find a difficulty in absorbing rapidly. In its more dwarfed forms (high up mountains or on bleak moors) the tree shows considerable likeness to the two-needled Mountain Pine (*Pinus montana*), though it never assumes the peculiar, serpentine-branched, shrub-habit of the Alpine form of this latter Pine. The Scots Pine is a tree demanding a considerable amount of light, and if it be in a forest the rapid rate of growth of the stem during early life aids the tree in its struggle for light.

## PINUS LARICIO (*Poir.*).—Austrian Pine and others (*Pinaceæ*)

Pinus Laricio is a species including several sub-species, among which are the Austrian and the Corsican Pines. In this description the former sub-species, *Pinus Laricio*, var. *austriaca*, will be particularly considered.

The species resembles the Scots Pine in many respects, but particularly in bearing its semi-cylindrical needles in pairs, in its sub-terminal female flowers, and in its somewhat conical cones. But it differs in the larger dimensions of nearly all details (buds, needles, male flowers, cones, seeds), in that the cones have a polished surface and usually stand out at right angles (instead of hanging down); in the longer life of its needles, which are not blue-

**Compared with Scots Pine.**

green; and finally in the darker, usually blackish-grey, bark which is fissured even up in the crown.

The root-system, though it can descend deep in loose soil, is marked by great horizontal extension of the lateral roots, which often run close to the surface. These may be exposed and extend actually over bare rock, here and there dipping into crevices, and by their great development giving the tree such a firm hold that, unlike the Scots Pine in the same position, it is not easily blown down.

The tree may attain a height of one hundred feet, and its trunk a diameter of a yard. The cylindrical trunk retains its lower branches for a longer period than does the Scots Pine, and consequently has a larger crown in relation to its height. And this crown is dense because the long needles remain attached usually for three and a half or four and a half years. It is of

Fig. 72.—Bark of Corsican Pine.

interest to note that this greater longevity of the needles and main branches is associated with the character that the Austrian Pine does not demand so much light as the Scots Pine; consequently the relatively dense shade of the upper parts of the crown or twigs does not so speedily lead to the death of the underlying branches or older needles. The usual occurrence of branches lower down the trunk than in the Scots Pine offers another means of distinguishing between the two species. At first the main stem bears long branches arranged in very regular false whorls, but in the full-grown tree the shape of the crown varies considerably in the different varieties, being broadly egg-shaped in the Austrian Pine until ripe age is attained, when the crown is more umbrella-like.

Fig. 73.—Austrian Pine—*Pinus Laricio.*

The bark at the base of the trunk is massive and deeply fissured (*see* Fig. 72). The bark-scales remain attached for a much longer time than in the Scots Pine, so that the trunk is of a dark colour throughout.

The long needles vary in length from two to more than six inches; they are two and a half up to eight years, but usually for about four years.

The arrangement and general structure of the dwarf-branches and long-branches are as in the Scots Pine. The long, con-

Fig. 74. Corsican Pine—*Pinus Laricio.*

dark green on both faces, with yellow tips and finely saw-like margins. Apart from these features they resemble those of the Scots Pine, and are ranged in pairs (rarely in threes) on dwarf-shoots (Fig. 75). They remain attached for periods varying from spicuous sheaths of the former branches do not fall off; but one characteristic feature of the long-shoots requires notice. On these each scale, instead of falling off as a whole, merely sheds its upper portion, while the lower portion remains attached to a prominent "leaf-cushion"; these persistent basal parts of the scales (Fig. 75) give to the stem a rough and furrowed appearance until the formation of bark causes the superficial rind to be thrown off.

**Fig. 75. Twig and Resting-buds of Austrian Pine.**

**Buds.** The buds destined to produce long-shoots are in all conditions large. The terminal resting-bud (Fig. 75) is about one inch in length, oblong, very pointed at its end, glistening, and of a light chestnut colour. Its fringed scales are very numerous, the lower ones being bent backwards and outwards, and the upper ones lying flat (adpressed) and being cemented together by resin.

**Flowering.** The Austrian Pine commences to flower in the open at an age of from fifteen to twenty years, but in the forest not until about the thirtieth year. The general structure and arrangement of the flowers are like those of the Scots Pine. Hence, in the descriptions of the flowers only the distinctive features will be mentioned here. The flowers open late in May or early in June.

The bright yellow male flowers (Fig. 76) are cylindrical in shape, and as much as an inch in length. The connective-crest of the anther is large, finely-toothed, and tinged with purple.

The bright-red female flowers are subterminal (Fig. 77), and have extremely short stalks. After pollination (by the agency of wind) the young cones become blue-violet, and remain erect or bend down far less than in the case of the Scots Pine. At the end of the first season they are about the size of hazel-nuts. The fruits require two seasons to ripen, and the scales gape open only in the spring or early summer of the third season.

**Cones.** The cones when ripe are characteristic in pose, form, and surface. They are often grouped in pairs and point outwards, more or less at right angles to the stem (Fig. 78). Each cone has an

**Fig. 76.—Male Flowers of Austrian Pine.**

Fig. 77.—Female Flower and Young Shoots of Austrian Pine.

almost imperceptible stalk, and is conical, being usually from two to three, never more than four, inches in length. The apophysis bulges, and has a transverse ridge as well as a central nipple-like umbo, the pinkish-brown colour of which contrasts with the yellow-brown of the rest of the apophysis. The upper apophyses may be prolonged into little spines.

The two seeds lying on the upper face of each fertile cone-scale are larger, heavier, and longer-winged than in the Scots Pine. Each grey-brown seed is $\frac{1}{4}$ to $\frac{1}{3}$ in. long, while the wing is usually about one inch in length (Fig. 65).

The structure of the seed, its germination, and the form and behaviour of the seedling all differ so slightly from the corresponding features in the Scots Pine that detailed description here would be superfluous.

The timber of this long-lived species is scarcely distinguishable from that of the Scots Pine.

Compared with the Scots Pine, all the varieties of *P. Laricio* are more southerly in distribution, as they are naturally limited to South Europe (including Spain and Central Austria) and Asia Minor.

The Corsican Pine differs from the Austrian in the tint and smaller size of its needles, which do not seem to form such large, dense tufts of dark green foliage. Another variety, *P. Laricio* var. *stricta*, seen in this country, is marked by the shortness, the regular arrangement, and prolonged retention of the branches on the main stem.

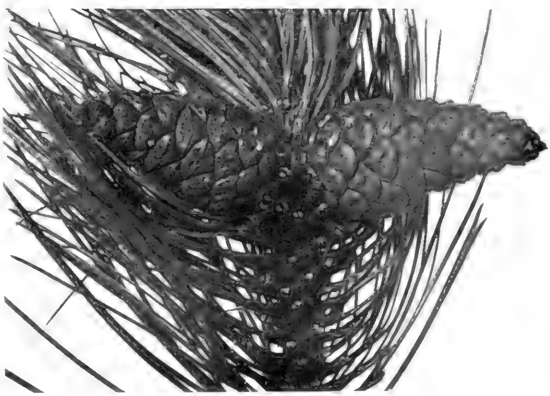


Fig. 78.—Cones of Austrian Pine.

## PINUS PINASTER (*Sol.*).—Cluster Pine (*Pinaceæ*)

The Cluster Pine agrees with the Scots and Austrian Pines in having its semi-cylindrical needles arranged in pairs, and in its somewhat conical cones. In the dimensions of its details it generally exceeds both these species. It is marked by the following special features: its long needles are thick and distributed in clusters; the resting-buds are large, show no resin externally, and their scales are all curved outwards at their tips; the large and brightly-polished cones

**Fig. 79.—Bark of Cluster Pine.**

**Distinctive Features.**

are often clustered in numbers together. The name "Cluster Pine" is due to the arrangement and number of the cones, though it might to some extent apply also to the leaves.

The root system consists of a deep main

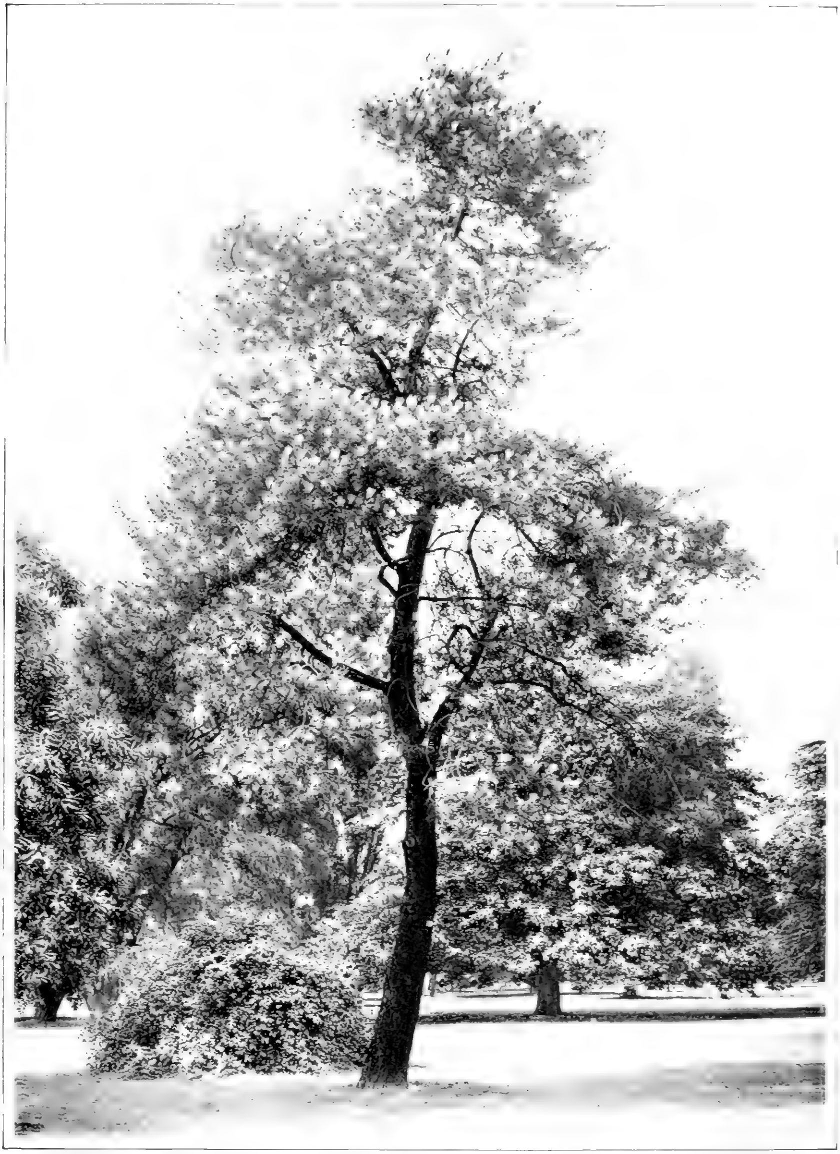


Fig. 80.—CLUSTER PINE—*PINUS PINASTER*.

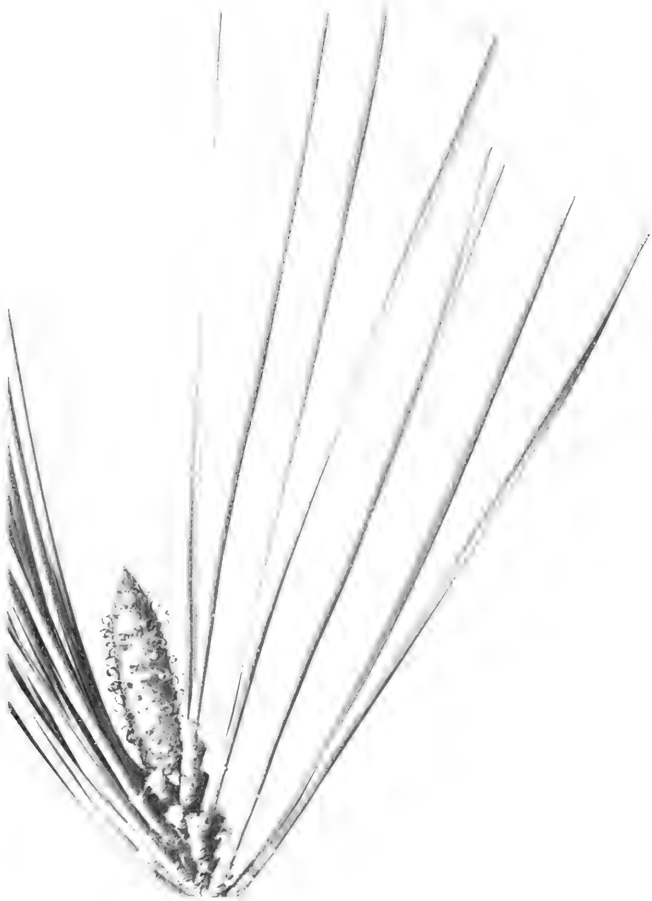


**Fig. 81.—Bud of Cluster Pine.**

root with many branches, which descend deeply or run near the surface. The depth of the root-system is associated with the young tree's exceeding rapidity of growth and with the faculty the tree has of growing on sand.

**Root System.**

The columnar trunk attains a height of from sixty to a hundred feet, and a diameter of three feet; and the tree, even when old, preserves the regular pyramidal shape of its crown. (The illustration provided scarcely indicates the typical character of the tree.) The thick, dark grey bark is traversed by deep longitudinal furrows (Fig. 79).

**Trunk.**

The long, pure green, often twisted, needles are arranged in pairs (or, on young plants,

Fig. 82.—Male Flowers of Cluster Pine.

often in threes) on dwarf-shoots. They vary in length from four and three-quarters to eight or even nine inches, and their unusual width is associated with marked stiffness. The needles live for three or four years. Their clustered arrangement towards the end of the year's-shoot is especially noticeable on the shoots that have borne male inflorescences (Fig. 82).

**Needles.**

The large red-brown resting-buds vary in length from one to two inches, and at first sight display two characteristic features—the tips of all the scales are curled outwards (Fig. 81), and there is no resin on the outside of the bud (contrast *P. Laricio*). The margins of the scales are frayed out into white cottony "cilia" which interweave. The bud is rather blunt at the tip, and much less pointed than that of the Austrian Pine. Though there is no external resin, yet within the bud the scales are cemented together by this substance. The resting-buds frequently behave in a peculiar manner, for they often sprout during the season of their production. These precocious buds shoot forth in late summer instead of waiting until the following spring. Perhaps the sensitiveness of the tree to frost is partially due to this habit.

**Resting-buds.**

The tree commences to flower at the age of ten or fifteen years; indeed, even in its fifth year of existence it may produce female flowers, but the cones resulting from these are sterile (similar sterile cones may arise on juvenile specimens of Scots and Austrian Pines). The flowers open in April and May, and agree in general structure with those of the Scots Pine.

**Flowering.**

The male flowers are arranged in very large golden, broadly oval, inflorescences situate at the base of the current year's-shoot (Fig. 82). The oval flower is up to three-quarters of an inch long; and each anther has a large, erect, ruddy, connective-crest which is toothed, so that the young flowers show a reddish colour, since only these crests are visible from the outside.

**Male Flowers.**

The stalked violet-red female flowers are about half an inch in length. They are usually arranged in whorls of three or more. The female flowers are close to the tip of the young twig, and the mature fruits are

**Female Flowers.**

therefore only slightly, if perceptibly, below the false whorl of branches among which they occur (Figs. 83, 84); so that I do not regard this as a case in which the cones are lateral,* though they are so described in various works.

After pollination, which is accomplished in the same manner as in the Scots Pine, the cone requires two seasons to ripen. It becomes roundish-oval (Fig. 84, upper cones), and subsequently elongated-conical, but is usually bent at its tip (Fig. 84, lower cone); at this stage the surface shines as brightly as if it had been polished. In its early stages the cone possesses a stalk of relatively considerable length, but the stalk elongates so slightly as to be comparatively insignificant in the mature cone. The ripe cones, though gently inclined downwards, radiate from the stem in a somewhat star-like manner in false whorls. The mature cone is six or eight inches long and from two to four inches thick. The apophysis projects and has a prominent transverse ridge: the central umbo usually also projects strongly, is pointed, and continued out into a straight or hooked process. When the cone is ready to shed its seeds, in the autumn of the second season or the spring of the third, it has lost something of its glistening appearance and is dull brown, and may remain closed for years. Like those of most other Pines, the cones are unequal-sided; the face towards the stem being less prominent in all its features than the outer face that is exposed to the light.

**Cones.**

* See the description of Pinus muricata, p. 67.

The two seeds on each fertile scale are about one-third of an inch in length, while the wing is from three to five times as long (Fig. 65, 2). In the structure and germination of the seeds, and development of the seedling, the Cluster Pine is so similar to the Scots Pine as to require no special description.

**Seed.**

The Cluster Pine, like *P. Laricio*, naturally is more southern in distribution than the Scots Pine. It occurs in the evergreen region of Mediterranean countries as well as in Portugal. More sensitive to cold and shade than the Austrian Pine, it demands as much light as the Scots Pine. Growing readily on sand, even if this be dry and

**Distribution.**

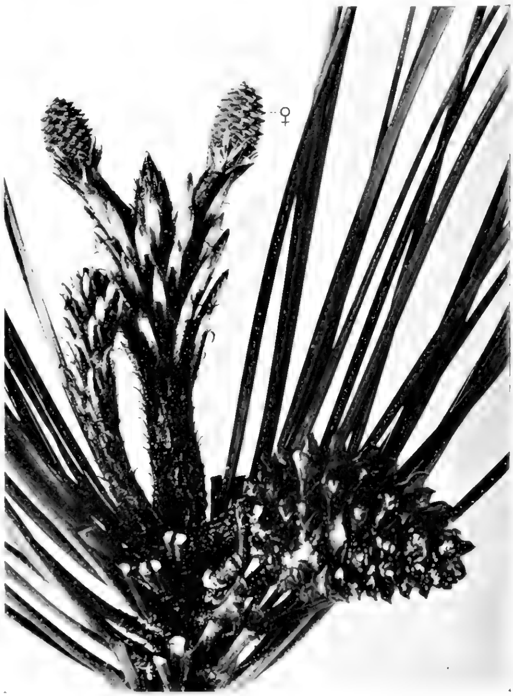



Fig. 83.—Female Flowers (♀) and Cone of Cluster Pine.

Fig. 84.—First and Second Years' Cones of Cluster Pine.

sterile near the surface, so long as there is moisture in the deeper layers to which the roots penetrate, the Cluster Pine is the conifer which is the best adapted in warm-temperate countries for the afforestation of sandy plains and dunes.

**Habitat.** As its forests are for the most part on the coast, and as the tree can grow near the sea, it is frequently termed the "Maritime Pine"; but the needles are easily injured by salt spray, and *P. pinaster* perishes if the roots be laved by sea-water, so that it can be said to scarcely deserve the name.

In contrast with the Austrian Pine, it can hardly endure a chalky soil; if it grows on such a soil, it remains very stunted, and bears needles of a sickly yellow-green tint.

## PINUS MURICATA (*D. Don*).—Prickle-cone Pine (*Pinaceæ*)

The Prickle-cone or Bishop's Pine is a two-needled species: its prickly cones are arranged in false whorls between the false whorls of branches, and remain closed and attached to the stem for several years. These features afford sufficient means of identification.

This Pine is cultivated only in comparatively few gardens and parks in Great Britain, but is briefly described in this book because it illustrates two points of interest in reference to the cones.

Its home is in California, where it becomes a rough-barked tree usually forty to fifty feet in height, but sometimes as much as ninety feet. When full-grown, in California, it has a compact round-topped crown, so that the illustration here given of a specimen grown in England can hardly be regarded as typical.

The stiff needles (which are sometimes in tufts of threes) are long, being usually four to six inches in length, and pure green, and are grouped into clusters at intervals. They commence to fall in their second year.

The resting-buds (Fig. 85) are very pointed, and coated externally with resin.

The male inflorescence is striking, because of its long and cylindrical shape (Fig. 86), as well as its distinctly reddish-

**Fig. 85.—Resting-bud and Withered Male Flowers of Prickle-cone Pine.**

**Flowers.** orange colour. The length of the inflorescence accounts for the separating successive groups of needle-tufts on stems that successively bear male flowers (Fig. 85).

But it is in the arrangement of the female flowers, and subsequently of the cones, that this Pine is most interesting. The female flowers are produced in false whorls considerably below the terminal bud of the year's-shoot, so that they occupy the positions of lateral dwarf-shoots. Sometimes two such false whorls are produced in one season (as is shown in Fig. 88).

**Fruit.** The consequence is that the fruits are arranged, not in the same false whorls as the branches, but on the stem between two false whorls of branches (Fig. 89).

Another peculiar character of the fruits concerns their behaviour. In place of opening, shedding the seed, and falling off soon afterwards, the ripe cones remain for years firmly closed and attached to the stem (Figs. 87 and 89). Similar behaviour is characteristic of some three-needled Pines, such as *P. tuberculata*, which, like the species here described, has unequal-sided cones. The prickly character of the conical, glistening, brown cones (Fig. 89) gives to the species one of its popular names.

The seeds are winged, but how they naturally contrive to escape is

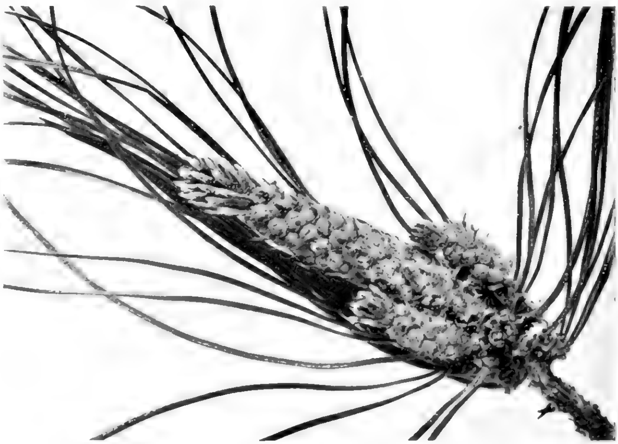


**Fig. 86. Male Flowers and Sprouting Shoots of Prickle-cone Pine.**

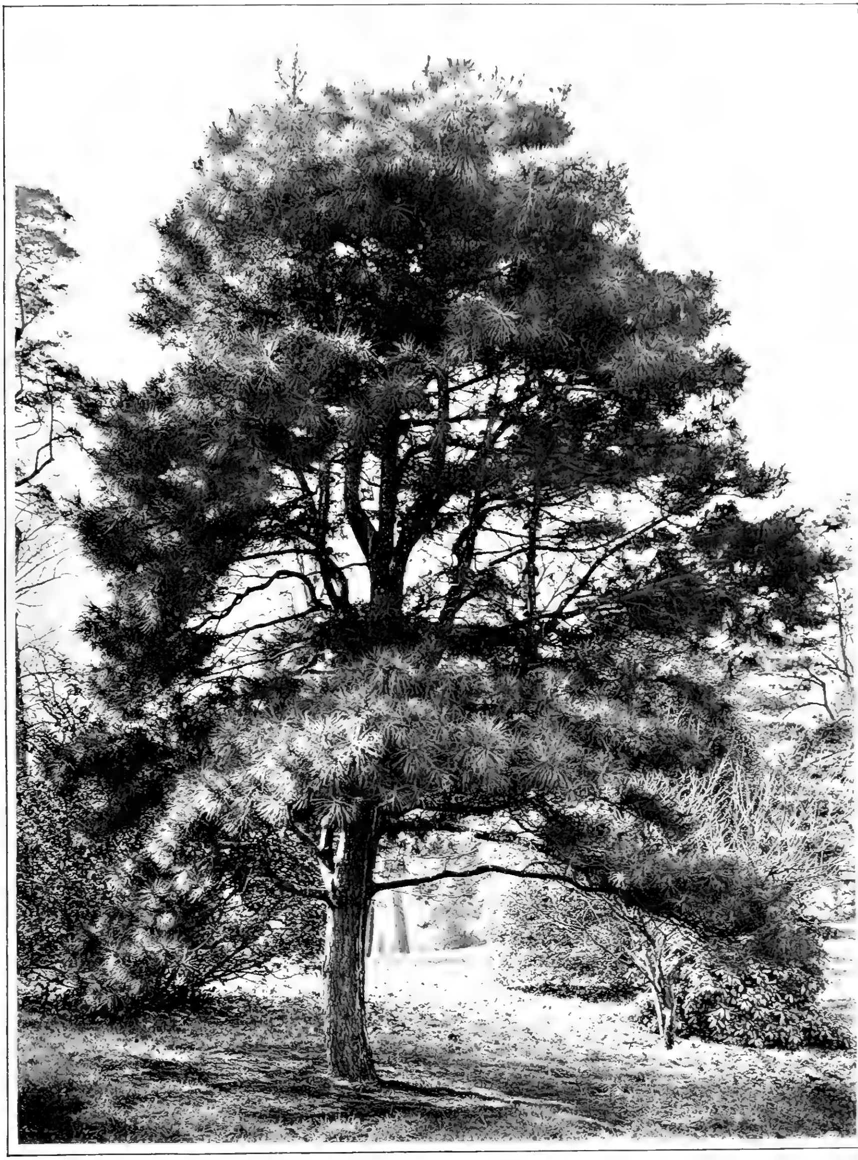


Fig. 87.—PRICKLE-CONE PINE—*PINUS MURICATA.*

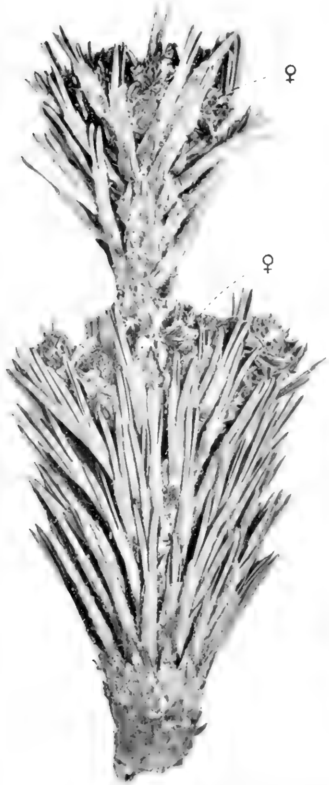



Fig. 88.—Two False Whorls of Female Flowers (♀) on Sprouting Shoot of Prickle-cone Pine.

not fully understood. It is, however, known that closed pine-cones of this type can be artificially induced to open by the application of dry heat. Hence the suggestion has been made that they are adapted to provide for the continuance of the species after fire has devastated the forest.

**Escape of Seeds.**

In possessing prickly cones the Bishop's Pine rather shows a similarity to three-needled species of *Pinus* which are apt to display spines or hooks on their cones; and the likeness is intensified when the Bishop's Pine acquires shoots with three-needled tufts. Yet even in this guise it can be distinguished by the somewhat dark hue of its not large cones, as well as by their position and prolonged attachment in a closed condition. There are, however, two three-needled species that retain their cones in the same manner—namely, *P. tuberculata* and *P. insignis*. But the cones of these are remarkable for their extremely unequal-sided shape and are relatively light in colour; moreover, they are feebly or not at all equipped with sharp prickles.

**Similarity to other Pines.**

Fig. 89.—Closed Old Cones of Prickle-cone Pine.

## PINUS PINEA (*Linn.*).—Stone Pine or Umbrella Pine (*Pinaceæ*)

The popular names of this two-needled Pine indicate two of its distinctive features—the umbrella-like shape of the tree when mature, and the very large stony seeds; in addition, the long paired needles, and, above all, the lustrous broad, almost globular, cones render the tree well-nigh unmistakable.

The rough-barked tree in its Mediterranean home attains a height of ninety feet, and when full-grown has a long trunk with a wide, flat-topped or umbrella-like crown. But the specimens occasionally seen in England are much shorter, and possess a compact, broad, rounded crown, so that the comparatively small tree, with its

Fig. 90.—Bark of Stone Pine.

strong, low-pitched boughs, often resembles an overgrown bush (Fig. 91).

The long, thick needles (Fig. 62) recall those of the Cluster Pine. The upper scales of the resting-bud are loose and curved outwards (Fig. 62).

The male and female flowers occupy the same position as in the Scots and Austrian Pines, so that the cones are sub-terminal (Figs. 62-4).

**Cones.** The first point of interest is that after pollination the cones require, not two years, but three, to mature (*see* Figs. 62, 63), and shed their seeds in the spring of their fourth season. Each lustrous, brown, mature cone (Fig. 63) is broadly egg-shaped, or approaches a globular form, being usually four or five inches in length and three or four inches in thickness, and stands out horizontally or inclines slightly downwards.

Each large, bulging apophysis is marked by five or six radiating ridges, and capped by a flat, central umbo.

**Seeds.** The very large, edible seeds are equal in size to a hazel-nut; they contrast sharply with those of the Pines previously mentioned, not only in this respect, but also in the very feeble development of the wing which separates at once from the seed (Fig. 65, 4). This extremely short wing affords us an example of a functionless relic representing a structure useful in the ancestors, but now useless and degenerate. The seeds are thus not distributed by the wind, but probably are scattered by the agency of animals, though their seed-coat is hard and woody.

The large seedling has ten or a dozen bluish-green cotyledons.

In distribution the Stone Pine resembles the Cluster Pine, for its centre is the Mediterranean region, and it extends, mainly near the coast, from the Canary Isles to Asia Minor.

Fig. 91.—STONE PINE—*PINUS PINEA.*

## PINUS STROBUS (*Linn.*).—Weymouth Pine (*Pinaceæ*)

The Weymouth Pine differs from all the Pines previously described in the following respects: the dwarf-shoot bears five needles, and sheds its sheath very early; the cones are long and narrow, with thin cone-scales, which are each capped by a *terminal umbo*.

The enormous root-system, with its deep main root and far-reaching lateral roots, is, no doubt, largely responsible for the varied situations in which this tree can grow.

Fig. 92.—Bark of Weymouth Pine.

In its youth the tree is very symmetrical

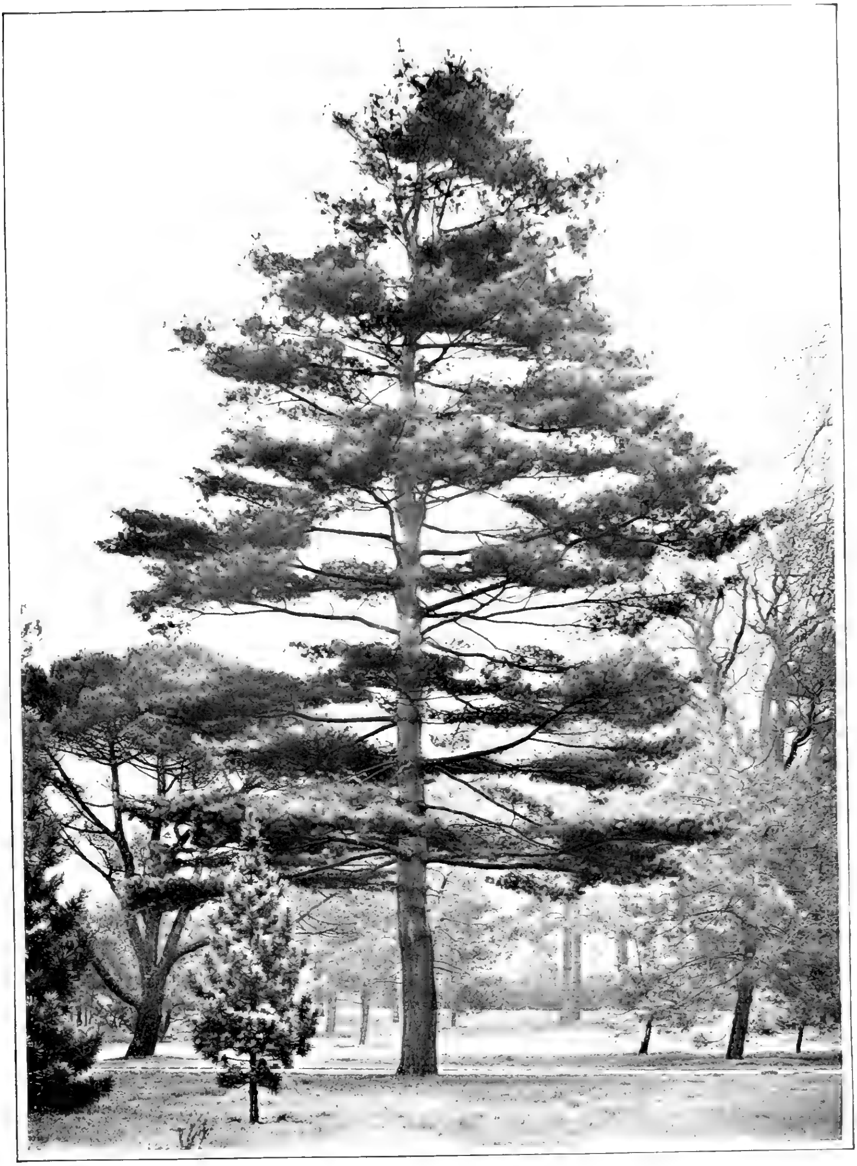


Fig. 93. -WEYMOUTH PINE—*PINUS STROBUS.*

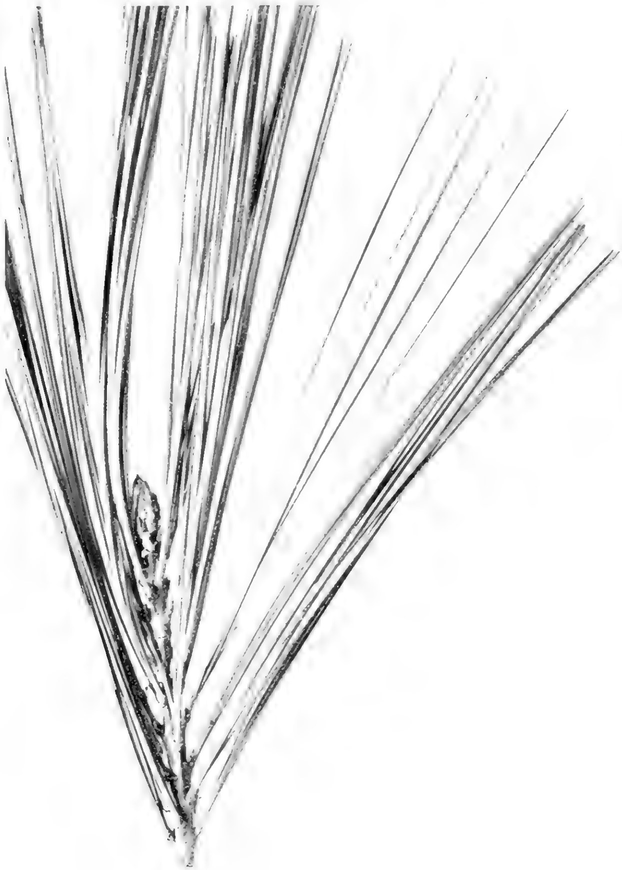


Fig. 94.—Foliage of Weymouth Pine.

in form, with regularly succeeding false whorls of branches. These are retained for a long time, so that the regular pyramidal form of the tree persists for many years. Indeed, in the open country the Weymouth Pine may attain a height of ninety feet and bear branches right down to the ground: no other common Pine shows such a power and habit. The very straight trunk often attains a height of 100 feet and a diameter of a yard; but in its North American home the "White Pine" (as it is there named) occasionally towers head and shoulders above its fellows, with a height of 250 feet and a diameter of six feet.

**Form and Dimensions.**

**Bark.**

The bark during the first twenty or thirty years is smooth, lustrous, and blackish-grey, but raised here and there into small blisters caused

**Fig. 95.—Resting-bud of Weymouth Pine.**

by resin-filled sacs lying in the rind. After this the bark becomes longitudinally fissured, and has little scales firmly pressed on to the main ridges (Fig. 92).

**Needles.** The thin needles are grouped in fives (rarely fours) on the dwarf-shoots; they vary in length from two and a half to four and a half (or more) inches, and are softer than those of the Pines previously described. But from these they differ in another and important respect. In order to understand the distinction in question, it must be remembered that when the pine-needles of a single dwarf-shoot are young and enclosed in the sheath they are all packed together to form a cylinder. Hence, when there are two needles on the shoot, each is shaped like a half-cylinder, and the flat faces of the two are pressed together in the bud, while the rounded outer faces are in contact with the sheath; when cut across, therefore, each needle shows a semicircular section, the inner face being flat and the outer rounded: such is the form of the needle in all the two-needled Pines previously dealt with. But if there be five needles to form the cylinder, each can only form a fifth of this, and, when cut across, must be approximately triangular in section, with two side (inner) faces where two contiguous needles are pressed against it in the bud, and with one outer rounded face. Such is the form of the needle in the Weymouth Pine. On the two flat faces the stomata are ranged and their presence is indicated by wax, which lends a bluish tinge to the green; while the convex outer (lower) face of the needle is of a pure, dark green. The margins have minute saw-like teeth which can be detected by rubbing the needle between the fingers in a downward direction.

During their first year the needles are directed upwards at the ends of the twigs,

**Fig. 96.—Male Flowers of Weymouth Pine.**


**Fig. 97.—Female Flowers and One-year-old Cone of *Pinus excelsa*.**

**Behaviour of Leaves.**

but in their second season they spread out. In cold weather they move and tend to be parallel to the stem. This behaviour may partly account for the little injury done to the tree when snow threatens to overload it, but the danger is guarded against also by the short duration of the leaves, which usually live for only two years. The brevity of life of the needles is of special interest when it is remembered that the Weymouth Pine endures shade better than the Scots Pine, whose needles are, nevertheless, longer-lived. It is thus evident that the number of years during which needles remain attached to a species of Pine is no critical indication of the amount of light needed by that species.

**Dwarf-shoots.**

Two characteristic features in regard to the dwarf-shoots deserve attention. In the first place, from the beginning they are more restricted in distribution than in the Scots Pine. They are limited to the upper (apical) portion of the year's-shoot, because no dwarf-shoots arise in the axils of the lower scales produced near the base of each season's twig (Fig. 98); only on some long-shoots do these lower scales have male flowers in their axils. The second special character of the dwarf-shoot is that its lustrous brown sheath is shed more or less completely in the first season of its existence (Fig. 94) instead of remaining attached till the fall of the dwarf-shoot; so that the sheathless dwarf-shoots contrast with the permanently sheathed ones of the two-needled species previously described.

Apart from these features the branching proceeds on the plan described in connection with the Scots Pine.

The orange-brown resting-buds (Figs. 94, 95) are nearly half an inch long, of a narrow egg-shape, and coated with resin.

**Flowering.**

The tree produces its first crop of flowers at the age of from ten to fifteen years in the open, or from fifteen to twenty years within the forest. Really good seed-years seem to succeed at intervals of about five years, though flowers and cones are produced at shorter intervals. It is of interest to note that in the United States in some seasons the tree bears many cones that produce no seeds capable of germinating. The flowers open in May or June, and their distribution on the tree is as in the Scots Pine.

The egg-shaped little male cones (about half an inch long) are grouped together in comparatively small numbers (Fig. 96). The connective-crest of the anther is erect and short.

The pink "bloom"-coated female flowers occur alone, or in groups of from two to five, at the tip of the current year's-shoot (compare Fig. 97). They are cylindrical, almost half an inch in length, and perched upon a relatively long stalk, which is clothed with narrow, fringed scales.

**Development of Cone.**

The cone requires two seasons to change from a flower to a ripe fruit. After pollination each seed-bearing (placental) scale grows equally on its upper and lower face, thickens but slightly, and therefore produces no thick shield-like apophysis such as is produced in all the Pines previously described. The elongated scales are pressed flat and close together. In the autumn of the first year the young, reddish-brown cone is still erect and has grown to a length of nearly one inch, though it still remains slender (about a quarter of an inch thick). It is not until the following spring that the cone-stalk bends downwards (Fig. 98), and the cone commences to grow very rapidly, attaining maturity in August or September.

**Ripe Cone.**

The ripe, closed cone (Fig. 99) hangs down on a distinct, but rather short stalk; it is narrow, being of a cylindric-spindle shape, and varies in length from four to seven inches (or more) and in thickness from one to one and a half. Its dull brown surface is here and there flecked with resin. Each woody cone-scale is relatively thin, and, in place of showing an umbo in the centre of its exposed face, has an umbo at the tip. Thus the Weymouth Pine is distinguished from all the two-needled pines in possessing a *terminal* umbo on its cone-scale.

The cone dries and gapes open very shortly after ripening, either in September or October (Fig. 99). The winged seeds are liberated, but the empty cones remain attached for years. (This behaviour must not be compared with the retention of the closed, seed-containing cones of the Bishop's Pine.)

The seed is about a quarter of an inch in length, and its wing four times as much (Fig. 65, 3).

The germination and form of the seedling (with from eight to eleven cotyledons) require no special description.

The resinous heart-wood is reddish in

**Fig. 98.—Young Growing Shoot and One-year-old Cone of Weymouth Pine.**

Fig. 99.—Open and Closed Cones of Weymouth Pine.

colour, and in each annual ring the light-coloured "spring-wood" gradually shades into the red "autumn-wood."

**Distribution.** The true home of the Weymouth Pine is the eastern part of North America (from 49° N. to 34° N.). It lives on the plains, and as regards soil is extremely accommodating. It demands but little light, and is not sensitive to frost.

*Pinus excelsa* (Himalayan or Blue Pine) is a tree in cultivation that is exceedingly like the Weymouth Pine, from which it differs generally in the larger dimensions of its details, and particularly in the longer stalk of the larger and relatively broader cone. The greater breadth of the ripe cone is already suggested by the one-year-old cone shown in Fig. 97 when compared with that in Fig. 98.

Very similar to *Pinus excelsa* is *P. Peuce*, which is, however, a shorter tree with much shorter leaves and cones and with almost spherical resting-buds.

Another five-needled species not uncommonly cultivated in Great Britain is *P. Cembra* (Cembran Pine), which rather recalls *P. Peuce* in general habit. But it contrasts sharply with all three of the above species in the shape of its cone, which is short and plump, has thick scales, each possessed of a terminal umbo, and encloses wingless seeds.

## LARIX EUROPÆA (*D.C.*).—LARCH (*Pinaceæ*)

The Larch is easily recognised by reason of the following characters: (i.) Its dwarf-shoots bear tufts of numerous light-green, deciduous, flat needles; (ii.) even in winter the leafless dwarf-shoots are conspicuous on the twigs; (iii.) its general form is that of a coniferous tree, but the main branches are not regularly disposed in false whorls; (iv.) its branchlets hang down and bear purple female flowers or small woody cones, which nevertheless point upwards.

The root-system has no true main root, but consists of numerous lateral roots, some of which descend suddenly, others only after extending horizontally for a long distance. The Larch can thus grow on rocky sites or stony slopes without being easily uprooted by the wind.

**Dimensions and Form.** The tree may attain a height of 160 feet, though it does not commonly exceed ninety or one hundred. The tapering trunk (Fig. 101) is straight, save in unfavourable circumstances, when it becomes bowed. The crown is slender, loose, and fresh green in hue; the main boughs, which are not arranged in regular false whorls, are relatively thin, extend horizontally or incline downwards, but sweep up at their ends; while the swaying branchlets mostly hang vertically downwards. The lightness of the crown and the early death of the boughs below it harmonise with the intense demands for light made by the Larch, though it is true that trees grown in the open retain their branches low down the trunk (Figs. 101–2).

face); they are therefore easily distinguished from the darker, stiffer, four-sided, evergreen needles of the Cedars, which show a similar distribution

**Needles.**

Fig. 100.—Bark of Larch.

The mature bark (Fig. 100) is thick and scaly, sometimes traversed by very deep fissures; its tint is a dark, sometimes reddish, grey except for freshly-exposed red patches.

The light-green needles, which become golden and fall every autumn, are soft and flat (though slightly keeled on the lower



on the tree. On the long-shoots they are more pointed, solitary, and spirally arranged; but on the dwarf-shoots they are longer, also narrower, and form tufts, including from twenty-five to sixty needles.

The structure and mode of growth and branching of the twigs show many points

Fig. 101.—LARCH—*LARIX EUROPÆA:* WINTER.

Fig. 102.—LARCH—*LARIX EUROPÆA*: SUMMER.

**Fig. 103. Twig of Larch in Winter.**

**Twigs.**

of interest. If we examine the part of a long-shoot that has concluded its first year's growth, we note its terminal, bluntly egg-shaped resting-bud and, in the axils of only some of the needles, hemispherical lateral buds (Fig. 103). Thus, unlike the Pines, the Larch has no dwarf-shoots with tufted needles on the long-shoots of the current season. The surface of this twig is raised into ridges which are the leaf-cushions, as each continues into the stalk of the leaf (Figs. 103 and 104). As the twig slowly thickens in subsequent years the ridges become distorted and sinuous, but still can be traced upwards to the persistent projecting leaf-scars. In the spring of the twig's second season of existence all the buds that awake into activity, and are destined to become vegetative branches, sprout in the same manner, giving rise to close tufts of needles, as if they were dwarf-shoots. This tufted condition lasts for about a month, after which the terminal bud and some of the higher lateral ones grow out into long-shoots, while the other tufted young branches remain as dwarf-shoots (Fig. 106). In the third active season the buds of this shoot behave as before, at first presenting the young tufted appearance; subsequently the terminal buds on the main shoot and on the lateral long-shoots grow out vigorously, as also do the buds of some of the dwarf-shoots, which thus develop, so to speak, into belated long-shoots. These never afterwards develop so vigorously as the other long-shoots; they ramify but slightly, live for a shorter time, and may bear male flowers. But there still remain on this three-year-old shoot some lateral dwarf-shoots that continue to act as such. Thus, year after year, dwarf-shoots may live, each year showing an additional ring of scale-scars (as the scales of the resting-bud fall off) and producing a fresh tuft of needles, but remaining short. After from ten to twenty years they become overgrown by the rind of the stem bearing them, and thereafter act as resting-buds; and it is to the possession of these buried buds that the Larch owes its power of shooting forth branches from old parts of the trunk. Thus the dwarf-shoots of the Larch differ from those of the Pine in having a growing point that is regularly active year after year.

The resting-buds (Fig. 104) are resinous and clothed with glistening brown scales, which have fringed margins.

**Flowering.**

Flowers occur when the Larch has attained an age of fifteen years in the open, or from twenty to thirty years in the forest, though precocious individuals may produce cones with sterile seeds. The purple-red female and yellow male flowers occur on the same tree, and open in early spring, when the leaves unfold. They arise from buds externally like purely vegetative buds, and may be close together on the sides of the same slender hanging long-shoot. Each arises as the termination of a dwarf-shoot.

**Fig. 104. Resting-bud of Larch.**

The male flower (Fig. 105, ♂) in the season of its production is preceded by no needles on its axis. Unlike the male flower of the Pines, this sulphur-coloured little cone stands alone; it always points more or less upwards even when borne on a hanging branchlet

(Fig. 105). In structure the flower is essentially like that of the Scots Pine; but a most interesting difference presents itself in the structure of the pollen-grains, which have no balloon-like little bladders to assist them in floating in the air. This fact must, perhaps, be correlated with the occurrence of female flowers low down the tree or among the very numerous male flowers, and be contrasted with the generally higher position of the female flowers in Pines, Silver Firs, and Spruces, whose pollen-grains possess bladders.

The dwarf-shoot ending in the pretty female flower, on the other hand, shoots forth a rosette of needles (Fig. 105, ♀). Thus we see on the dwarf-shoot, in succession, an envelope of bud-scales, a rosette of needles, which gradually give way to bract-scales, above which is the purple-red flower itself.* The plump, egg-shaped flower always is erect, as is the ripe cone, whatever the direction of the branch bearing them may be (Figs. 105–7), as the flower-stalk executes the necessary curvature. In general structure the flower is like that of the Scots Pine, in so far as it consists of spirally-arranged double-scales, each of which has two ovules on the upper face. But there is this essential difference: the large-scale is the purple-red carpellary (bract) scale, which alone is seen from the outside, and has a long, slender tail; while the small seed-bearing (placental) scale is only just large enough to bear on it the two downwardly directed ovules.

Pollination by the agency of the wind takes place just as in Pines, except that the large carpellary scale guides the pollen-grain to the ovules. The erect position of the female cone is therefore a matter of necessity. It has been observed that absolutely isolated Larch-trees do not produce fertile seed; this probably indicates that, to secure proper seed-formation, the female flower must be pollinated by pollen from another individual.

* It is not uncommon for the stem of the cone to go on growing as a long-shoot and bear foliage-leaves, so that in a sense the flower continues as a vegetative branch. And, contrary to the statements usually made, the female flower occasionally terminates a long-shoot.


**Fig. 105.—Male (♂) and Female (♀) Flowers of Larch.**

After pollination the carpellary scales (as in the Pines) remain small and dry up,

**Cones.**

but the seed-bearing scales grow vigorously, close together, and become woody but not thick nor possessed of an apophysis. The cone, unlike those of the Pines, ripens in its first season, and when mature in September it has not greatly enlarged, being only about twice the size of the original flower (Fig. 106). The light-brown, mature cone is oblong or egg-shaped and about one inch or one and a half inches in length. It does not open until the following spring, when its scales gape asunder and do not fall from the cone. As the cones are still erect (Fig. 107), the seeds are not easily dislodged from the niches in which they lie; some are blown and shaken out by the wind, others disturbed by birds and squirrels which peck the seeds or gnaw the cones; but seeds may still be found even in old cones. This at once shows the effect of the pendent position of Pine-cones in facilitating the dispersal of seed. The Larch-cones remain hanging on the tree for years, but such old cones are easily distinguished from the recent ones by their darker colour, just as the older twigs in winter are distinguished from the lighter straw-coloured recent ones.

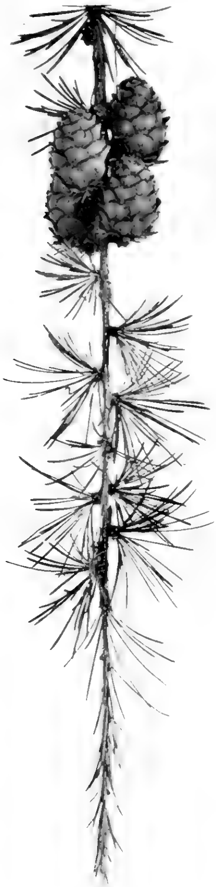


**Fig. 106.—Closed, Ripe Cones of Larch.**

The little seeds are, in design and structure, like those of the Pines, each having a firmly attached wing, and containing an embryo enveloped in food-material.

The seedling, which usually has six (four to seven) cotyledons, is most interesting in one respect: it is partly evergreen. During the first four years it produces needles, of which the uppermost live through the winter and part of the following season. This peculiar feature may be an instance of a plant preserving in its youth an ancestral character that it loses later in life; for undoubtedly the ancestors of the conifers were evergreen. Another point worthy of note is the very rapid growth of the main stem of the young plant: this behaviour must be associated with the urgent demands for light made by the Larch.

The resinous red heart-wood is very like that of the Scots Pine.

**Distribution.**

The Larch, though so widely cultivated in the plains and hills of Great Britain and Europe, is really a mountain plant whose centre of development lies in the Alps of Central Europe (Switzerland, Austria, etc.). It reaches an altitude of 7,500 feet, where it marks the limit of tree-growth, and is reduced to a grotesque dwarf. But in the plains the

Larch can be widely cultivated, partly because it can grow on various kinds of soil and can endure extreme cold; indeed, in its mountain home the tree even shoots forth leaves while the soil is covered with snow. Having a small crown, and being leafless in winter, the Larch does not suffer from being overloaded with snow. Even when disturbed by the storm of wind it can recover itself. But it is extremely exacting as regards supply of light, for it demands more light than any other forest-tree grown in this country, with the possible exception of the Birch; and its seedlings can practically endure no shade. Its light crown, rapid growth in height when young, and rough bark all denote a light-loving habit.

The Larch is subject to a number of serious diseases in its lowland situations.

**Diseases.**

Larch-canker is caused by a fungus (*Dasyscypha calycina*), which enters by a wound, locally kills the living part of the bark and the creative layer responsible for the production of new wood, and gradually extends its attack round the stem. The disease reveals itself specially in the form of cracks, cankers, and depressions in the bark-clad stem; and on the diseased spot may be seen the tiny, fiery red, saucer-like fructifications of the fungus. Another disease is caused by a small moth (*Coleophora laricella*), whose caterpillar tunnels the leaves, and causes them to turn brown and die. Finally, an insect (*Chermes viridis* [*Ratz*]), related to common Green-flies, does damage by piercing and sucking the needles; but, as its life is partially passed on the Common Spruce, its history will be briefly described in connection with that tree.

**Fig. 107.—Half-grown Cones and Open Old Cone of Larch.**

## CEDRUS.—CEDARS (*Pinaceæ*)

A Cedar is recognised by its dwarf-shoots, each bearing numerous tufted needles, which are darker and stiffer than those of the Larch. The characteristic cones are erect, plump, with densely-set, thin scales, which fall off separately and liberate the broad-winged seeds.

Fig. 108.—Bark of *Cedrus Atlantica*.

In this country the Cedar is represented by three introduced varieties or species—the Deodar, Cedar of Lebanon, and Atlantic Cedar—whose general shapes will be described subsequently.

The bark is rough (Fig. 108).

The boughs, though clothed in youth with

Fig. 109. CEDAR OF LEBANON—*CEDRUS LIBANI.*

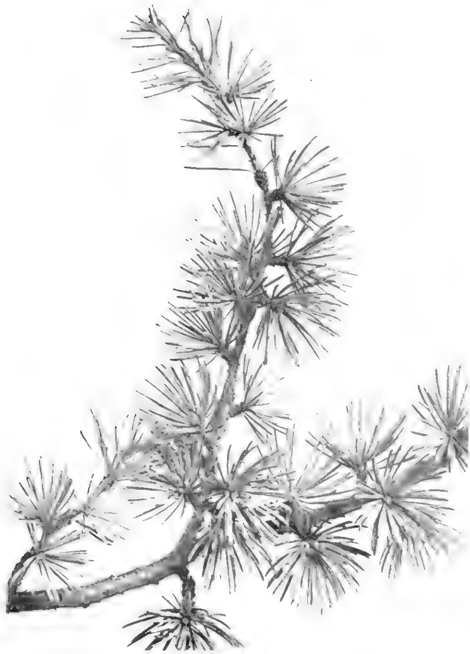


Fig. 110.—Shoots of Atlantic Cedar.

ally arranged on the long-shoots are longer than the numerous ones tufted on the dwarf-shoots (Figs. 110 and 111).

**Needles.**

The growing point of these latter remains active year after year, and gives rise either to long-shoots, dwarf-shoots or terminal flowers. But so long as the dwarf-shoot behaves as such its growth in length is extremely slow; in addition to lengthening by growth at its tip, the stem elongates at its base, which lies within the parent stem, and in this way avoids being completely buried within the latter. On the long-shoots each needle may be seen to consist of a four-sided green upper part, and a pallid short basal part, which remains attached to the stem after the green portion has fallen off. Thus the leafless twig is studded with small leaf-cushions and recalls that of the Spruce, which, however, bears no tufted needles. The leaves of the Cedars live and remain attached for three, four, or five years.

spirally-arranged needles, have their lateral long-shoots approximately in one plane because they branch particularly from the flanks. The foliaged dwarf-shoots spring from the upper face and flanks of the sloping long-shoots and incline upwards, thus rendering the lower face of the branches devoid of tufted needles, with which the upper face bristles. The boughs are not arranged in definite false-whorls.

**Branching.**

The solitary needles spir-

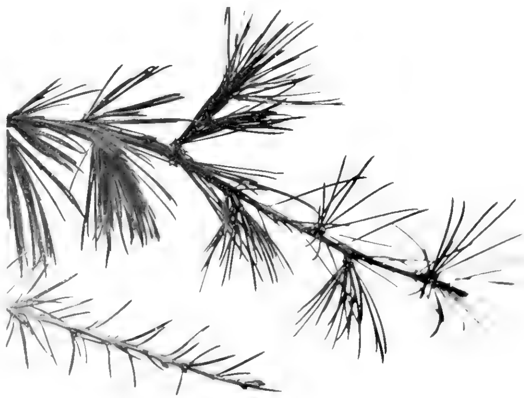


Fig. 111.—Shoots of Deodar.


Fig. 112.—Male (♂) and Female (♀) Flowers of Deodar.

**Flowers.** The flowers do not open until September or October. Both kinds occur on the same individual, and are solitary, erect, elongated, egg-shaped cones terminating foliaged dwarf-shoots. In general structure and in mode of pollination the flowers agree with those of the Scots Pine.

The yellowish male flower (Fig. 112. ♂) is about two inches long, and each anther is tipped with a well-developed connective-crest.

The similar female flowers (Fig. 112. ♀) are generally inserted somewhat higher up the tree. The cone-scales are double.

After pollination the carpellary (bract) scales remain small and are ultimately invisible from the outside, but the seed-bearing scales enlarge and become broad, thin, hard, and very closely packed together.

**Cones.** The cones require between two and three seasons to ripen, by which time they have attained a length of from two to five inches, and a thickness of from one and a half to three inches (Figs. 113–4). The mode of release of the seeds is quite different from that prevailing in the Pines and Larch, but is very similar to that characteristic of the Silver Fir: for the cone-scales loosen and become detached from the axis of the cone, leaving this erect and bare on the branch (Fig. 113).

In order to gain an insight into the construction of the closed Cedar-cone, one does not endeavour to cut it open, or to cause the separation of the cone-scales by the application of dry heat (as in the case of most cones), but one immerses the ripe cone in cold water for twenty-four or thirty-six hours, after which the cone-scales readily fall apart.

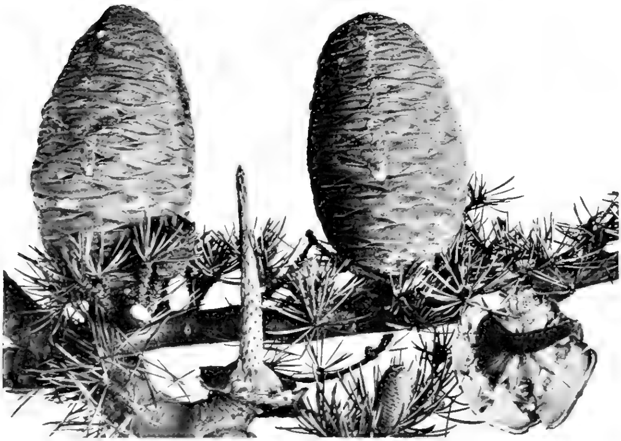


Fig. 113.—Cones of Cedar of Lebanon before and after fall of Cone-scales.

The seed is about half an inch in length, and has a large, broadly-triangular wing twice as long. The embryo possesses from eight to ten narrow cotyledons.

**Seed.**

The reddish-brown heart-wood is fragrant, and, unless diseased, is devoid of resin passages.

The Cedar of Lebanon attains a very great age—possibly two thousand years.

**Kinds of Cedars.**

The distinctions ordinarily drawn among the three kinds of Cedars are not wholly satisfactory, as they depend upon comparisons made between trees at different ages and places, and partly upon insufficient examination of the cones.

In old age, at least in forest, all three kinds of Cedar may have the flat-topped crown that is often regarded as distinctive of the Cedar of Lebanon, but in this country the younger specimens of the other two are more pyramidal in crown (Figs. 109, 115–6).

**Cedar of Lebanon.**

The Cedar of Lebanon (*C. Libani* [Barrel.]) has long, far-stretching, horizontal boughs, and a more or less flat-topped crown; moreover, even in young trees the main stem soon bends to one side. The dense, dark-hued foliage casts a deep shade, and the needles are shorter than in the Deodar. This Cedar occurs on Mount Lebanon, as well as on mountains in Cyprus and Asia Minor generally.

**Atlantic Cedar.**

The Atlantic Cedar (*C. Libani*, var. *atlantica*) approaches the preceding one in shortness of the needles (Fig. 110), and usually in the dark tint of the foliage.

Fig. 114. Cones of Atlantic Cedar.

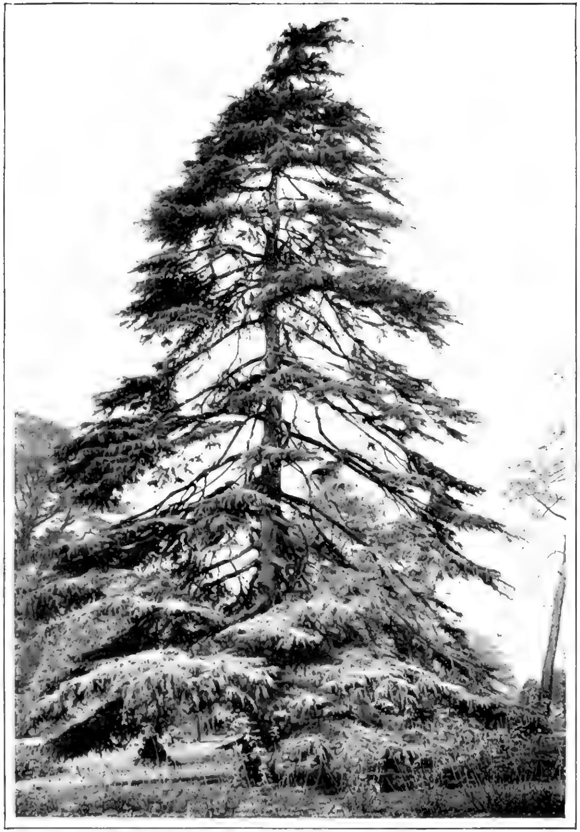


Fig. 115.—DEODAR—*CEDRUS DEODARA*.

Fig. 116. ATLANTIC CEDAR—*CEDRUS ATLANTICA*.

But in this country the boughs usually incline sharply upwards, and the main stem remains erect to its very tip. The home of the tree is on the Atlas Mountains in North Africa.

**Deodar.**

The Deodar (*C. Libani*, var. *Deodara*) has the longest and lightest-coloured needles (Fig. 111). The boughs are usually more horizontal than in the Atlantic Cedar; and the branches differ from those of both other forms in that their ends droop, as do the young little twigs. The Deodar differs from the Atlantic Cedar also in its sensitiveness to frost and (at Kew) in the date at which its buds sprout. The Deodar is the Himalayan Cedar.

It will be noted that the three kinds of Cedar are naturally restricted to mountains, and that each kind is confined to its own narrow area of distribution. If they be regarded as belonging to one species they provide an admirable example of a single species with a discontinuous geographical distribution, since it occurs only on mountains separated by vast stretches of country. Some time in the distant past the common ancestor of the three occupied a continuous area on plains in the Northern Hemisphere, but stress of competition and climate have driven its descendants to their separate highland homes, where they have acquired slight differences.

All three kinds of Cedar show their own varieties as regards length and colour of needles, and pattern of growth.

Column-shaped and weeping forms are met with, as are cultivated varieties with light-green, bluish-white, or even variegated foliage.

[In various books it is stated that the cones of the Deodar are smooth, and not hollowed at the top; while those of the other two are stated to be slightly hairy and depressed at the top. Furthermore, the Atlantic Cedar is described as having the smallest cones. But these distinctions can hardly be upheld, though they may indicate tendencies.]

## ABIES PECTINATA (*D.C.*).—COMMON SILVER FIR (*Pinaceæ*)

**Distinctive Features.**

The Silver Fir differs from Pines, Cedars, and Larches in having all its evergreen needles solitary and arranged in distinct spirals, and none of them in dense tufts. The needles are flattened and have two white lines on the lower face; and on the horizontal branches their stalks twist and cause them to form apparently two ranks of leaves with the under surfaces facing the ground. When the leaf falls its scar is flat or concave (contrast the Spruce). The ripe cone is erect, and its scales fall off separately, releasing the winged seeds and leaving behind the upright bare axis (contrast the Pines, Larch, Spruce, and Douglas Fir). Finally, the bark remains smooth for a long time, and is usually light in colour, while the main branches are arranged in false whorls.

**Dimensions and Form.**

The height attained is great—sometimes as much as 150 feet (or rarely 200 feet), and the thickness of the trunk six feet (or even nearly double that). On the straight, tall trunk the boughs are arranged in false whorls; they remain attached for a long time, and in the open may extend almost to the ground, as the crown changes from a pyramidal to a cylindrical shape, which it retains very late. The retention of the branches agrees with the character of the Silver Fir as a tree capable of enduring much shade. When it has attained full height the Silver

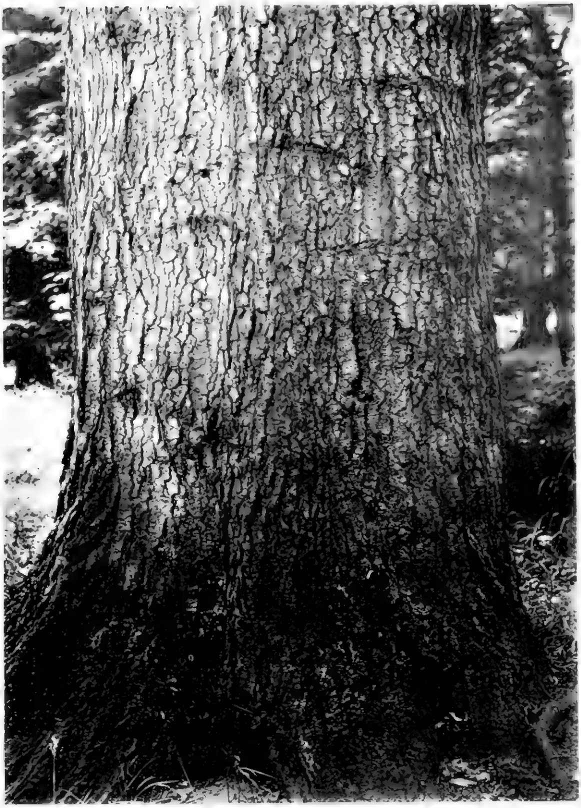


Fig. 117.—Bark of Silver Fir.

Fir produces at the summit a collection of branches which together form a large nest-like complex, in the centre of which the end of the main stem is concealed. (This is already denoted in the tree represented in Fig. 120.) On the boughs the branches and branchlets are arranged in a horizontal plane, so that the tier-like disposition of the boughs is very evident.

**Bark.** The bark remains smooth for from fifty to one hundred years; this again suggests the shade-bearing character of the tree. The colour of the bark varies, but is often light, because it is incrusted by certain lichens. On the smooth surface of the stems three sets of markings are visible: elevations caused by resin-bladders, raised circular scars due to lenticels, and leaf-scars. Eventually the bark becomes divided by longitudinal and transverse cracks, and produces thin scales (Fig. 117).

The needles are flattened, with a slight keel, half to one inch in length, and possess a short stalk, which expands below into a disc. The leaf-tip varies from a single sharp point to an indentation

**Fig. 118.—Branches of Silver Fir, seen from above and from below.**

(Figs. 118-9). The needles are solitary and spirally arranged; on erect stems they are disposed equally round the axis; but on the horizontal stems their stalks twist and cause them to be arranged in double comb-like pattern on the shaded branches (Fig. 118), and to be inclined upwards on the more exposed branches in the crown, where they are also thicker and have broader white bands (Figs. 119, 122, 124). On the branch there is a remarkable difference in the sizes of the leaves, those on the upper face being shorter than those on the lower face, where they may be twice as long (Fig. 118). The upper face of the needle is of a rather dark green, but the lower face has two long, white stripes of wax that indicate the distribution of the stomata. The needles are long-lived, usually remaining attached for eight or ten years (or even fifteen), so that the Silver Fir may cast a relatively deep shade. This longevity of the needles is yet another sign of the shade-enduring quality of the Silver Fir. The fallen needles leave flat, or even concave, circular scars (Fig. 121), so that the smooth twigs contrast sharply with the very rough ones of the Spruce.

**Needles.**

In its general scheme of production of the long-shoots the Silver Fir agrees with the

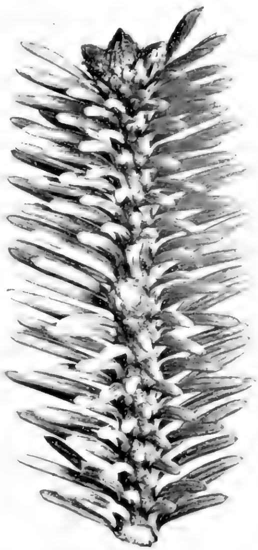


**Fig. 119.—Exposed Branch, with Resting-buds, of Silver Fir.**

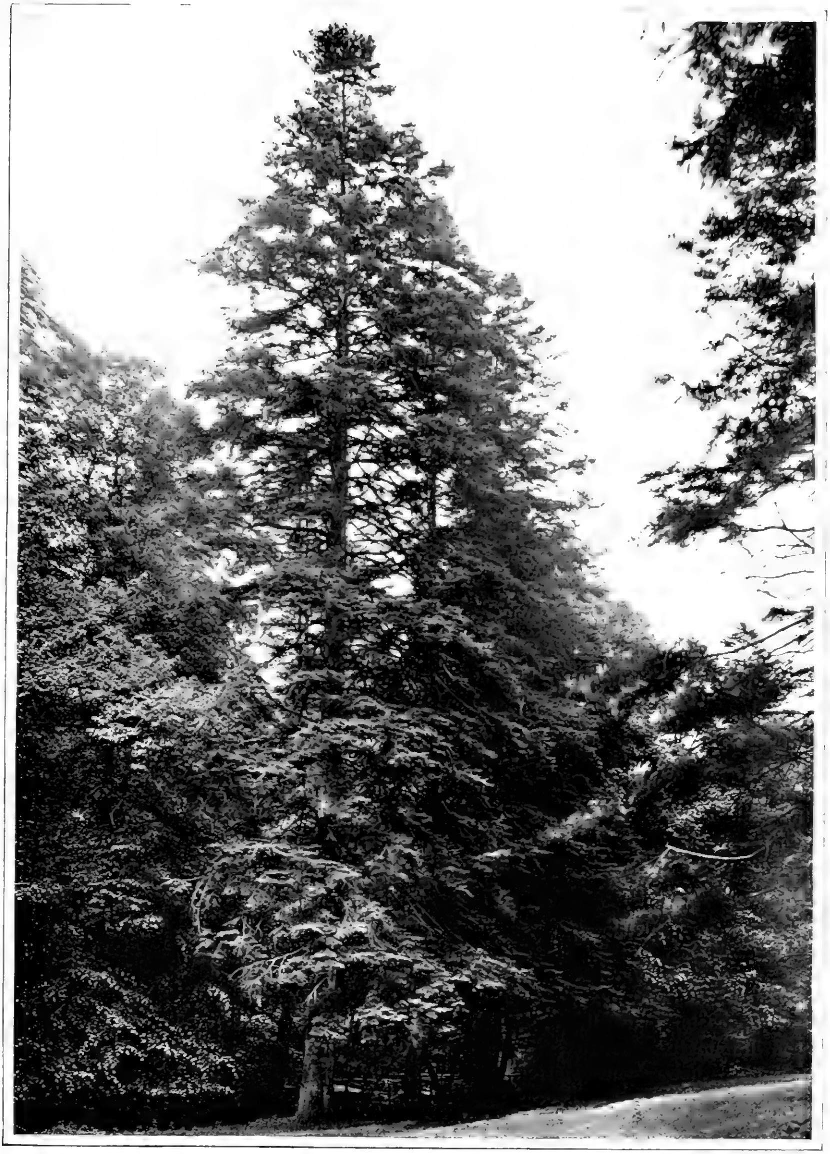


Fig. 120.—COMMON SILVER FIR—*ABIES PECTINATA.*

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Fig. 121. Stem of Silver Fir showing Leaf-scars.

Scots Pine. At the end of each season's growth the

**Branching.**

stem produces a terminal bud, and, close to this, two or more marked lateral buds arranged in a false whorl (Fig. 119). In the following year the latter buds grow out to produce the long-shoots. On the horizontal branches these lateral buds, often two in number, are mainly on the flanks, so that the branching is in one plane. But, in addition to the buds behaving in this manner, there are others lower down the year's-shoot in the axils of some of the needles. These grow out into much more slender dwarf-shoots (whose leaves, however, are not tufted). The dwarf-shoots may develop subsequently into long-shoots, especially when the tree is well illuminated. There are still other resting-buds that remain inactive for years and provide for future emergencies; indeed, all the different kinds of buds, lateral or terminal, can remain for years in a quiescent condition. When the main terminal bud is injured, several of the topmost lateral buds develop into erect shoots, or one alone may behave thus, and in this way replace the missing "leader."

The resting-buds (Fig. 119), which are not resinous on the outside, open simply by

**Buds.**

the scales gaping asunder and remaining attached; whereas in the Spruce the scales break at their bases and, glued together by resin, are lifted aloft by the developing needles.

The tree does not commence to flower until it has reached an age of thirty years in the open, or of sixty

**Flowering.**

to eighty in forest. The male and female flowers occur on the same tree, but on different twigs, and open in April or May.


Fig. 122.—Female Flowers and Sprouting Buds of Silver Fir.

The erect light-green female flowers occur as

**Arrangement of Flowers.**

dwarf-shoots on the upper face of twigs high up the crown. They are situated on the shoot formed during the previous year, near its tip or middle (Fig. 122). The yellow male flowers are at the same height up the tree or lower down, and appear

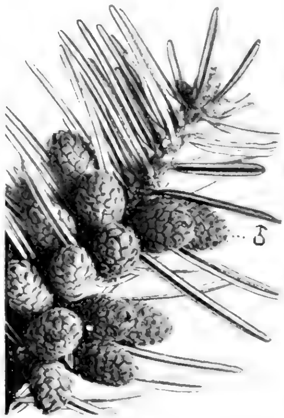


Fig. 123.—Male Flowers of Silver Fir. Branch viewed from below.

crowded together near the base of the previous year's-shoot, but are mainly on its under side, or at least lie under the leaves (Fig. 123). This arrangement may serve to protect the pollen from rain. Thus the open flowers are on stems one year older than in the case of the Scots Pine. But there is one feature common to both kinds of trees, namely, that the male flowers are near the base and the female nearer the tip of the year's-shoot.

**Male Flower.**

The yellow male flower (Fig. 123) may be an inch or less in length, and is surrounded at its base by a rosette of little brown scales which remain attached like a cup even after the flower has fallen. The structure of the flower is much like that of the Pine, but the numerous club-like anthers burst open transversely.

**Female Flower.**

The slender, graceful female flower (Fig. 122) assumes the form of a light-green erect cone more than two inches long. It agrees in main structure with that of the Pine, but the carpellary (bract) scales are larger than the entirely concealed seed-bearing (placental) scales. Each carpellary scale is prolonged into a tail-like awn, while each seed-bearing scale has two ovules on the upper face of its base.

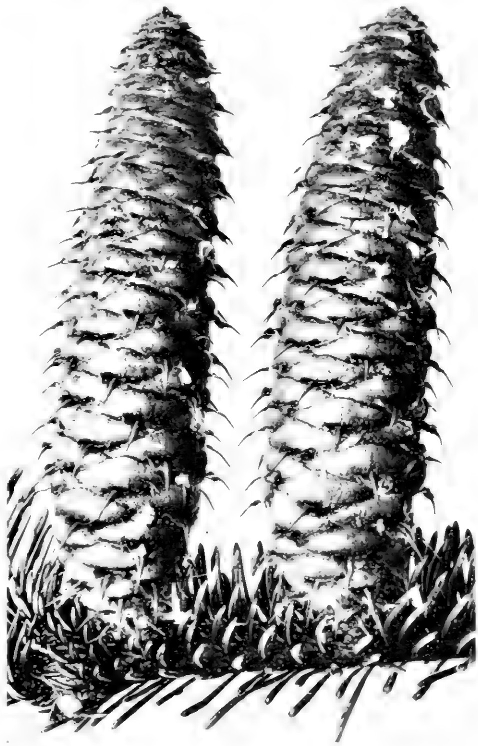

Fig. 124.—Closed Ripe Cones of Silver Fir.

**Pollination.**

Pollination takes place much as in the Pine. The pollen is produced in enormous quantities, so that near forests of Silver Fir it may be carried down with the rain and give rise to the phenomenon of yellow "sulphur-rain." Each grain is buoyed up by two air-bladders.

**Cones.**

After pollination the female cone grows rapidly, becomes a mature fruit, and sheds its seeds even before the winter of the same year. It remains erect, and as both kinds of scales enlarge and cause the cone to become "closed," they change in tint from green to brown. The ripe cone is cylindrical or narrowed above, with a blunt apex; it varies in length from three to seven or even more inches, and in thickness from one and a quarter to two inches (Fig. 124). The thin seed-bearing scales are somewhat woody, but devoid of any apophysis;

Fig. 125.—Cones of Silver Fir showing Cone-scales commencing to fall, also completely shed.

while projecting between them are usually the awned ends of the still thinner membranous carpellary scales. Soon after ripening, in September or October, and especially after the first frost, the scales loosen and fall off separately, carrying with them the winged seeds (Figs. 125–6); while the erect, bare, woody axis of the cone (Fig. 125) may remain on the tree for years.

The seed is somewhat large, irregular, and possessed of a firmly attached wing (Fig. 65, 6). Its embryo is surrounded with food-material (endosperm).

When it germinates the seedling lifts above the ground usually five (four to six) narrow cotyledons, which are succeeded by a whorl of five short primary needles. The leaves produced in the second year are spirally arranged, and gradually pass over into ordinary needles. The first branch is emitted in the third or fourth year. The young tree reflects its shade-enduring quality in its slow rate of growth in height.

**Germination.**

This introduced tree has a greater power than any other conifer in this country of bearing shade, and vies with the Beech in this respect. In fact, the Common Silver Fir and the Beech often battle with one another on hill-sides.

Fig. 126.—Cone of Silver Fir with Cone-scales half-fallen.

## PICEA EXCELSA (*Lk.*).—COMMON SPRUCE (*Pinaceæ*)

The Spruce, like the Silver Fir, has all its needles solitary and spirally arranged, and is thus distinguished from Pines, Cedars, and Larches, which have tufted needles. But the Spruce differs from the Silver Fir in that its fallen needles leave behind them prominent projections which cause the bare twig to be like a very coarse file (Fig. 130). In addition, *Picea excelsa* differs from *Abies pectinata* in that its needles are not flat, but four-sided, with white markings on all four faces. Its pendulous, long cone, with persistent scales, is somewhat like that of a Weymouth Pine, but is devoid of apophyses, and contrasts sharply with the Silver Fir's erect cone, whose scales fall off separately.

**Distinctive Features.**

The root-system has no deep main root, but consists chiefly of far-stretching horizontal roots which send finer ones deeper into the soil. Thus the Spruce can grow on shallow, rocky soil if there be sufficient moisture, but cannot live on dry, sandy soil.

Its straight trunk attains a height of 150 or even 180 feet, and a thickness of from three to six feet. One marked feature is the great vigour of the main stem, which even when at its full height does not allow itself to be overtopped by the adjoining branches, so that the Spruce forms at its top no nest-like clump of branches similar to that of the Silver Fir. Yet if the end of the main stem be destroyed, the buds or younger branches near it grow upwards, and thus produce one or more leading shoots. The relatively weak boughs are arranged regularly in false whorls; they either slope gently downwards, are horizontal, or incline upwards; and these three poses may often be seen succeeding one another up the trunk, but the young terminal parts curve upwards. The boughs remain attached for a considerable time, even when dead, so that, especially in the open, the tree is deeply branched, and has a long, rather narrow, pyramidal crown. The duration of the branches suggests what is the fact; namely, that the Spruce can well endure shade. On the boughs the branches and branchlets incline or even droop downwards, and not only add to the characteristic habit of the tree, but also provide full shade.

**Dimensions and Form.**

The bark, which sooner or later acquires a reddish-grey tinge, remains very smooth up to the age of twenty years; and even for a further period of twenty or thirty years it is relatively smooth, showing only thin scales, which thereafter give way to coarser ones (Fig. 127). But, again in conformity with its shade-enduring habit, the Spruce never produces a thick, dead bark. And this independence of strong light is also reflected in the slowness of the growth of the tree during its first ten years of existence.

**Bark.**

The green needles vary considerably in length, but are usually one-half to one inch long, and terminate in hard yellow points. They are always four-sided, but may be somewhat flattened vertically or laterally; on the four faces are lines of stomata whose presence is revealed by minute white dots of wax. Traced downward, each needle has a stalk which continues into the projecting peg-like tip of the leaf-cushion, which in turn is prolonged downwards along the stem into a narrow ridge; so that the rind of the twig seems to be partly constituted of numerous leaf-cushions separated by narrow furrows (Fig. 130). The needles, when dried either on the tree or on a plucked twig, easily fall off, and thus leave the bare twig beset with sharp little pegs (Fig. 130). Yet ordinarily

**Needles.**

Fig. 127.—Bark of Spruce.

the needles live on the tree for eight to nine (or even twelve) years, and thus emphasise the shade-bearing capacity of the Spruce.

The needles are solitary, and spirally arranged, but the clue to their precise pose is to be found in the occurrence of the stomata on their four faces. The Silver Fir has flat needles with stomata only on the lower face, so that it arranges its needles horizontally by flat branching and appropriate twisting. The Spruce requires other devices. On vertical shoots the needles preserve their obvious spiral disposition, and are inclined upwards (Fig. 129); on well-lighted twigs that are inclined or horizontal they curve from the lower face and are directed obliquely upwards (Fig. 131); but on horizontal shaded branches they bend so as to be aggregated towards the upper face of the branch, thus forming half a cylinder (though not showing the clear, comb-like arrangement of the Silver Fir), with the needles truly belonging to the upper face distinctly shorter than the others (Fig. 132).

Fig. 128.—COMMON SPRUCE—*PICEA EXCELSA.*

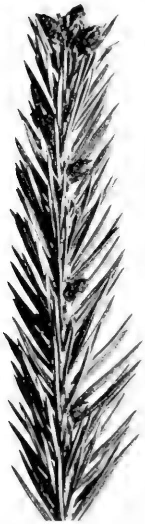

Fig. 129.—Foliaged Twig and Resting-buds of Spruce.

**Branching.** The Spruce agrees with the Silver Fir in its general scheme of branching. Each season the twig produces at its end a terminal resting-bud, and close beneath it a false whorl of lateral resting-buds; lower down, near the middle of the year's-shoot, are about six irregularly - arranged buds in the axils of some needles; but the lowest portion of the year's-shoot bears no buds (Fig. 129). In the following year the terminal bud and most of the lateral buds close to it grow out to long-shoots (thus producing a false whorl), while some of the lower buds develop into shorter dwarf-shoots, and the remaining buds continue to rest. In later years the dwarf-shoots may, if called upon, develop vigorously into long-shoots, the dormant buds may shoot forth, and even in the axils of the lower leaves on the year's-shoot there may subsequently arise "secondary" buds that enable the Spruce to replace buds or branches destroyed by hostile agencies. On shaded branches the lateral shoots spring from the flanks, but there does not arise a regular flat system of branches as in the Silver Fir, because the branchlets and twigs incline or droop downwards. On well-lighted branches ramifications also occur on the upper and lower faces.

**Buds.** The conical resting-buds (Fig. 129) are clothed with membranous yellow-brown scales, and are not externally coated with resin. When the bud opens, its upper and middle scales break off at their bases and, glued together, they are lifted aloft by the emerging needles, over which they form a protective cap (contrast the Silver Fir); whereas the basal scales remain attached for a long time. One interesting point in the behaviour of the buds is that the lateral ones sprout earlier in the season than do the terminal ones; the result is that late frosts may kill all the young lateral twigs, but leave the more tardy, still protected, terminal bud uninjured.

**Flowering.** The Spruce commences to produce flowers at an age of thirty or forty years in the open, but not before seventy years in dense forest; yet on poor, sun-bathed situations stunted trees may bear female flowers in their fifteenth year of existence, but the resultant seeds are mostly sterile. The flowers open in April or May, just when the young needles are emerging, and when, too, the chief fall of the old needles is setting in. Both male and female flowers may be on the same twig, but the latter occur more abundantly on the higher branches. The flowers are already recognisable in the season before they open, the female ones as terminal buds and the male flowers chiefly as lateral buds produced during that season. Hence, when they open, the flowers are attached to twigs formed during the immediately preceding season.

Fig. 130. Twig of Spruce showing Raised Leaf-scars.

The male flowers (Fig. 131, ♂) before opening are pretty, red buds, reminding one of strawberries. Whether they point downwards or not, as their axes elongate they bend upwards and may become perfectly erect; and as the pollen becomes visible their red is flecked with yellow. In general structure each agrees with the male flower of the Pine, the red colour being due to the erect connective-crests of the stamens. The pollen-grain has two air-containing bladders, so that the pollen may be carried in vast quantities for miles, and cause the phenomenon of "sulphur-rain."

The pretty, purple-red female flowers are cones nearly two and a half inches long (Fig. 131, ♀). In design each is like that of the Pine, with which it further agrees in that the large scales are the seed-bearing (placental) ones, while the small concealed scales are the carpellary (bract) scales (contrast the Silver Fir). The oval seed-bearing scales have their exposed terminal parts sharply bent down and purple-red in colour.

**Cones.**

After pollination, which takes place as in the Scots Pine, the cone soon bends downwards, its scales close together, and it acquires a green or sometimes a purple-violet tint. The seed-bearing scales grow vigorously, but the carpellary scales remain insignificant. The cone is ripe in the October of the same year, and is cylindrical, its usual length being from four to six inches, and its thickness slightly over or under one inch and a half. Though somewhat like the cone of a Weymouth Pine in general shape, and in the relative thinness of its woody scales, these latter differ in having no apophysis. The lower and uppermost scales of the cone are sterile, but the middle ones (usually in the

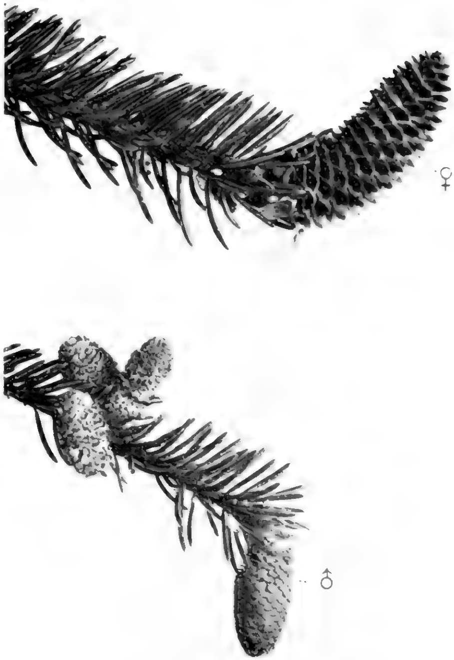


**Fig. 131.—Male (♂) and Female (♀) Flowers of Spruce.**

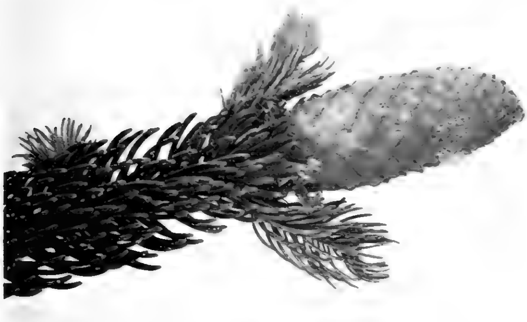

**Fig. 132.—Half-grown Cone of Spruce.**

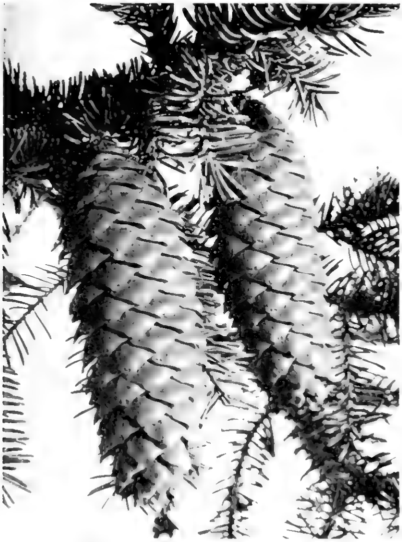

Fig. 133.—Ripe Cones of Spruce.

following spring) gape asunder and allow the escape of the winged seeds. Within a year the empty cone falls off as a whole, with its scales still attached to it.

**Seed.**

In general structure the winged seed agrees with that of the Pine and Silver Fir. And the germination closely resembles that in the latter plant, the cotyledons numbering from eight to ten.

**Distribution.**

Though not a British tree, the Common Spruce is extensively grown in Great Britain. It naturally ranges from central to northern Europe, going as far north as Lapland, and extends into Asia. In its northern stations the Spruce belongs to the plains, whereas in southern localities—in Switzerland, for instance—it is a mountain tree. Though incapable of existing on very dry soils, it can live in soaking swamps. Not only is it found growing in the open, but its great shade-bearing capacity adapts it for its usual life in the shade of forest. With its wide range of country and station, the Common Spruce displays exceeding variety of shape and stature. Two extreme forms may be briefly described. Far north the Common Spruce assumes the shape of a dense, low bush with a flat top extended like a table; the height of the tree is determined by the depth of the snow in winter, as all the twigs projecting above the snow are dried up and killed by the icy wind. The bush, nevertheless, has a main stem, and its lower branches creep over the surface of the soil, into which they send numerous roots. But in its most extreme form this tree recalls our own tiny Alpine Willows, and is seen on the tundras of Lapland. Here the Spruce-forest has dwindled to form "meadow," over which one can walk. The pygmy Spruces forming the "meadow" have no main stem, but consist of many prostrate branches creeping among lichens and emitting roots at intervals. The habit of giving off roots from the branches is not confined to these stunted forms of the Common Spruce; for the tall tree can trail its lower branches over the ground, and these may give off from their under surface roots, and from their upper surface erect shoots which grow like individual trees, so that the whole plant

Fig. 134. Open Spruce Galls (Stage II.).

Fig. 135.—Still Closed Spruce Galls (Stage I.).

resembles a "family" with the offspring ranged round or near the parent trunk.

**Galls.**

Characteristic cone-like galls (Figs. 135, 134) very frequently occur on the Common Spruce. These are produced by a species of *Chermes* (allied to "Green-fly"), the larvæ of which suck at a Spruce-bud, causing its leaves to be deformed and to remain closely packed, so that the analogy between these galls and cones is close. The tiny larvæ are concealed in spaces between the gall-leaves, which eventually gape asunder and permit the escape of the winged insects (Fig. 134). One species, *Chermes viridis* (Ratz.), spends some of its generations on needles of the Larch, so that it alternates between Spruce and Larch, just as some parasitic worms pass different stages of their lives in carnivorous and herbivorous animals respectively, or as certain parasitic fungi require two host-plants (say Grass and Barberry, or Groundsel and Scots Pine) to complete their life-histories.

## PSEUDOTSUGA DOUGLASII (*Carr.*).—DOUGLAS FIR (*Pinaceæ*)

The Douglas Fir has all its needles solitary and spirally arranged. As in the Common Silver Fir, the needles are flat and have two white lines on the lower face; but when they fall they leave behind them a scar on a distinctly prominent leaf-base, though these projections are not so long as in the Spruce. Most characteristic are the pendulous fruit-cones, which show narrow, three-pronged, membranous (carpellary) scales projecting from between the persistent woody scales.

Fig. 136.—Bark of Douglas Fir.

The bark becomes rough, thick, and deeply furrowed (Fig. 136). The stem frequently

Fig. 137.—DOUGLAS FIR—*PSEUDOTSUGA DOUGLASII.*

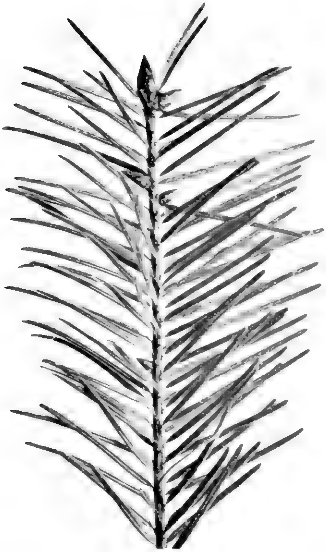

Fig. 138.—Twig and Resting-buds of Douglas Fir.

attains a height of from eighty to a hundred feet and a thickness of two feet in England, while in favourable situations in its North American home the Douglas Fir towers up to 300 feet. The slender boughs tend to be arranged in false whorls, but from the intervals between these there spring many smaller branches that obscure the tiered pattern of the ramification on the main stem. Grown in full light, the young tree often shows a loose, pyramidal crown reaching nearly to the ground (Fig. 137); but in shady forest the tall tree usually has a long, bare bole capped by a narrow crown. On the boughs the branches largely arise from the flanks and go to form a flat horizontal system, from which the branchlets and young twigs incline or hang downwards and impart a Spruce-like pattern to the sprays.

**Dimensions and Form.**

**Needles.**

The solitary, spirally-arranged needles are flattened, and display a white band of wax on each side of the prominent midrib on the lower face (Figs. 61, 142). They are short-stalked, from three-quarters of an inch to one inch and a quarter in length, and spread out well from the stem. On shaded branches they twist and arrange themselves in a double comb-like manner with the stomata (and white lines) facing the ground; and the needles springing from the upper face of the twig are shorter than the others. But on erect shoots the needles are arranged all round the stem, while on well-lighted inclined branches they approximate to this disposition. Though relatively delicate in texture, the needles usually live for eight years. When they

Fig. 139.—Opening Buds of Douglas Fir.

**Fig. 140. Twig of Douglas Fir showing Leaf-scars.**

are shed they leave behind them tiny peg-like eminences (Fig. 140), so that the bare twig is, as regards roughness of surface, intermediate between those of the Silver Fir and the Spruce.

**Branching.** The mode in which the buds behave (Fig. 139), and the resultant scheme of branching, are on lines so similar to those in the Spruce that readers are referred to the description of that tree (on page 104); but in the Douglas Fir dwarf-shoots more frequently develop into long-shoots, which are thus inserted at intervals between the successive false whorls of still larger branches.

**Buds.** The glossy, chestnut-coloured resting-buds are narrow, taper to a fine point, and show no resin on the outside. The terminal one is considerably larger than the lateral ones close beneath it (Fig. 138).

**Flowering.** The tree produces flowers, if not before, at the age of twenty-five years. These open in April to May, at the same time as the foliage-buds are sprouting, and are arranged much as in the Spruce, save that the female flowers may be abundant also on lower parts of the crown. Both kinds of flowers are solitary and inserted on twigs produced in the previous year: the red-flecked female flower arises from the terminal bud, or from one of the lateral buds near this; while the orange-red male flowers are grouped in larger numbers near the middle of the year's-shoot (Fig. 141).

**Male Flower.** The cylindrical male flowers in general structure agree with those of the conifers previously described: the connective-crest of each anther ends in a short, narrow, peg-like process. The pollen-grains have no air-bladders to aid their flotation in the air. This is perhaps to be associated with the fact that the female flowers often occur low down the tree as well as high up.

**Female Flower.** The cone-like female flower (Fig. 142) agrees in general construction with the types previously described, but owes its peculiar appearance to the long, narrow, three-pronged, carpellary (bract) scales, which greatly exceed in length the little, concealed, seed-bearing (placental) scales that bear two ovules each. It is interesting to note at the base of each cone the series of leaves

**Fig. 141.—Male Flowers of Douglas Fir.**

and leaves tinged with greyish-blue; this form is often regarded as a separate species, *P. macrocarpa*. In another form the needles are very glossy, though pure green.

[*Tsuga* (Hemlock Spruce) has little cones like those of the Spruce, but in the species more commonly cultivated in this country the needles resemble in type and arrangement those of the Common Silver Fir.]

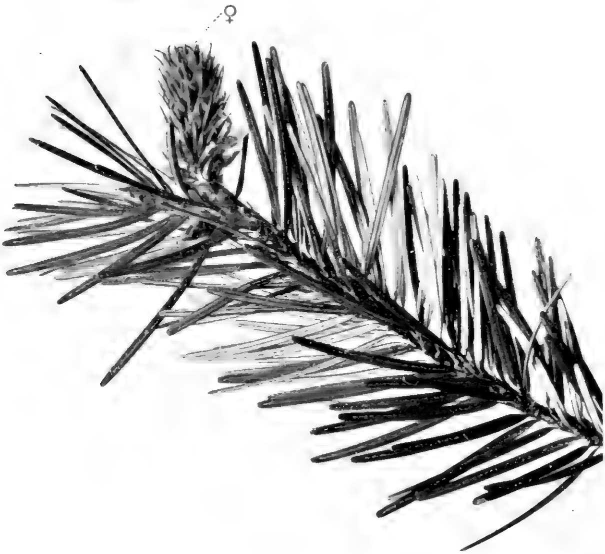


**Fig. 142.—Female Flower of Douglas Fir.**

transitional between narrow needle-like green leaves and the green three-pronged scales.

The pollen conveyed by wind to the crevices of the female cone rolls down, and reaches the ovules. The fruit gradually bends over and ripens in the same year, its seed-bearing scales growing vigorously, and the thin three-pronged carpellary scales more than keeping pace with them.

The light-coloured ripe cone is from two to four and a half inches in length, and is shaped like a long, narrow egg (Fig. 143). In the autumn of the same year the persistent cone-scales gape asunder and allow the winged triangular seeds to fall out of the pendulous fruits, though the empty cone is not detached until after winter.

**Cones.**

The seed includes food-material (endosperm) and an embryo which possesses from five to twelve narrow cotyledons.

Among the several varieties of *P. Douglasii*, one has larger cones with bract-scales that project to a less extent,

**Fig. 143.—Cone of Douglas Fir.**

## TAXODIUM DISTICHUM (*Rich.*).—MARSH CYPRESS (*Pinaceæ*)

The Marsh Cypress is (with the exception of *Pseudolarix*, which is rarely seen in this country) the tree most like a Larch in general appearance, for it has soft, light green, deciduous needles, a tapering straight trunk, and somewhat irregularly-arranged slender boughs; but it can instantly be distinguished from the Common Larch by its lack of the cones and of numerous hanging twigs that characterise the latter tree.

**Fig. 144.—Bark of Marsh Cypress.**

*Taxodium*, though not very commonly met with in England, is described here because of two interesting features—the habit of annually shedding its foliage, and the production of remarkable respiratory roots

**Distinctive Features.**

Fig. 145.—MARSH CYPRESS—*TAXODIUM DISTICHUM:* WINTER.

Fig. 146.—MARSH CYPRESS—*TAXODIUM DISTICHUM:* SUMMER.

Fig. 147. Twig of Marsh Cypress in Winter.

The significance of the latter becomes clear when it is remembered that the natural home of the tree lies in swamps and wet places in the United States. In such soaking soil there is difficulty in providing the roots with the necessary supply of air; and to meet this danger of suffocation the Marsh Cypress, like certain trees in mangrove swamps, sends up into the air erect, "knee-like" roots, whose peculiar structure adapts them for absorbing oxygen from the air, and conducting it to the long, shallow roots that run horizontally in the mud. The "knee-roots" (Figs. 9, 149), which may be a yard or more in height, are not always present, probably being absent especially when the soil is not very wet. But this arrangement for providing the subterranean roots with air is perhaps supplemented by a peculiar structural feature in the stem which is about to be described.

**Trunk and Bark.**

The tall trunk tapers often to a height of 150 feet. Its buttressed base (Figs. 145-6) is frequently very thick, sometimes twelve feet in diameter, though more commonly less than half this. The base of the trunk is hollow, and perhaps acts as an air-reservoir upon which the roots can draw for supplies of oxygen. The reddish bark is furrowed (Fig. 144). The relatively slender boughs incline upwards to a greater degree than in the Larch.

The tree has two kinds of shoots—long-shoots, which persist for years, and foliaged dwarfs-hoots, which are shed in the autumn of each year. The soft, flat, light green needles are shaped somewhat like those of the Yew (*Taxus*), hence the name *Taxodium*.

**Shoots.**

Upon the erect long-shoots they are arranged all round the stem in a spiral, and often are directed more or less parallel to the stem. But on the dwarf-shoots the spirally arranged leaves are posed in a double comb-like fashion along the two flanks of the stem and arranged in a horizontal plane, so that they resemble compound leaves (Fig. 148). And this likeness is increased by their behaviour, for in autumn they are bodily shed with their burden of warm-brown dead needles. Thus the Marsh Cypress, or, as the Americans style it, the "Bald Cypress" sheds not its leaves alone, but its foliaged branchlets.

The scaly resting-buds are extremely small and rounded (Fig. 147).

As flowers, fruit, seeds, and seedlings will be available to very few of our readers, it

Fig. 148.—Foliaged Shoots of Marsh Cypress.

will suffice to say that male and female flowers may occur on the same tree, the former being grouped into slender, branched inflorescences, and the latter giving rise to globular woody cone-fruits which recall those of true Cypresses.

[That the knee-roots of *Taxodium* serve to supply oxygen to roots lying in the mud is suggested by three sets of facts. First, analogous roots on trees occur only in connection with species growing on mud; for instance, in mangrove-swamps some kinds of trees have knee-roots, or serpentine roots that dip in and out of the mud; other kinds send up erect asparagus-like rootlets which project into the air. Secondly, such roots, in place of being coated with an envelope of cork, are clothed with a rind that has numerous openings by which air can pass into the air-containing rind and thence to the roots in the water-logged soil. Thirdly, experiments have proved that these roots do absorb oxygen and exhale carbonic acid in large quantities.]

Fig. 149.—Knee-roots of Marsh Cypress.

## SEQUOIA GIGANTEA (*Lind. et Gord.*).—WELLINGTONIA (*Pinaceæ*)

This tree is recognisable by its characteristic leaves, bark, and cones; but detailed description of these is given below.

**Dimensions and Form.**

The mighty stem attains a stature only exceeded by the gigantic Australian Gum-trees, and perhaps rivalled by some less-known Malayan trees. The trunk may be 320 feet or more in height, and thirty-five feet in thickness. It is powerfully buttressed at the base and fluted higher up. The crown of the young tree is pyramidal, and in the open may extend down to the ground (Fig. 151). One of the most striking characteristics of the full-grown tree, which has a more irregular crown, is the remarkable disproportion between the great length of the towering trunk and the shortness of the thick horizontal branches composing the crown, below which there may be a bare branchless bole 150 to 200 feet in length.

The reddish-brown bark (Fig. 150) is rough and often extremely thick, and peels in stringy bands.

**Leaves.**

The leaves are spirally arranged. Each is shaped like a narrow, shallow, but pointed, boat with a prominent keel on the lower face; and it is prolonged downwards into a ridge running along the stem, so that the latter presents the appearance of being completely concealed by leaves. Some of the leaves are wholly pressed close against the stem, but others have their sharp ends spreading out* (Fig. 152). Dots of white wax on the upper and lower faces of the leaves mark the positions of the stomata.

The small resting-bud is "naked"—that is to say, it is invested by little foliage-leaves and not by scales.

**Flowering.** The male and female flowers, which occur on the same individual, are minute and solitary. When open in springtime they are seen to be attached to the summit of shoots produced in the previous year.

* The tree that is cultivated in this country and has shoots most similar to these is *Cryptomeria japonica*, which is distinguished by the much greater length of its somewhat curved needles, the serpentine bend of its boughs, the larger number of male flowers near the twig-ends, and the conspicuous little spines and hooks on its cone-fruits.

Fig. 150.—Bark of Wellingtonia.

Fig. 151.—WELLINGTONIA—*SEQUOIA GIGANTEA.*

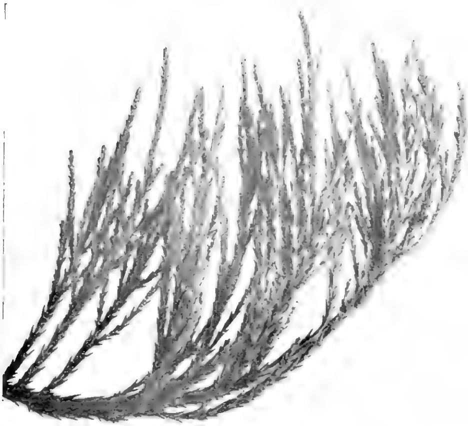

Fig. 152.—Shoot of Wellingtonia.

The male flowers are single, or there may be two or three close together (Fig. 154 ♂). The cone-like flower has at its base a rosette of bracts, and bears on its axis a number of spirally-arranged stamens, each of which shows beneath its distinct connective-crest a cluster of from two to five pollen-sacs.

The terminal female flower (Fig. 154 ♀) is preceded on the stem by a number of short bracts. Its spirally-arranged carpel-scales give no clear evidence of any double nature. To every scale there is attached a double row of from two to five ovules.

After pollination, by the agency of wind, the cone does not ripen until the second season.

**Cones.**

Nevertheless, when mature, the oval fruit is relatively small, from two to three and a half inches in length and one and a half to two and a quarter inches in width (Fig. 153). Each woody cone-scale is broadened at its thick shield-like end, and marked in the centre of its exposed face by a pit, and also sometimes by a distinct prickle; it bears from four to nine winged seeds. These drop out from the pendulous cones when the firmly-fixed scales gape apart.

Judging by the somewhat unsafe evidence of thickness of trunk and number of "annual" rings of wood, it has been estimated that this tree attains an age exceeding two thousand years; and it will be safe to assume that *Sequoia gigantea* can live for at least a thousand years.

The genus *Sequoia*, though it was widely distributed in past geologic ages, is represented now merely by two species, *S. gigantea* and *S. sempervirens*, both of which are

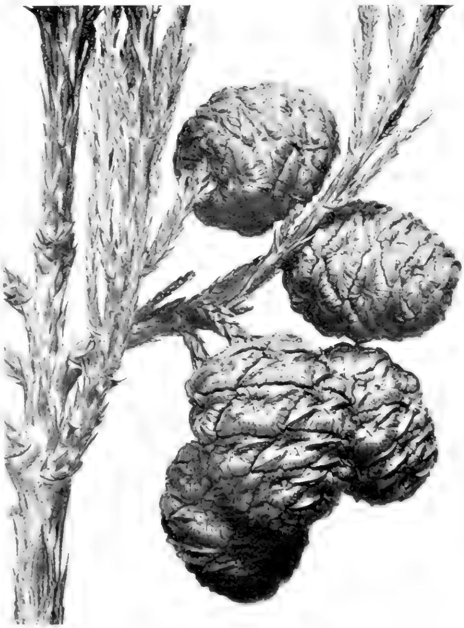

Fig. 153.—Ripe Cones of Wellingtonia.

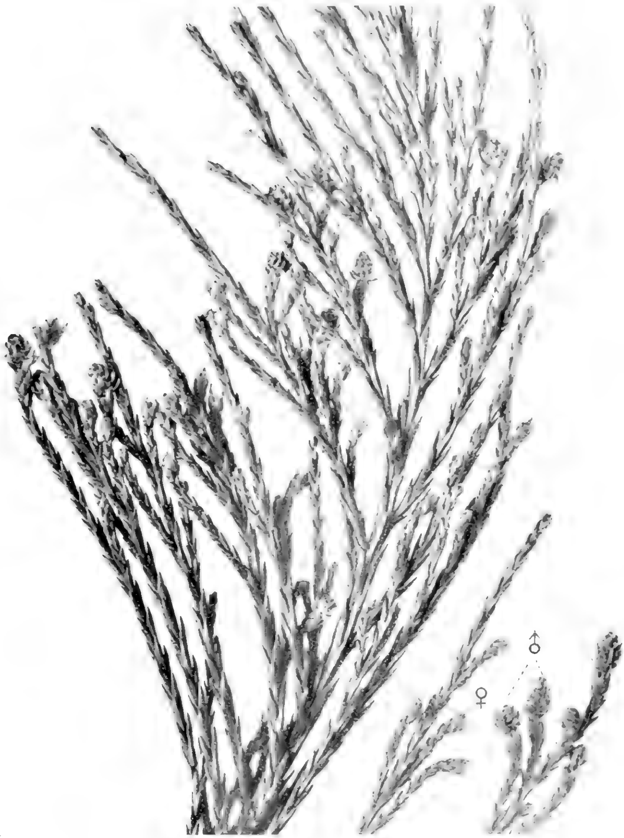


Fig. 154.—Male (♂) and Female (♀) Flowers of Wellingtonia.

naturally confined to mountain districts of California.

*Sequoia sempervirens* (Red Wood Tree) attains similar colossal dimensions, and has similar flowers and fruits, but its foliage assumes the form of flat needles which twist themselves into two comb-like series on the flanks of the horizontal twigs and give to these a Yew-like appearance. The leaves very distinctly show a gradual increase and decrease in length when traced from the base to the tip of each year's-shoot. The resting-buds show a few true scales on their exterior.

## ARAUCARIA IMBRICATA (*Pav.*).—MONKEY-PUZZLE TREE (*Pinaceæ*)

This tree is rendered unmistakable by its unique habit, as the boughs stand out in false whorls at right angles to the main stem, and the broad-based, sharp-pointed leaves are arranged in close spirals so as to conceal the stems.

As the flowers are not abundantly available for examination, and as the main features of the tree are easily seen, only few words will be devoted to this striking tree.

Fig. 155.—Bark of Monkey-Puzzle.

In this country the tree, grown in the open, may often be seen to retain its more or less horizontal serpentine branches right down to the ground (Fig. 156); but in its Chilian home, where the Monkey-Puzzle tree

Fig. 156.--MONKEY-PUZZLE TREE--*ARAUCARIA IMBRICATA.*

forms forests, the crown of the full-grown tree is limited to the upper part of the trunk. The thick leaves remain living and attached for many years, and completely ensheath the stem in spiny armour (Figs. 59, 60). The resting-buds are devoid of scales.

**Flowers.**

The uncommonly large male and female flowers are usually on different individuals, and show very pointed spirally-arranged stamens or carpels. The male cones are the narrower (Fig. 60), and include many stamens, each of which possesses from eight to fifteen slender pollen-sacs. The egg-shaped female flower (Fig. 59) shows many scales, which bear only one ovule on the upper face of each, and are apparently not double. (The only possible trace of the double nature of the cone-scale in the genus *Araucaria* is provided by a minute membranous outgrowth on its upper face, situated higher up than the ovule.)

When the fruit is ripe the winged cone-scales fall separately and hold the seeds firmly attached to them.

## CUPRESSINEÆ.—Cypress and Juniper Group (*Pinaceæ*)

With the Cypresses and Junipers we come to a group of conifers contrasting with all the types previously described, as their foliage and floral leaves are arranged, not in spirals, but in true whorls. A number of trees and shrubs belonging to this group have characteristic twigs, as these are covered with little scale-like green leaves that are closely pressed against the stem (Fig. 157). To distinguish among all the species with this cypress-like foliage requires experience, and often the use of a microscope; but the fruits at once allow us to range them into two sub-groups. In the Juniper the fruit is fleshy and berry-like (Fig. 168), but in the Cypress sub-group (including Cypress and Arbor-Vitæ trees) it is a scaly cone (Fig. 159). Another confusing feature is due to the fact that both Junipers and Cypresses may have spreading narrow leaves in addition to those already described; in such cases, on the spreading leaves the white wax is confined to the upper face in the Juniper, but occurs on the lower face in the Cypresses. The spreading foliage is particularly apt to occur in juvenile stages or on vigorous shoots; but it, and no other kind, occurs on the Common Juniper throughout the whole life of the tree.

**Fruit.**

**Leaves.**

In the Cypress sub-group the leaves are nearly always opposite, with the successive pairs standing at right angles to each other, and the buds are scaleless. This sub-group may again be distinguished into two sections according to the fruits: (i.) Cypresses have a rounded fruit, whose cone-scales merely touch at the edges, but do not overlap, and are shaped somewhat like thick-headed hob-nails or wedges (Figs. 159, 164). (ii.) The species belonging to the Arbor-Vitæ (*Thuya*) section have more elongated fruits, whose scales overlap at their margins and are of ordinary shape, and not nail-shaped (Fig. 165).

**Fruits.**

## CHAMÆCYPARIS LAWSONIANA (*Parl.*).—Lawson's Cypress (*Pinaceæ*)

This tree is a native of North America, where its main stem attains a height of 200 feet and a diameter of 12 feet, and acquires red-brown, thick, furrowed bark. In this country it is seen as a much smaller tree with the lanky end of its stem drooping to one side, its pyramidal crown often extending down to the ground in open places, but with the branching in the higher parts of the tree looser than below (Fig. 158). The horizontal or drooping boughs are repeatedly branched in a horizontal plane, as the side-shoots spring from the flanks of the successive generations of branches.

**Branches and Leaves.**

The leafy branches forming these flat systems are themselves flattened from above downwards, and are paler in colour on the under surface. The scale-like green leaves are closely pressed against the stem, and overlap regularly; being opposite, with the successive pairs at right angles, they ranged in four ranks. As the branches are flattened the leaves are of two kinds; those on the flanks are narrow, more sharply curved round the narrow edge of the stem, while those on the upper and lower faces of the branch are flatter and broader. Looking at the upper or lower faces of the branches, and especially

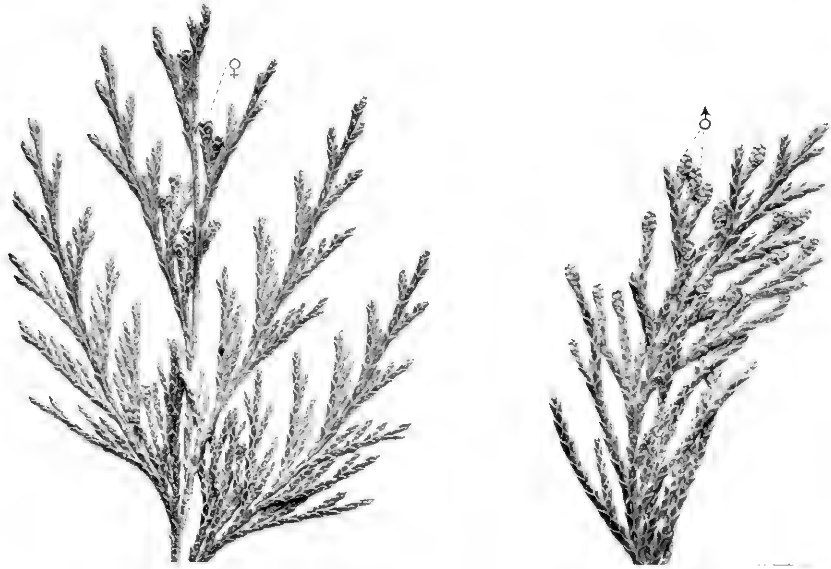


**Fig. 157.—Male (♂) and Female (♀) Flowers of Lawson's Cypress.**

of their younger shoots, we see that the white wax gives rise to characteristic V-, Y-, or X-shaped markings (Fig. 157), because the wax is most abundant along the lines of contact of the different leaves; we also see in the centre of each leaf an elongated, translucent, resin-gland lying in a little furrow traversing the middle of the leaf. Each leaf is continuous down the stem with a ridge, so that the stem itself seems to be visible only in the furrows between these ridges, and the leaves are often described as being "fused" with the stem. The internodes of the long shoots are longer than those of the very numerous dwarf shoots that build up the foliaged "spray," so that they show the leaf-ridges distinctly. The leaves remain attached for years, and, before being shed, become brown in tint and woody in texture.

The resting-buds are "naked,"—that is to say, devoid of scales.

**Flowers.**

The very small male and female flowers occur on the same individual, which may be only twelve years old. They open late in March or in April, and terminate in twigs produced during the preceding year. The two kinds are, however, ranged on different branches.

The male flowers (Fig. 157 ♂) are red, owing to the colour of the young pollen-sacs. The stamens are in opposed pairs, so that they are ranged in four vertical ranks, as may easily be seen by observing the greenish-brown connective-crests. Each stamen is short, and bears beneath the connective-scale two or three pollen-sacs. The pollen grains have no air-bladders.

The female flowers (Fig. 157 ♀) are bluish-green or steel-blue, with patches of waxy yellow. The short, broad scales are relatively flat and pointed. Like the stamens and leaves, they form four series, because they are attached in opposite pairs. Each

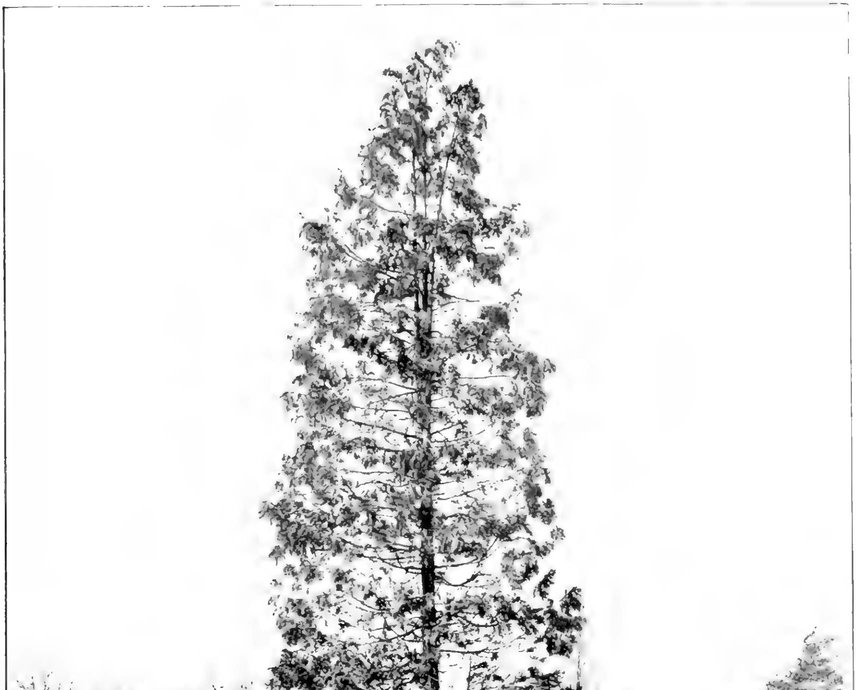

Fig. 158.—LAWSON'S CYPRESS—*CHAMÆCYPARIS LAWSONIANA.*

bears near its base a row of from two to five flask-like ovules, which direct their open mouths upwards.

Pollen is conveyed to the female flowers by the wind, but it is usually stated that the scales do not guide the grains to the ovules. Yet if the scale be examined it will be seen to be convex along the middle of its inner (upper) face, and when the flowers are erect this cushion-like swelling must help to direct the grains to the ovules standing on each side near its base. Many of the female flowers, however, are not erect.

After pollination, the cone grows and is ripe by September or October, even opening and shedding its seeds during the same season. The spherical fruit is only one-third of an inch in diameter, and is partly incrusted with wax, which gives to it a bluish-green tint before maturity, and is visible as whitish "bloom" on the red-brown ripe cone. Each cone-scale is of a shape very different from its original flattish scale-like form; for it is like an inverted pyramid, with a thickened terminal shield which is angled because of the pressure of the contiguous shields. The exposed face of each cone-scale (that is, of the shield) shows slightly above its centre, a pointed scale-like projection or boss, the point of which is the true original tip of the scale. Each cone-scale bears at its narrow base from two to five flattened, winged seeds which are shaped like tiny elm-fruits. The seeds escape by the gaping open of the persistent scales; but the open cones (Fig. 159) remain attached until the following spring, when they often still contain some seeds.

**Fruit.**

The seedling has two narrow cotyledons, and at first produces whorls of spreading ("primary") leaves utterly different from the scale-like leaves of the ordinary shoots.

[It is interesting to note that, in a number of Cupressineæ, this juvenile condition can be artificially prolonged by means of cuttings, which may give rise to large bushes with spreading needles in place of adpressed green scales. Such persistently juvenile forms, generally known under the name of *Retinispora*, consequently differ in their appearance very widely from their natural parents.]

This hardy American tree is widely cultivated in gardens, and its garden varieties show wonderful diversity of shape, size, and colour. Pyramidal, pillar-like, spherical, flat-topped, and weeping forms occur. These vary in stature from tall trees to prostrate shrubs; while their tints may be green, bluish-green, steel-blue, silver, white, yellow, golden, or variegated combinations of these.

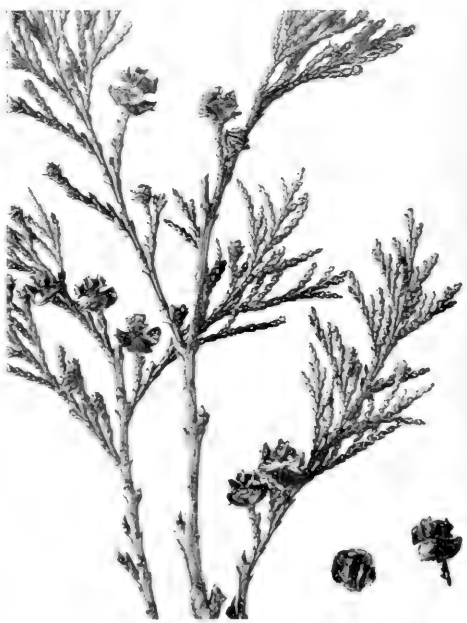

Fig. 159.—Open Cones of Lawson's Cypress.

## CUPRESSUS SEMPERVIRENS (*Linn.*).—CYPRESS (*Pinaceæ*)

This description of the Common Cypress will be mainly confined to pointing out differences between it and Lawson's Cypress.

The tree in Mediterranean countries may attain a height of 150 feet; but in this country it generally assumes the form of a bush perhaps fifteen feet tall. The main stem is always relatively vigorous, and the crown reaches low down. The most familiar form is the *pyramidal* variety, in which the crown is narrow and conical (and much like that of the familiar pyramidal Poplar) because the branches are nearly or quite upright; but in the *horizontal* variety the branches are horizontal and produce an utterly different wide pyramidal crown.

Fig. 160.—Bark of *Cupressus sempervirens.*

Fig. 161.—Shoot of *Cupressus sempervirens.*

The bark is thin, but becomes furrowed lengthwise.

**Twigs and Leaves.**

The twigs (Fig. 161) are four-angled, not flattened, and the leaves on the flanks are like those on the other two faces. The scale-like green leaves show no clear white waxy markings.

**Flowers.**

The flowers open in spring, and may occur on a tree that is only six years old; the male flowers (Fig. 162, ♂) being cylindrical and yellow, the female (Fig. 162, ) brownish-green. They agree in structure and position with those of Lawson's Cypress, but the pollen-sacs are usually in fours, and the ovules on each scale are numerous.

**Fruit.**

After pollination the fruit presents the appearance of not ripening until the following year, so that in nearly all books it is described as ripening in two years. But the truth seems to be that the fruit ripens either in the winter after pollination or in the succeeding spring, though it does not open until the second autumn. Thus, although the maximum time required for ripening appears to be one year, the cones remain closed and attached to the tree for considerably longer—so that two crops of closed cones may be seen on the tree. The spherical or oval fruit (Fig. 164) is much larger than in the Lawson's Cypress, being often the size of a small walnut; each woody scale bears from eight to twenty flattened seeds, which have very small wings.

A tree liable to be mistaken for *C. sempervirens* is

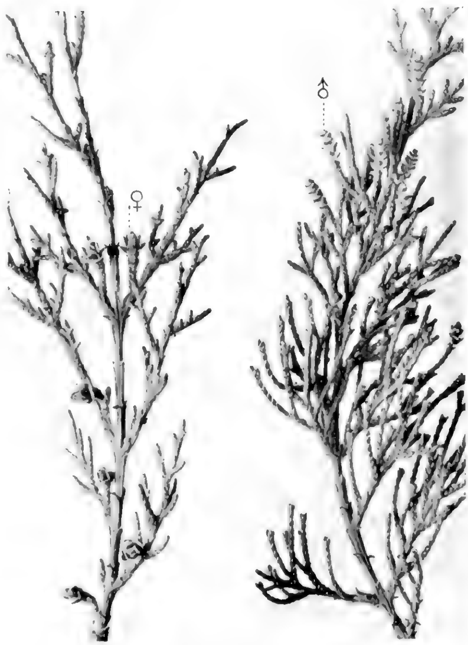


Fig. 162.—Male (♂) and Female (♀) Flowers of *Cupressus sempervirens.*

Fig. 163.—CYPRESS—*CUPRESSUS SEMPERVIRENS.*

Fig. 164.—Cone of Cypress.

*C. macrocarpa.* But the leaves of the former are blunt at the tip, while those of the latter are prolonged into a sharp point.

### *Thuya.—Arbor-Vitæ*

There are some other coniferous genera which have cypress-like foliage and flattened twigs, but possess fruit-cones whose scales overlap and are not nail-like nor inverted pyramidal. These include *Libocedrus*, *Thuyopsis* (with very broad flat twigs and white markings), and the much more common *Thuya* (Arbor-Vitæ). *Thuya* can, then, be distinguished from the Cypresses instantly by its cones; but it is divided into two sub-genera, *Biota* and *Euthuya*. *Biota* has its branches ramified repeatedly in a vertical plane, so that the bush is vertically stratified; its cones (Fig. 165) have six large recurved horns, and remain fleshy for a considerable time; moreover, its seeds are wingless. *Euthuya* has its branches repeatedly ramified in a transverse plane so that it is horizontally stratified; its cones (Fig. 165) have only tiny points (no hooks) and become woody very early; and its flat seeds are winged.

*Biota orientalis*, a very common garden shrub, has leaves that are green throughout; each leaf on the broad face of the stem shows in the middle of its outer face a furrow-like resin-gland. In *Thuya occidentalis*, also common, the leaf is dark green on the upper face and light green on the lower; moreover, the resin-gland in the centre of the outer face of the broader leaves is spherical and bulges out (*see* Fig. 165).

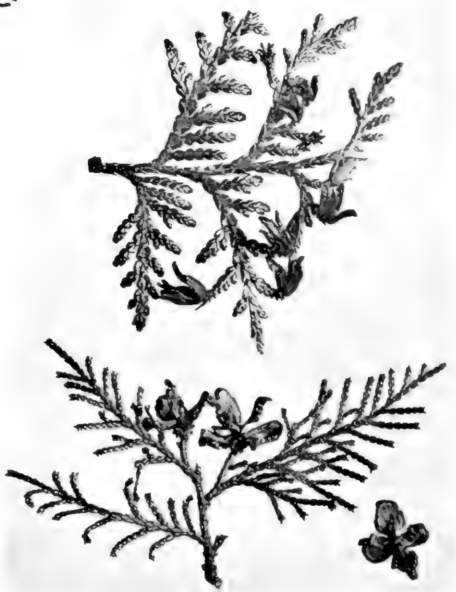

Fig. 165. *Thuya occidentalis* (above), and *Thuya* (*Biota*) *orientalis* (below).

## JUNIPERUS COMMUNIS (*Linn.*).—Common Juniper (*Pinaceæ*)

The Common Juniper is a shrub, less commonly a tree, recognisable by its narrow, sharp-pointed leaves arranged in whorls of three, with their upper faces white in the middle; also by its bluish-black berry-like fruits, which are coated with "bloom."

*Juniperus communis* occurs in two wild forms—the ordinary variety and the dwarf variety. We shall first describe the former, and subsequently mention the points of difference shown by the latter.

**Dimensions and Form.**

The Common Juniper is either a tree or a shrub, occasionally from twenty to thirty feet in height, but much more commonly only a quarter as much. In the tree form the trunk, which rarely exceeds one foot in diameter, soon ceases to be distinct, so that the short, bare bole is surmounted by a crown that is very variable in form, as the branches may spread out or ascend sharply. The shrub form is equally diversified in shape; indeed, high up mountains or far north it dwindles to a prostrate, spreading pygmy. The Juniper owes its habit to slow growth, early cessation of predominance of the main stem, and to the fact that the branches are emitted irregularly from indifferent parts of the year's-shoot.

The stringy, red-brown bark (Fig. 167), clothing the coarsely-ribbed base of the stem, flakes off in long papery strips.

**Leaves.**

The narrow evergreen leaves stand out from the stem in whorls of three, and the successive whorls are separate by distinct internodes. Each leaf is awl-shaped in outline with a long, hard, and sharp point, and has its concave upper surface lined with white wax. (The limitation of the white wax and the stomata to the upper surface of the leaf enables us at once to distinguish Junipers from juvenile shoots or cuttings of *Thuya* or *Cupressus* which may possess somewhat similar spreading leaves.) The needle is jointed at the base, but has no marked leaf-cushion. The young leaf-bearing twigs show three angles and three flat faces. The angles, when traced up, are continuous with the three leaves at a whorl. In the middle of each flat face of the stem is a furrow which, traced upwards, leads to the gap between two leaves at a node.* As the leaves at the successive nodes alternate, so likewise do the angles and flat faces of the successive internodes. The leaves remain attached for from five to seven years, and in winter show change of tint.

The resting-buds are transitional between scaly and naked types; for the leaves towards the summit of the year's-shoot decrease in size, so that those encasing the resting-bud are relatively broad, short, pointed, green leaves. Yet in the following season a number of these leaves can be seen to be brown and dead, although much older foliage-leaves are still green and living; thus these annual leaves are transitional between scales and foliage-leaves.

**Flowers.**

The Juniper has its male and female flowers (with rare exceptions) on different individuals. Both kinds of flowers are initiated in autumn in the axils of leaves near the middle of the current year's-shoot, but they do not open until the following spring (April to June).

The little yellow male flowers (Fig. 166, ♂)

* The leaves are usually described as not being "decurrent," that is to say, as not being prolonged as ridges down the stem, and are contrasted with the "decurrent" leaves of some other Junipers. But such a purely "descriptive" account must not be taken as indicating any wide difference between the two contrasted types; for, if we imagine the furrows in the centres of the three flat faces only a fraction of an inch deeper, the leaves would be described as "decurrent" despite of the joint at the base of each.


Fig. 166.—Male (♂) and Female (♀) Flowers of Juniper.

are oblong, and consist of a few whorls of stamens, arranged in threes like the foliage-leaves. The stamen has a distinct connective-scale and bears from three to seven (usually three or four) rounded pollen-sacs, except near the summit of the flower, where the scales dwindle and pollen-sacs decrease in number, until the topmost stamens are represented solely by solitary pollen-sacs attached directly to the stem.

**Male Flower.**

The bud-like little female flower (Fig. 166, ♀) shows several whorls of scale-like leaves, but only the topmost whorl of three is fertile. These three little fleshy scales act as carpels; for directly above the gaps between them stand three erect, projecting ovules, which are close together and form the summit of the flower.

**Female Flower.**

The three carpels are united at their bases by a ring-like ridge, which after pollination grows vigorously and forms a cup-like envelope round the three fertilised ovules, which also grow vigorously. The three carpels grow strongly on their inner faces and, pushing back their real tips, eventually grow completely over the young seeds, which are thus entirely closed in. The real tips of the carpels are recognisable as three little projections near the summit of the "berry." Inside the "berry" the three ovules become three (or one or two) separate seeds, which are encased in hard, bony shells. These changes require two seasons after pollination to be completed. The "berry" remains green and by no means juicy during its first year, and until the autumn of the second year, when it becomes fleshy, blue-black in colour, though covered with waxy "bloom." The "berry," which is now nearly rounded, and from one-sixth to one-third of an inch in diameter, may fall in winter or remain attached for one or two years longer.

**Fruit.**

These fleshy fruits are adapted for dispersal inside animals. Hence while they are unripe, being green in colour, they do not attract notice, and being disagreeable in flavour as well as lacking in juiciness, they do not invite fruit-eating animals. But when once the seeds are ripe and protected by bony armour, the blue-black colour advertises the fruits, while their juicy nature and agreeable flavour render them appetising. Several kinds of birds peck the fruits and bolt the seeds, which pass through their bodies uninjured, and are thus disseminated.

**Dispersal.**

The seedling has only two cotyledons.

The Common Juniper has an immense area of distribution and occupies wonderfully diverse situations. It ranges from Mediterranean countries, Persia, Afghan-

Fig. 167.—COMMON JUNIPER—*JUNIPERUS COMMUNIS.*

istan, and the Himalayas, up to northern Siberia, Lapland, Scandinavia, Iceland, and thence into North America. It ascends mountains going up to nearly 8,000 feet in the Sierra Nevada, and to decreasing altitudes as the situation becomes more northern, until, in Lapland, 680 feet registers its highest climb. Its habitat varies equally. Usually it seems to be at home in dry and sunny, open situations on arid sand-dunes, rocks, or heaths; yet it can grow in soaking moors in the midst of bog-mosses. Nor does the Juniper shun shady places, for it thrives in moist forests near the coast, where fog and rain are rife, or as undergrowth in less humid Pine-woods and even shadier Beech-woods. It lives on various soils, calcareous or not, fertile or sterile. Thus the bush resists alike scorching drought and freezing cold, the full blaze of sunlight or the comparative shade of forest.

**Distribution.**

Its variety of home is reflected in diversity of form, as it shows all stages between a tree to a table-like bush or a prostrate spreading shrub; while in cultivation it may have a crown that is columnar, pyramidal, hemispherical, spherical, spreading, prostrate, or "weeping."

### *Juniperus communis* var. *nana*

This Alpine and Arctic variety is a spreading shrub, inclined to be prostrate, and never exceeding one yard in height. Its needles differ from those of the common form in being pressed against the stem, and in being shorter, blunter, and usually curved.

It is even more slow-growing than the Common Juniper; for instance, the stem of one plant, though sixty years old, had wood only about two-fifths of an inch thick.

The Dwarf Juniper has a very wide and discontinuous distribution, being found high up mountains in Europe, Asia, North Africa, and North America (even at 10,000 feet in the Swiss Alps), and occurring far north on plains within the Arctic zone.

Its very close relationship to the Common Juniper is shown by the fact that in Lapland where both forms occur all kinds of intermediate links between the two present themselves. When cultivated high up the Alps the Common Juniper assumes the shape of the dwarf variety; while conversely the Dwarf Juniper, when cultivated in the plains of Central Europe, takes the habit of the common variety.

Among other Junipers seen in gardens, *J. Oxycedrus* differs from *J. communis* in having red or reddish-brown fruits; while *J. Sabina* (with bluish-black fruits) and *J. phœnicea* (with red fruits) possess cypress-like foliage in addition to pointed needles.

**Fig. 168.—Fruits of Juniper.**

# TAXACEÆ

## TAXUS BACCATA (*Linn.*).—Common Yew (*Taxaceæ*)

The Yew differs from all the trees previously described in the structure of its fruit, which cannot be described as a cone. The fruit has no woody or fleshy scales, as it consists of a single seed standing fully exposed within a red fleshy cup (*aril*). The tree is further recognisable by its dark green flat leaves, which are posed on the branches in two ranks, just as in the Silver Fir, but show no white lines.

Fig. 169.—Bark of Yew.


Fig. 170.—Male (♂) and Female (♀) Flowers of Yew.

The Yew is a deep-rooted tree rarely exceeding forty-five feet in height, and it is often scarcely more than a bush. Even low down the deeply channelled trunk there are attached relatively slender boughs, which spread horizontally or incline upwards, and bear thin pendent branches and branchlets. The shape of the crown varies greatly.

**Branching.**

As the trunk becomes very peculiar in structure we must here consider the method of branching. In the axils of many of the spirally-arranged leaves buds arise each year, and in the following or even in the same season those near the tip of the year's-shoot grow out into branches, which are not arranged in false whorls. On horizontal and inclined shoots the branches spring preferably but not exclusively from the flanks. But the Yew possesses great powers of throwing out additional branches. These can spring from the numerous buds that have remained dormant for years, or from "secondary" buds (*see* page 104), or may take origin from buds that arise at indefinite points on old parts of the trunk. Thanks largely to these last, one often sees groups of shorter or longer branches clustering at or above the base of the trunk. To its great capacity of producing new shoots the Yew owes a power, unusual to a conifer, of enduring and repairing injuries; and to this power is due its successful employment to form cropped hedges or trees fashioned into various shapes.

**Trunk.**

As a special example of the throwing out of branches we may describe the development of the trunk. Comparatively early in life some of the branches on the main stem tend to grow erect and give to the tree several "leaders" in place of the single leading main shoot. This development of several strong branches in itself is probably partly responsible for the ridges shown by the trunk; but the ridges later in life have another origin. When the tree has reached an age of between one hundred and two hundred years, and its main stem has ceased to grow in length, the latter becomes encircled by numerous erect stool-shoots that spring from its base. These grow up, thicken, and eventually coalesce with the main trunk and with one another to form a single, ridged column, which is therefore no true trunk, but a collection of fused stems. According to one authority the Yew retains

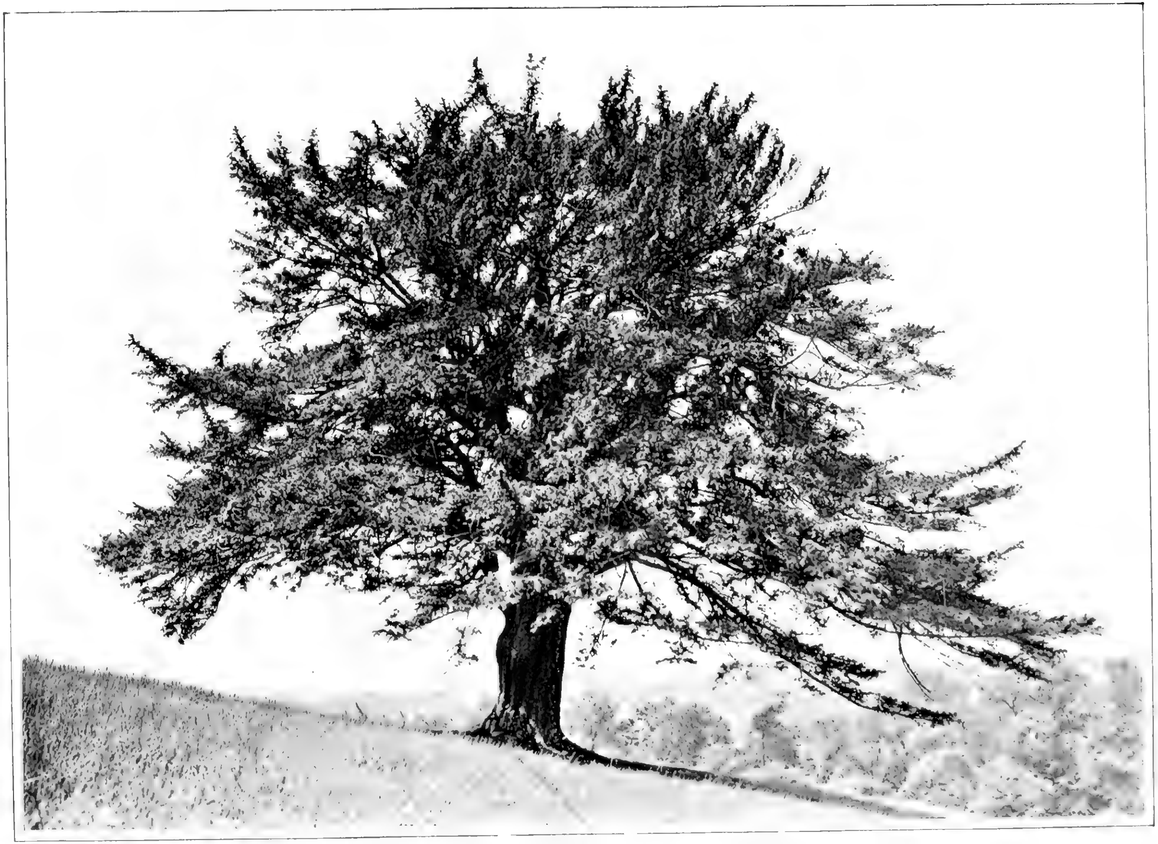

Fig. 171. COMMON YEW - *TAXUS BACCATA.*

its true trunk for, at most, two hundred and fifty years. The false trunk may attain a great thickness and lend to the tree a partly spurious appearance of antiquity. The thickest which I have seen—that at Gresford in North Wales, in 1888, measured more than thirty-two feet in circumference at the height of four feet.

The extremely slow growth in length (as well as thickness) of the Yew-shoots corresponds with the circumstance that among conifers in Europe this is the tree that endures the deepest shade.

And the red-brown bark (Fig. 169) reflects the same character, as it is thin and flakes off in delicate papery plaques.

**Leaves.**

The foliage, too, tells the same story, as the dark green leaves remain attached for from four to eight years, and, inasmuch as the branching is copious, the tree casts so deep a shade that a Yew-forest is especially gloomy and sustains the scantiest of vegetation on the ground. The narrow, pointed, flexible leaves are flat; on the leaf the stomata are confined to the lower face, which, nevertheless, is not marked by white lines, though it is paler than the upper face. The leaves are all solitary and spirally arranged, and each is continuous, with a ridge running down the twig. On erect shoots they radiate in various directions, but on horizontal or inclined branches they are twisted so as to form two ranks ranged in one plane like a double-comb (Fig. 170).

The little resting-buds are scaly, but not resinous. (Often large light green buds with radiating leaves are to be seen on the branches: these are deformities produced by a small fly, *Cecidomyia taxi*.)

**Flowers.**

The Yew commences to produce its male and female flowers, which are on different individuals, at the age of twenty years. The flowers, which are initiated in autumn, do not open until the early spring (February to April) of the following year; they are produced regularly every year. The solitary, open flowers occur at the ends of little scale-bearing branches, which are borne on shoots produced during the previous season, the males being arranged underneath the foliage of the supporting shoot.

**Male Flower.**

The globular yellow male flower (Fig. 170, ♂) terminates a very short stalk that is clothed with brown scales. It has from six to fifteen spirally arranged stamens, each of which is shaped like an umbrella, with from five to nine pollen-sacs hanging down yet fused together by their sides. In dry weather the umbrella opens, the pollen-sacs are split, and the bladderless pollen escapes.

**Female Flower.**

The so-called female flower (Fig. 170, ♀) in appearance resembles a green bud, and has a stalk clothed with scale-leaves. This short branch is not in reality the flower itself; for on its stem, above the two first scales, there

Fig. 172.—Half-ripe Fruits of Yew.

Fig. 173.—Ripe Fruits of Yew.

are from eight to thirteen spirally-arranged scales, and in the axil of the uppermost arises a tiny branch which pushes aside the true end. The tiny branch bears three pairs of opposite scales, and ends in a solitary ovule; the branch itself, or the ovule alone, may be regarded as being the true flower, but in the formation of the fruit the scales take no part (contrast all the conifers previously described). The minute erect ovule projects freely from the bud-like collection of scales, and shows a drop of liquid oozing from its mouth. Just as in the Juniper and Cypresses the drop of liquid serves to detain pollen grains blown on to the ovules.

**Fruit.** After pollination a little ring-like growth becomes clearly visible round the base of the enlarging ovule, and as this grows the half-ripe fruit (Fig. 172) resembles a green egg in a green egg-cup. The latter enlarges more vigorously than the developing seed, and in October or November has become a red, bloom-coated cup ("aril"), within which stands the brownish-black seed (Fig. 173).

**Dispersal.** The seeds are dispersed by birds, which, attracted by the red pulpy aril, peck this or swallow the fruit; the seed is protected from digestion inside the bird by its hard, woody shell. Here again we note that the fruit remains green and inconspicuous until the seed is ripe, when it becomes brightly coloured.

In germination the two green cotyledons and the succeeding leaves are in shape very like the ordinary foliage-leaves.

**Age.** The Yew-tree may attain a great age, but the ages assigned to old specimens are not reliable, for two reasons: first, the stem is a false one; secondly, the annual rings of the red heart-wood are so narrow as to render their enumeration difficult.

**Distribution.** Distributed widely in Europe, Asia, and North Africa, it usually occurs isolated among other trees, only rarely forming forests of its own. Yet the Yew is far from exacting in its demands. Although it endures deep shade, and as a seedling cannot withstand much direct sunlight in the open, the tree may yet be seen on sun-bathed rocks thrusting its roots into crevices. Indifferent to frost, it is able to grow on most soils save parched sand. Man has probably been responsible for its relative scarcity; and its survival near old castles and villages is a relic of its mediæval employment in the manufacture of bows.

The Yew is the solitary conifer completely devoid of resin, and apparently the only one containing considerable amounts of a poisonous alkaloid (taxin). Despite of this poison the leaves and twigs are gnawed by stags, goats, horses, and cattle, which gradually accustom themselves to this diet.

**Poison.**

One variety of the Common Yew has an orange-coloured aril to the fruit; another, the Fastigiate or Irish Yew, is characterised by numerous erect branches with radiating leaves, and by its column-like shape; still other garden varieties assume weeping, dwarf, rounded, or prostrate shapes, and have leaves that are self-coloured or variegated in yellow, gold, white, and green.

**Varieties.**

# GINKGOACEÆ

## GINKGO BILOBA (*Linn.*).—Maidenhair-tree (*Ginkgoaceæ*)

The Maidenhair-tree is instantly recognisable by its deciduous, partly tufted leaves, which are shaped somewhat like the fronds of a Maidenhair-fern.

This beautiful tree is by no means commonly cultivated in England, but as it is perhaps the most interesting tree in existence, a very brief account is given here.

Fig. 174.—Shoots of Maidenhair-tree.

The deciduous leaves are spirally arranged, and solitary on the long-shoots, but tufted on the dwarf-shoots (Fig. 174). In the pattern of its veining the fan-shaped leaf is quite unlike that of a dicotylous tree, as the radiating veins are repeatedly forked. The dwarf-shoots, as in Larches and Cedars, may give up their slow, stunted mode of growth, and develop as long-shoots.

**Leaves.**

The male and female flowers are on different trees and spring solely from dwarf-shoots. It is not decided as to what exactly constitutes a single flower on this tree.

**Flowers.**

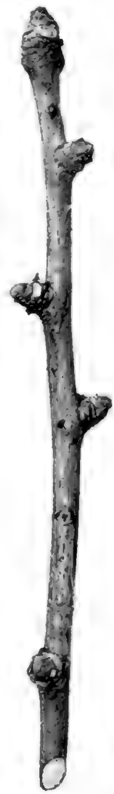

Fig. 175. Twig of Maidenhair-tree in Winter.

The stamens are arranged along a long axis to form a catkin-like collection (Fig. 176), which arises in the axil of a scale on the dwarf-shoot. Each stamen has a long stalk, and bears at its summit usually two (two to four) pollen-sacs.

yellow or yellow-green, plum-like seed, which has a fleshy outer coat and a hard inner shell. Thus the seed is adapted for dispersal by animals.

**Seed.**

*Ginkgo* is a solitary species of a solitary

**Fig. 176.—Male Flowers of Maidenhair-tree.**

The ovules are fully exposed, and arranged at the summit of relatively long stalks, which arise in the axils of the leaves on a dwarf-shoot. On the stalk two ovules are opposed; and each is surrounded at its base by an aril-like collar.

Pollination by the agency of wind is succeeded by fertilisation, which in type is intermediate between that of a Flowering Plant and of a Fern.

The ovule changes into a freely exposed

genus that represents the family Ginkgoaceæ, which in past ages included many species and some genera. Formerly the genus *Ginkgo* was widely distributed over Europe, Asia, and North America, but now its solitary species may be extinct as a wild plant (excepting possibly in the interior of China), though it is cultivated near temples in China and Japan, whence come the trees now growing in European and North American gardens.

Fig. 177. MAIDENHAIR-TREE—*GINGKO BILOBA:* WINTER.

Fig. 178.—MAIDENHAIR-TREE—*GINKGO BILOBA:* SUMMER.

K

# DICOTYLEDONES

THE subjoined table will enable the reader to take the first steps towards the identification of the various dicotylous trees described in this book, by denoting the families to which they belong. All these have their ovules and seeds enclosed in ovaries.

## GROUP I.—NO PETALS

(In this group the flowers are small and inconspicuous, as they have no showy petals.)

I. Flowers unisexual: male flowers in catkins.

(A) Leaves simple, alternate, stipulate.

1. Male and female flowers on different trees. Ovary one-chambered with many ovules. *Fruit* opening, and *containing many cottony seeds* . . . . . . . Willows and Poplars (p. 147).
2. Male and female flowers on the same tree. Ovary two- or three-chambered. Fruit one-seeded, not opening, nut-like or winged . . . . . . . . . . *Fagales* (p. 178).
3. Male and female flowers on the same tree. Ovary one-chambered. Collection of fruits forming a "mulberry" (somewhat like a blackberry-fruit) . . . . . Mulberry (p. 243).

(B) Leaves *pinnately compound, alternate, without stipules. Pith chambered.*

4. Fruit, a walnut . . . . . . . . . . . Walnut (p. 237).

(The Ash-tree has pinnately compound leaves, but these are opposite and without stipules. Moreover, though the flowers have no petals, they are not arranged in catkins.)

II. Flowers unisexual, but not in catkins.

5. *Inflorescences and collections of fruits spherical* and attached to long, hanging stalks. Leaves *alternate*, palmate (with tubular stipules when young), *concealing the lateral buds within the base of the leaf-stalk. Bark peeling in large plaques* . . . . . . . . Plane (p. 258).

(The Beech-tree has its flowers arranged in somewhat spherical "heads.")

6. Inflorescence stalkless in the leaf-axil with a central female flower surrounded by many male flowers. *Leaves opposite, evergreen,* stiff. Fruit opening by three valves Box (p. 265).

III. Flowers bisexual.

7. Flowers appearing before the leaves in tufts. *Fruits in tufts, one-seeded, flat, with a wing on each side.* Leaves alternate, simple, stipulate, toothed . . . . . Elms (p. 249).

[Flowers appearing before the leaves. *Fruit* one-seeded, *strap-like*, with one *terminal wing*. Some flowers are unisexual. *Resting buds black. Leaves pinnately compound, opposite.* Ash (p. 384).]

## GROUP II.—SEPARATE PETALS

I. Flowers hypogynous.

(*a*) *Stamens numerous.*

8. *Inflorescences and fruits joined to a prominent strap-like bract.* Leaves alternate, stipulate, toothed. Resting-buds "hump-backed" . . . . . . . Lime (p. 269).

(*b*) Stamens not more than twice as many as the petals.

(*a*) *Flowers irregular.*

9. Stamens seven to nine. *Leaves opposite, palmately compound.* Resting-buds large. Fruit opening by three valves. *Seed very large* . . . . . . . . . . . Horse Chestnut (p. 296).

(For other irregular flowers with separate petals, *see Papilionaceæ.*)

(β) *Flowers regular.*

10. Stamens seven or eight (usually); a disk present. Leaves *opposite,* without stipules, *simple, palmately-lobed* (except in one case). *Fruit two-chambered with two strap-like wings* . . . . . . . . . . Sycamore and Maples (p. 27 )

11. Stamens four or five, alternate with the petals; no disk. *Leaves evergreen, mostly prickly.* Fruit a "holly-berry" Holly (p. 305).

12. Stamens four or five alternate with the petals; a disk present. Leaves opposite, simple, with small stipules. *Fruit opening and showing the seeds, each encased in an orange-coloured fleshy "aril"* . . . . . . Spindle-tree (p. 309).

II. Flowers perigynous.

(*a*) *Flowers irregular.*

13. *Stamens ten, of which all or nine are united by their filaments. Shapes of the petals characteristic.* Fruit a one-chambered dry pod opening spontaneously . . . . . . Some *Papilionaceæ* (p. 321).

(*b*) *Flowers regular.*

14. *Stamens four or five, opposite to the very small petals.* Ovary two- to five-chambered . . . . . . . *Rhamnaceæ* (p. 314).

15. Stamens numerous. Ovary one-chambered. Fruit a one-seeded stone-fruit . . . . . . . . . Some *Rosaceæ* (*Prunus*) (p. 331).

III. Flowers epigynous.

16. Flowers regular; stamens numerous; ovary one- to five-chambered. Leaves alternate and stipulate . . . Some *Rosaceæ* (*Pyrus*, etc.) (pp. 331, 347).

17. Flowers regular; stamens four or five. Leaves opposite, without stipules. . . . . . . . . . *Cornus* (p. 380).

GROUP III.—PETALS JOINED

18. Flowers hypogynous; stamens two; petals sometimes absent, as in the Common Ash. Leaves opposite . . *Oleaceæ* (p. 384).

19. Flowers epigynous; stamens four or five. Leaves opposite *Caprifoliaceæ* (p. 391).

# SALICACEÆ. WILLOW FAMILY

The Salicaceæ include only the Poplars and Willows, all of which are *woody plants with alternate, simple, stipulate leaves.* The *male and female flowers occur on different individuals,* not upon the same tree. The *inconspicuous, unisexual flowers are ranged in catkins.* Each of the numerous flowers composing the catkin stands alone in the axil of a bract (catkin-scale), and is devoid of any petals or distinct sepals. In the Poplars a basin-like envelope surrounds the stamens or ovary, while in the Willows this envelope is represented by a number of usually isolated outgrowths, which are nectaries. The stamens of one flower vary in number. But the pistil is quite constant and characteristic in its main features. It is composed of two carpels which are joined together to form an *ovary that is one-chambered* and *has two vertical lines of many ovules on its walls.* The ovary changes into a dry fruit, whose wall splits longitudinally downwards (usually along two lines) and exposes the *numerous cottony seeds.* Each seed has at its base a tuft of hairs that acts as a sail and facilitates dispersal by wind (Fig. 180).

There are other families, including those represented by the Oak, Hazel, Mulberry, and Walnut, that have catkins. From all these the Salicaceæ differ in the characteristic structure of the ovary and fruit and their cottony seeds. They are also peculiar in

Fig. 179.—Male Catkins of Aspen.

having the male and female flowers on different individuals.

In stature they vary from tall Poplar-trees down to tiny Willow-plants forming a sward over which we can walk on the mountain-tops in Scotland.

The important Poplar-trees and Willow-trees show two tendencies or even characters: first, their strong demand for light; secondly, their frequent presence near water-courses. So that trees of both kinds are, or tend to be, trees of the open country or to occur only here and there in woods.

As regards pollination Willow-trees and Poplars contrast. As the former are insect-pollinated their nectar-producing flowers are arranged in more or less erect, often quite conspicuous inflorescences, and the pollen-grains have a rough sculptured surface and thus cling to insects: whereas the Poplars are wind-pollinated, so that the male (and even the female) catkins are seen dangling and swaying with the breeze; the flowers are nectarless, the pollen is smooth, and the stigmas are well developed.

Fig. 180.—Escaping Seeds of Aspen.

Poplars and Willows can be distinguished by their leaves, resting-buds, catkins, and flowers, thus :—

*Populus* (Poplars): Leaves usually broad and long-stalked. Resting-bud showing several scales. Bracts (catkin-scales) more or less fringed or toothed. Flower with a basin-like envelope. Stamens in one flower, usually more than five, often numerous.

*Salix* (Willows): Leaves usually narrow and short-stalked. Resting-bud showing only one scale. Bracts (catkin-scales) nearly always devoid of any incisions. Flower with no basin-like envelope, but with one or more glandular outgrowths (nectaries). Stamens in one flower, usually from two to five.

## POPULUS. POPLARS (*Salicaceæ*)

In this country there are four common kinds of Poplars: the Aspen, the White, Grey, and Black Poplars, in addition to the less common Canadian and Balsam Poplars and some rarer species.

An account of the general architecture and mode of growth of Poplars is given in this book in connection with the description of the Black Poplar ; and this account holds good for the other species, excepting as regards details which are explained in the respective descriptions of these. It may be noted that, in contrast with the Willow, the terminal bud of a shoot often continues to grow in the following season, though this is by no means always the case (as is often stated).

The different kinds of Poplars can be distinguished by seeing : (1) Whether the bark remains smooth and light-coloured for a long time or becomes furrowed early in life. (2) Whether the resting-buds are dry and hairy, or are hairless and sticky. (3) Whether the catkins are furry (because their scales have many straight hairs) or are not furry. (4) The illustrations of the leaves belonging to the different species may be consulted. The subjoined table will facilitate identification.

POPULUS

| | *Bark in Early Life* | *Resting-buds* | *Catkins* | *Special Characters* |
|---|---|---|---|---|
| *P. alba* (White Poplar) | Smooth and light-coloured | Dry, white, hairy | Moderately hairy or feebly so | Snowy buds, twigs, and under-faces of leaves, which are lobed and unlobed. |
| *P. canescens* (Grey Poplar) | Smooth and light-coloured | Dry, grey, hairy | Furry | Some hairs on the lower face of the leaf that are grey or in patches. |
| *P. tremula* (Aspen) | Smooth and light-coloured | Sticky (more or less); not hairy, or slightly so | Furry | Leaves finally smooth. |
| *P. nigra* (Black Poplar) | Rough | Hairless, sticky | Not hairy | Leaves hairless, regularly toothed. Twigs not angled nor with cork ribs. |
| *P. canadensis* (Canadian Poplar) | Rough | Hairless, sticky | Not hairy | Leaves hairless. Twigs angled with cork ribs. |
| *P. balsamifera* (Balsam Poplar) | Not so rough, but fissured and dark-coloured | Hairless, sticky | Not hairy | Leaf hairless, under-surface whitish ; leaf-stalk not laterally compressed. Twig coarse, not slender. |

## POPULUS NIGRA (*Linn.*).—Black Poplar (*Salicaceæ*)

The characters by which this Poplar is distinguished from others have been given in the preceding table. As *Populus nigra* shows two common forms, the Black Poplar (Figs. 184–5) and Lombardy or Pyramidal Poplar (Figs. 10, 11), we shall at first describe the former variety.

The Black Poplar has deeply descending roots which associate it with a deep soil, as well as shallow horizontal roots which send suckers up into the air. In addition to possessing this power of producing suckers, the tree can easily emit shoots from its cut stump or from the lower parts of its intact trunk.

**Roots.**

Fig. 181.—Bark of Black Poplar.

Fig. 182.—Leaves of Black Poplar.

the Balsam Poplar, whose petioles are not flattened and whose twigs are thick). Secondly, the amount of water evaporated from the leaves is greatly increased by their movements. The golden, dead leaves are described as being shed in November, but (especially in fine, dry weather) they may commence to fall early in September. The tree also sheds foliaged twigs, which often exceed a yard in length and are separated by a carefully prepared device similar to that employed in connection with the casting of leaves, so that the scar left by a fallen twig is clean and protected in place of being jagged and open to the attack of fungus.

**Trunk.** The trunk, quite early in life, becomes clad with a thick, rough, longitudinally furrowed bark (Fig. 181). Before the tree has attained any great height the upper part of the trunk is already obscured by the vigorous development of boughs that incline upwards. The tree rarely exceeds 100 feet in height. The lop-sided crown, which varies in shape, is loosely branched as regards its ascending boughs, but includes numerous smaller branches, so that it casts fair shade.

**Leaves.** The spirally arranged leaves (Fig. 182) are variable in form and in margin, but are always regularly toothed and devoid of hairs. The under surface of the blade is approximately of the same hue as the upper face, and thus contrasts with the likewise hairless foliage of the Balsam Poplar. The stipules fall very soon from the unfolded leaf. The long petiole is characteristically flattened, like a narrow ribbon, so that the leaves hang slackly (Figs. 182, 13) and quiver with the least breath of wind. The result is double. First, the leaves oppose but little resistance to the wind, so that the slender twigs can withstand the strain of the latter (in this respect again contrast is provided by

**Twigs.** The tapering resting-buds (Fig. 183) and the one-year-old twigs are glossy, yellow-brown, and hairless. The twigs (Fig. 183) are cylindrical (not ribbed with cork as in the Canadian Poplar), but are raised into prominences formed by the leaf-cushions of fallen leaves. The lower parts of the lateral buds are pressed against the stem. One peculiar feature in these merits notice: instead of

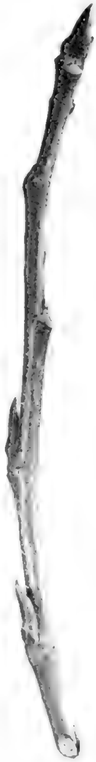

Fig. 183.—Twig of Black Poplar in Winter.

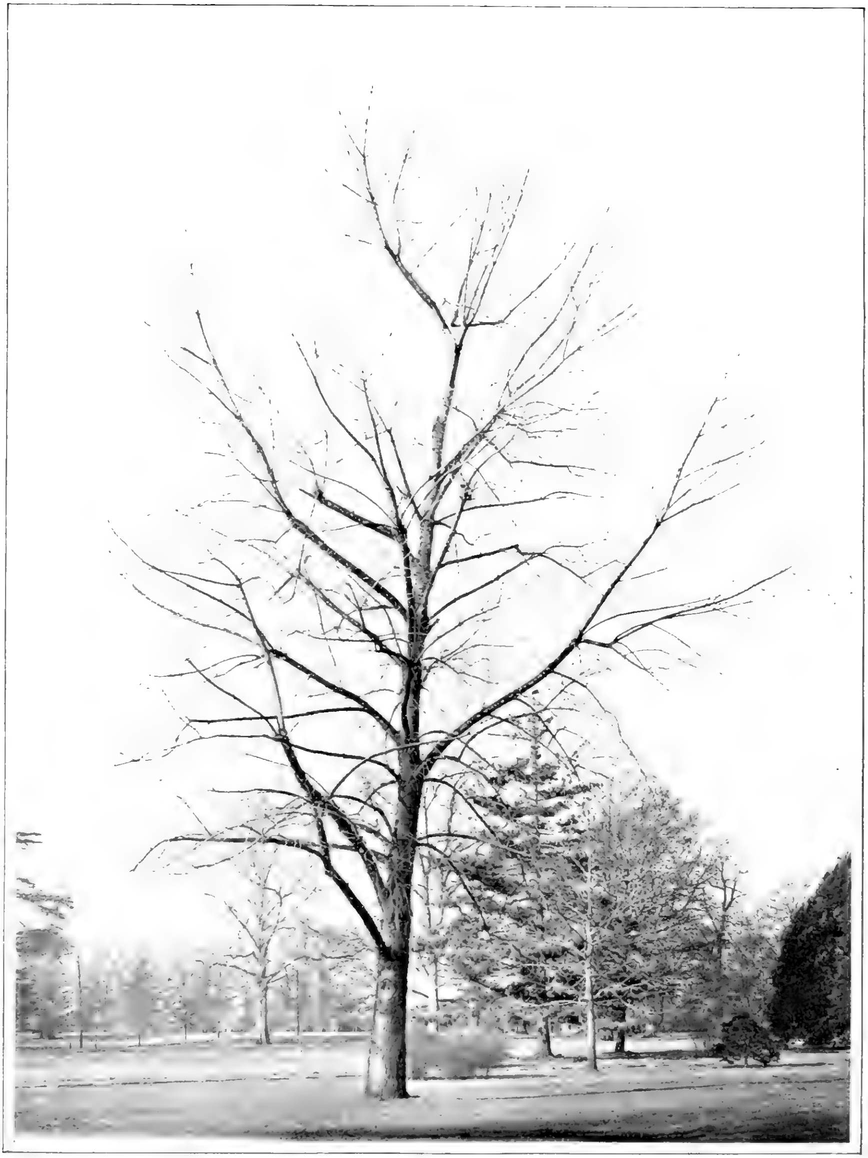

Fig. 184.—BLACK POPLAR—*POPULUS NIGRA*: WINTER.

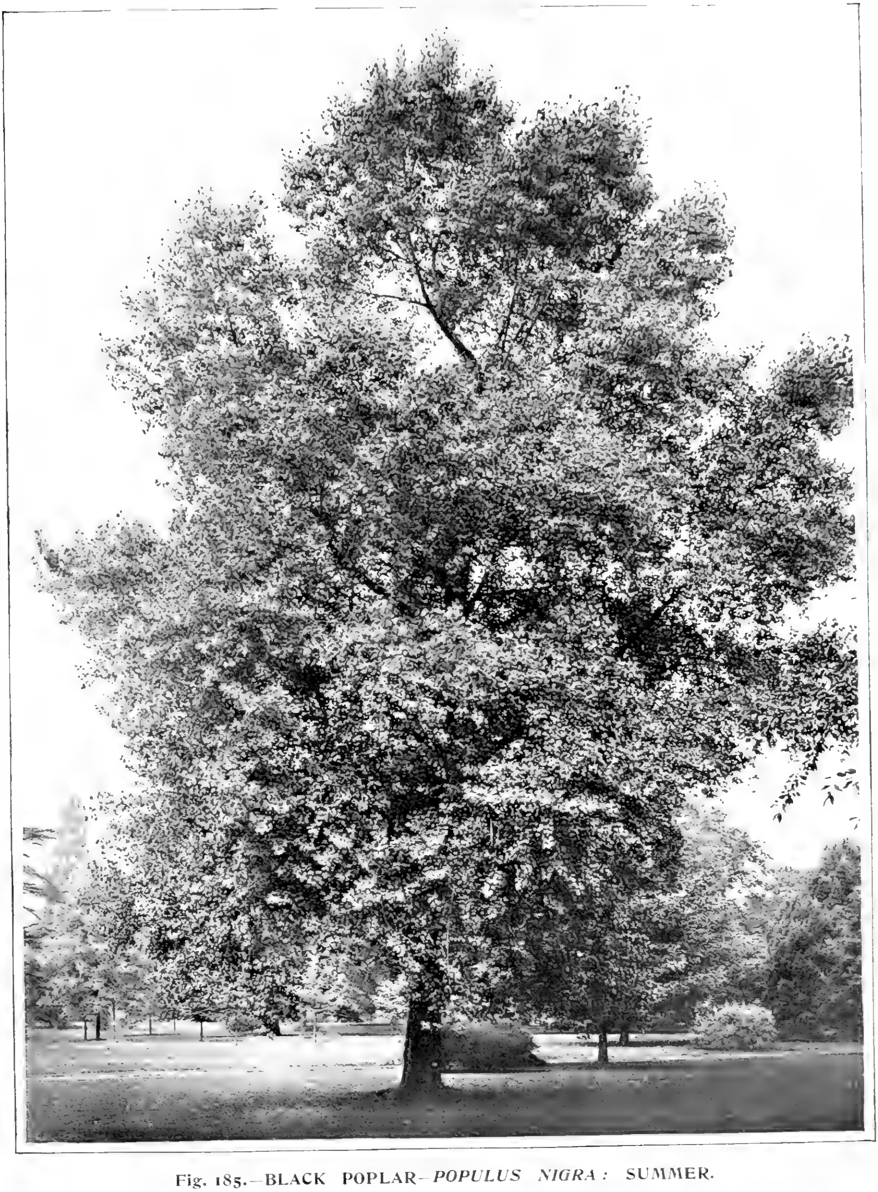

Fig. 185.—BLACK POPLAR—*POPULUS NIGRA*: SUMMER.

producing at first two scales on its flanks, the stem produces on its outer (lower) face a single scale which is more or less clearly two-keeled (compare Fig. 189). This is succeeded by three more scales, all four being alternate, but ranged in two ranks; then succeed spirally arranged leaves. When the buds awaken into activity they glisten with balsam (which is collected by bees). As they open the four scales fall, as do the stipules of the unfolding foliage-leaves, which force their way out and show themselves shining with sticky balsam. The lateral buds grow out into dwarf-shoots or inflorescences, but the uppermost bud develops into a long shoot which grows throughout the summer until it may be nipped off by frost. In the following year the growth is taken on by the highest lateral bud, which usurps the position of the true terminal one.

**Fig. 187.—Female Catkins of Black Poplar.**

**Fig. 186. Male Catkins of Black Poplar.**

The dangling, cylindrical, catkin-like inflorescences open in March or April, the male and female flowers being on different individuals and visible weeks before the leaves emerge.

The inflorescences thus are borne as branches on twigs produced during the pre-

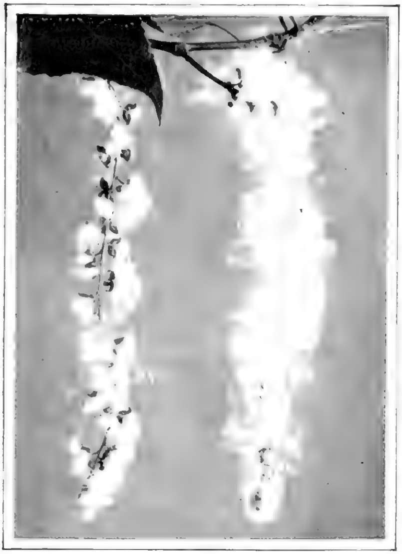

Fig. 188.—Escaping Seeds of Black Poplar.

ceding season. The buds producing them are in design like vegetative buds, except that the four bud-scales are succeeded by spirally arranged bracts (catkin-scales). Each catkin-scale broadens from its narrow base and frays out at its terminal margin into a ragged fringe, which, however, is devoid of the long, straight hairs that characterise the catkins of the White Poplar and Aspen. In the axil of each bract is a single flower.

**Flowers.**

The young male catkin includes many red flowers crowded along its axis. Each short-stalked flower shows a shallow, oblique, basin-like "envelope," occupied by thirty to fifty red anthers, which are nearly sessile. The young catkin does not hang down, but as its axis elongates, thus separating the flowers, it eventually droops over; the catkin-scales are then shed, while the filaments of the anthers elongate rapidly and thrust these out of the basin (Fig. 186). Thus the wind easily sways the lax catkins and blows the pollen from the protruding open anthers. The anthers shrivel and turn brown, and the whole catkin falls soon—often, in fact, before the pollen has been shed.

The design of the female catkin is similar (Fig. 187). But the basin-like envelope of each flower surrounds the base of a single ovary, which is surmounted by two relatively large, thick, yellow stigmas that are shaped like arrow-heads. The ovary is one-chambered, and bears numerous minute ovules in two vertical series on its wall.

After pollen has been conveyed to the stigma by the wind, the axis of the female catkin elongates, the ovary develops into a dry, yellow-brown fruit, whose thin wall splits along two longitudinal lines midway between the lines of ovules, and thus gives rise to a two-valved fruit containing many cottony seeds. Each minute seed has a tuft of cottony hairs at its base. Thus in May or early June the ripe catkins hang with snowy white fluff clinging to them (Fig. 188).

**Fruit.**

The fluffy seeds are transported by the wind. They contain no endosperm.

One prominent character of the tree is the frequent production of "burr-wood," with decorative "bird's-eye" marking. This burr-wood arises in connection with the huge lumps visible on the outside of the trunk (Fig. 181). The cause of the development of these is incompletely known, but each is largely constituted of exceedingly numerous buds that develop extremely slowly. As the stem of each bud should have concentric wood like that of a single stem, the burr thus constituted is like a confused complex of

**"Burr-wood."**

Fig. 189.—Bud of Lombardy Poplar.

little stems joined together, but radiating in different directions.

This tree, though not a native of Great Britain, is familiar especially on the banks of water-courses, but is not confined to wet soil. It demands a considerable amount of direct light, as is suggested by its exceedingly rapid growth during juvenility, its loose main branching, and its thick furrowed bark. Thus the Black Poplar is a tree of the open country, or forest-edge, while it is suppressed in the shady woods.

The *pyramidal variety of the Black Poplar*, which is often known as the Lombardy Poplar, differs by its columnar habit, the tall stem being concealed by numerous erect branches, which in open situations clothe the trunk almost to the ground (Figs. 10, 11). Though the lateral buds on the erect branches are spirally arranged, only those on the outer, exposed faces shoot out.

Fig. 190.—Bark of Lombardy Poplar.

This tree affords a good example of the influence of light in determining the sprouting of buds, for if we bend down a branch the buds that sprout are those on the now illuminated inner (upper) face. Another characteristic feature of the tree is the deeply ribbed base of the trunk (Fig. 190). With the exception of a few specimens cultivated in a few gardens, all the European specimens are male plants, so that the Lombardy Poplar is propagated solely by cuttings. Its stringent demands for light are clearly indicated by the behaviour of trees growing among others; for these shed their lower branches up to the height at which they are free from shade. In details this tree closely resembles the Black Poplar, with which it can apparently produce variety-hybrids.

## POPULUS TREMULA (*Linn.*).—Aspen (*Salicaceæ*)

The Aspen differs from the Black Poplar in its bark, which remains smooth for a long time, in the shape of its leaves, and in having furry catkins. In general characters the Aspen agrees with the Black Poplar, so that in the following description attention is directed mainly to points in which the two are not alike.

The root-system is very shallow and spreading, and readily throws up root-suckers, which may even appear years after the tree has been felled.

The straight trunk retains its light-coloured (yellowish or greenish grey) smooth bark for many years (compare Fig. 198), but later becomes fissured (Fig. 194), and eventually thick and deeply furrowed.

**Dimensions and Form.**

The tree is of moderate stature, being usually from forty to eighty feet in height, showing a trunk only about a foot in diameter; it is the smallest of the Poplars common in England. Its thin and usually small crown is commonly perched some height up the trunk, even in open situations, and has few and slender branches, is scantily foliaged, and therefore casts but little shade. The tree has a limited power of emitting additional new shoots from either its branches or bole, so that in this respect it is largely dependent upon the roots.

The stipulate leaves (Fig. 191) vary in form. The leaf-blade is most frequently rounded in outline, and before attaining maturity loses its scanty stock of hairs.

**Leaves.**

Attached by long, slender, compressed leaf-stalks, the leaves quiver and sway with the gentlest breeze. But the leaves on the suckers have each of them a short stalk and a more pointed blade which remains permanently hairy. The bright yellow dead leaves fall in October.

Fig. 191.—Shoot of Aspen.

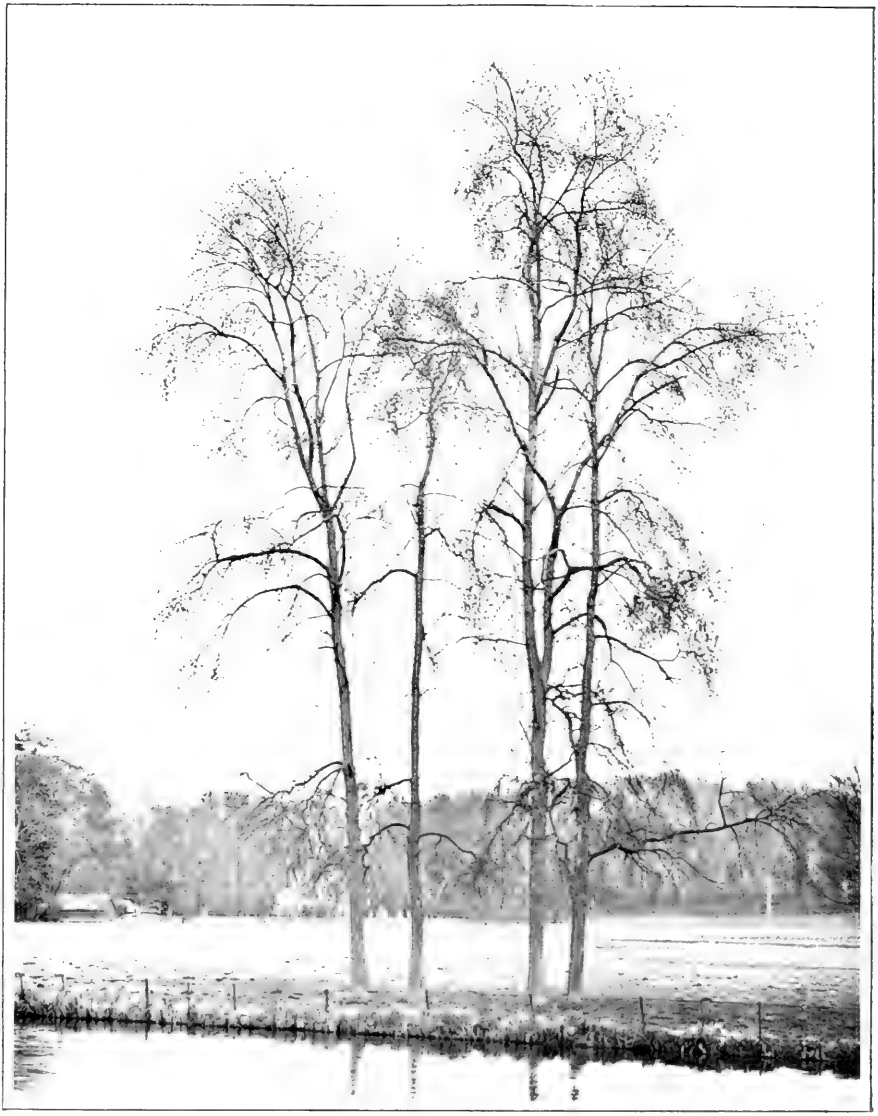

Fig. 192.—ASPEN—*POPULUS TREMULA:* WINTER.

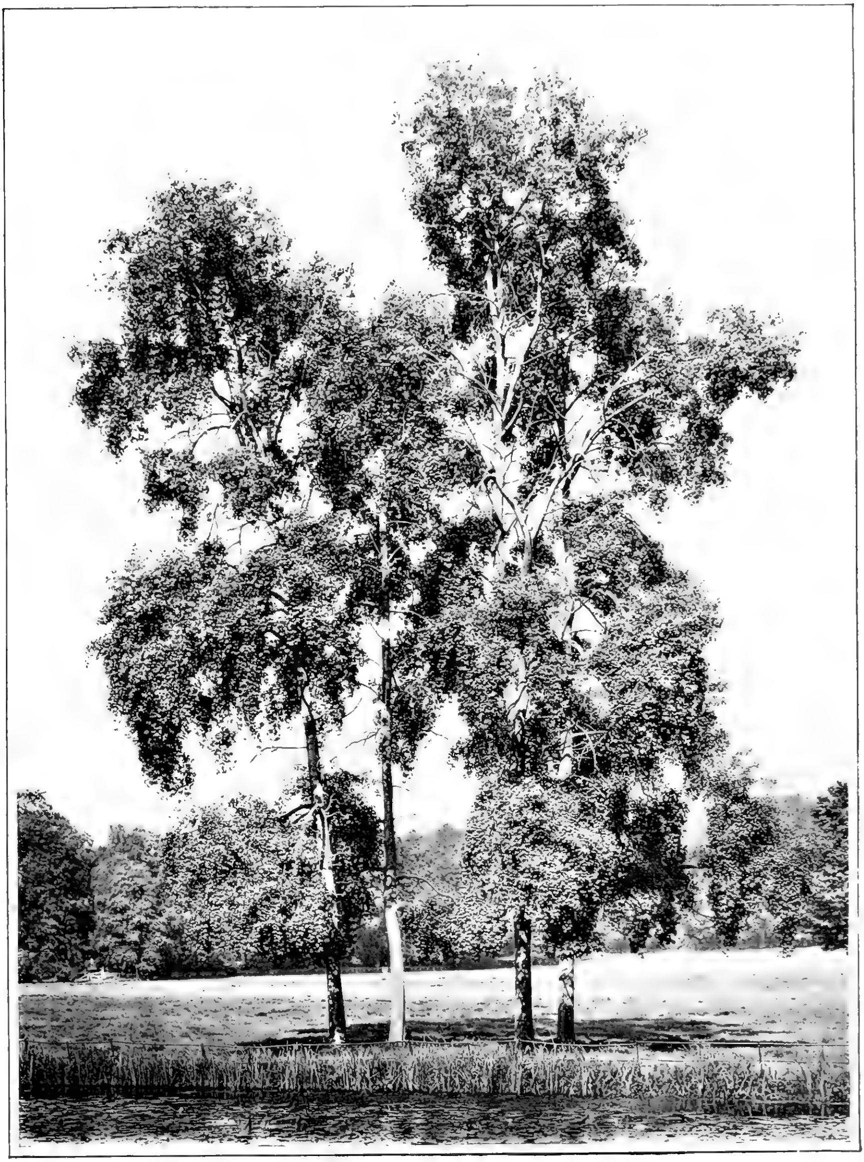

Fig. 193.—ASPEN—*POPULUS TREMULA:* SUMMER.

The glossy, chestnut-brown, resting-buds (Fig. 195–6) are hairless and more or less sticky when mature. As Fig. 196 shows, the slender vegetative buds (the terminal one in the figure) differ from the larger, plumper buds (two lateral ones in the figure) that give rise to catkins.

Fig. 194. **Older Bark of Aspen.**

**Flowers.**

The flowers open in March or April, long before the foliage reveals itself, and are grouped in furry catkins. This furry appearance is due to numerous long, straight hairs, given off from the deeply-fringed catkin-scales.

In design the inflorescences (Figs. 179, 197) and flowers agree with those of the Black Poplar. The stamens in one flower number only from four to twelve, and have purplish-red anthers. The two stigmas of the female are also of this colour, so that red tints prevail in both male and female catkins.

The cottony seeds are scattered (Fig. 180)

Fig. 195. Twig of Aspen in Winter.

Fig. 196.—Resting-buds of Aspen.

in May or June, and germinate within a few days.

**Fruit.** As in the case of other Poplars and, at least, some of our Willows that ripen their fruit early in the year, most of the seeds lose their power of germinating a few days after being shed; they must, therefore, in ordinary circumstances germinate at once or not at all.

Although the Aspen is a native of England it often dies in this country before reaching an age of eighty years.

**Habitat.** It is endowed with great versatility as regards its power of existing in diverse situations, which may vary from a wall-top to a wet river-bank. Yet in one respect the Aspen is exacting—it demands much light, and with this character accord its exceedingly rapid growth in youth and the lightness of its usually high-pitched crown. But the thin, smooth bark might seem to indicate rather a shade-loving habit; yet it must not be forgotten, on the one hand, that in old trees the bark is thick and furrowed, and, on the other, that the smooth, thin bark is light in colour, and therefore throws back a considerable proportion of the desiccating sun's rays, just as does the silvery bark of the Birch, which demands even more light. As the Aspen cannot endure much shade it is suppressed when overtopped by other trees, and in this country is a tree of the field rather than of the forest, though in some parts of Europe there are Aspen forests.

Fig. 197.—Female Catkins of Aspen.

## POPULUS ALBA (*Linn.*).—White Poplar (*Salicaceæ*)

The White Poplar is distinguished from the Black Poplar and the Aspen by the snowy white coating on the under-surface of the foliage and on the young twigs, by its dry, hairy resting-buds, and frequently by its possession of lobed leaves. The bark remains smooth and light-coloured for many years. The features described below largely concern differences between it and the Black Poplar.

Though the root-system includes a main root, its chief character is determined by the extremely long, horizontal lateral roots, which are shallow and freely emit erect foliaged shoots.

**Fig. 198.—Bark of White Poplar.**

The rapidly-growing tree may attain a height of 100 feet in forty years, and ultimately the base of its trunk may become more than six feet in diameter. The trunk gives off strong boughs, which bear moderately numerous branches, so that the large crown casts fair shade.

Fig. 199.—Bark of Old White Poplar.

The greyish or greenish white smooth bark (Fig. 198) in old age becomes deeply furrowed (Fig. 199).

The long-stalked leaves are of two forms. On the vigorous branches, especially on the suckers, they are lobed, and coated on the lower face with a dense snowy felt of hairs (Fig. 202); but on feebler shoots and older trees the leaves are unlobed, and may possess a snowy coating or a more evanescent grey one on the lower face. The upper face of the leaf is green; the petiole is much less compressed than in the Aspen and Black Poplar; the stipules fall early.

**Leaves.**

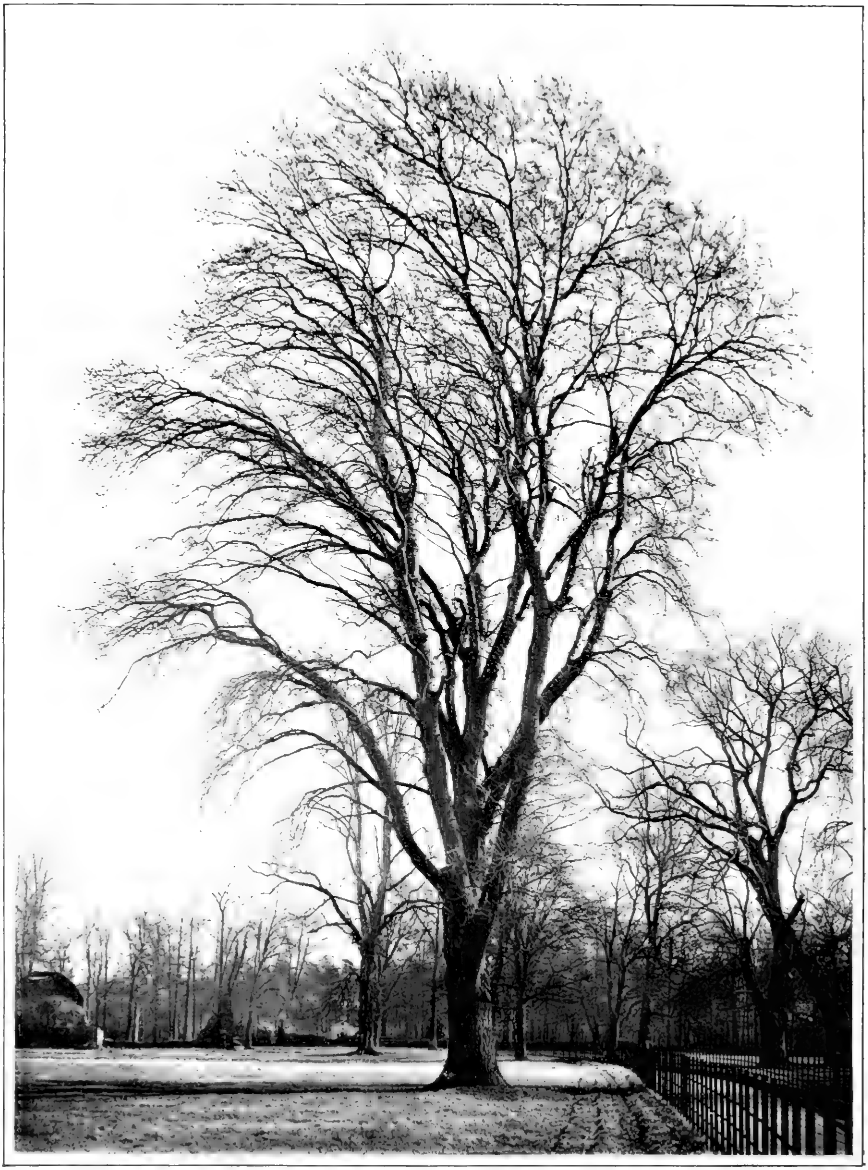

Fig. 200.—WHITE POPLAR—*POPULUS ALBA*: WINTER.

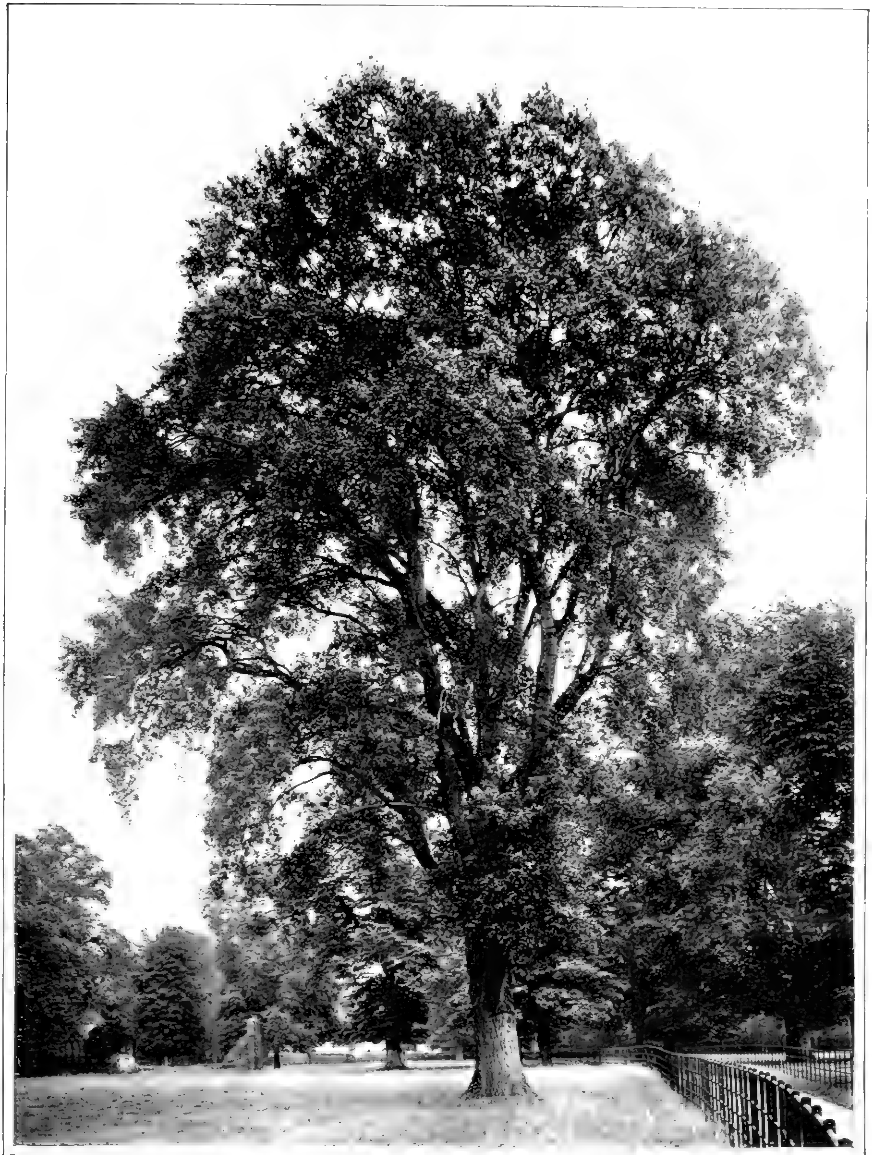

Fig. 201.—WHITE POPLAR—*POPULUS ALBA*: SUMMER.

The resting-buds (Fig. 203) are not sticky, but are coated with hairs, which are very evident only in the young bud. The shoot during its first active season is snowy white, yet before the following spring the coating of hairs has become a greyish film, which is easily rubbed off the olive-brown twig (Fig. 203).

In the male flower are from six to ten stamens, with purple anthers. The four slender stigma-branches of the female flower are yellow.

**Seeds.**

The short-lived cottony seeds, which are shed in May or June, germinate within a few days, and in favourable situations give rise to seedlings more than a foot in height in their first season.

**Fig. 202.—Leaves of White Poplar.**

**Catkins.**

The catkins (Figs. 39 and 204) are in flower in March or April, before the leaves appear. In design they are like those of the Aspen, but differ in that the hairs on the feebly-fringed catkin-scales are fewer and shorter: this is especially true of the light green female catkins, which may be nearly hairless, and thus more like those of the Black Poplar.

Its rapid growth enables the White Poplar to secure the considerable amount of light which it demands. Like the Black Poplar and Aspen, it often grows on the banks of rivers, but is more common than these in woods, and seems to endure heavier shade

Like the Black Poplar, it has a column-shaped pyramidal variety.

*Populus canescens* (*Sm.*).—*Grey Poplar*

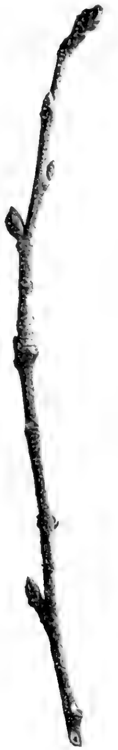

Fig. 203.—Twig of White Poplar in Winter.

The Grey Poplar is regarded as being a hybrid between the Aspen and White Poplar, so that its true botanical name would be *Populus alba* × *P. tremula*. Like its parents, it remains smooth-barked for many years. It differs from the White Poplar in that its leaves are not lobed; neither is there a lasting snowy coating on the lower face of the leaf nor on the young twigs. Its very variable leaves are more like those of the Aspen, but differ from these in being more persistently hairy; for, as a rule, they show on the lower face a thin, grey, silky coating, or patches of persistent hairs. The petioles are more compressed than in the White Poplar. The buds and young twigs are more hairy than in the Aspen, and the former are not sticky, as is often the case in the latter tree.

Fig. 204.—Female Catkins of White Poplar.

## SALIX.—Willows (*Salicaceæ*)

The Willows, which vary from trees of moderate height down to tiny woody plants only an inch tall, are especially familiar in well-lighted places on the banks of streams and pools, or in moist or wet soil. In this country there are more than thirty different kinds growing wild. Their identification is a matter of difficulty, especially as there exist a number of varieties and hybrids. The main points to notice are: habit (tree, shrub, sub-shrub, or tiny plant); the nature of the twigs, whether osier-like or not; breadth of the leaves; whether the catkins are borne on foliaged or not foliaged dwarf-branches; number of the stamens in each flower. Many subsidiary features require notice.

Their general scheme of growth is illustrated by the Crack Willow, of which a description follows.

## SALIX FRAGILIS *(Linn.)*.—Crack Willow *(Salicaceæ.)*

The Crack Willow is a narrow-leaved species with a rough bark, and lanky osier twigs that easily break off at the base.

It acquires a thick, furrowed bark (Fig. 205).

The spirally arranged leaves (Fig. 207)

**Fig. 205.—Bark of Crack Willow.**

It is a large shrub, or a tree which usually does not exceed forty feet in height but may reach ninety feet, and is often seen in the pollard form because of repeated lopping of its osier branches.

on the long-shoots are toothed, but are even-margined on the dwarf-shoots. The

**Leaves.** blade tapers to a long oblique point, is hairless when mature, and is pale green or whitish-bluish-green on the lower face. The stipules are half-heart shaped, and fall soon. Near the top of the petiole are usually some distinct little glandular lumps (whose presence distinguishes this tree from the White Willow).

The long, slender, straight, and supple long-shoots may attain a length of nine feet in one season, and are of the form used for making baskets, but their brittle nature decreases their value in this connection. In springtime only gentle force is needed to break the shoot off at its base, and it parts with a cracking sound, leaving behind it a fairly clean scar (though if broken across elsewhere the wound is ragged). If we consider the yellow one-year-old leafless shoot (Fig. 206) we see it ending in a resting-bud, and bearing on its sides a number of lateral buds pressed against the stem and standing above the prominent leaf-cushions. The terminal bud, which externally shows only one scale, develops into a long-shoot. Each lateral bud likewise shows only one scale, which is attached on the face away from the mother-shoot. The lateral buds may grow out into long-shoots or into flowering dwarf-shoots. In the latter case the shoot first produces one or two little green leaves which usually fall soon; these are succeeded by from three to five true foliage-leaves; and above these the stem ends in a male or female catkin.

**Long shoots.**

**Fig. 206.—Buds of Crack Willow in Winter.**

The catkins place themselves in an erect position (Fig. 210). The female and male catkins are on different individuals, and open their flowers in April or May, when the tree is in full foliage. They are constructed on the same plan as those of Poplars, as there are a number of spirally arranged bracts (catkin-scales) coated with hairs, and in the axil of each stands one flower. It should be noted that the catkin-scales of the female inflorescence fall very early.

**Catkins.**

**Fig. 207.—*Shoot of Crack Willow.***

The male flower shows two stamens, standing right and left, and capped by yellow anthers; between and outside their bases are two little fleshy lumps—the nectaries—which are placed fore and aft.

The female flower has two nectaries occupying the same positions, and a single tapering ovary mounted on a relatively long stalk. The one-chambered ovary contains two vertical lines of (about six) ovules on the lower part of its wall. The short style

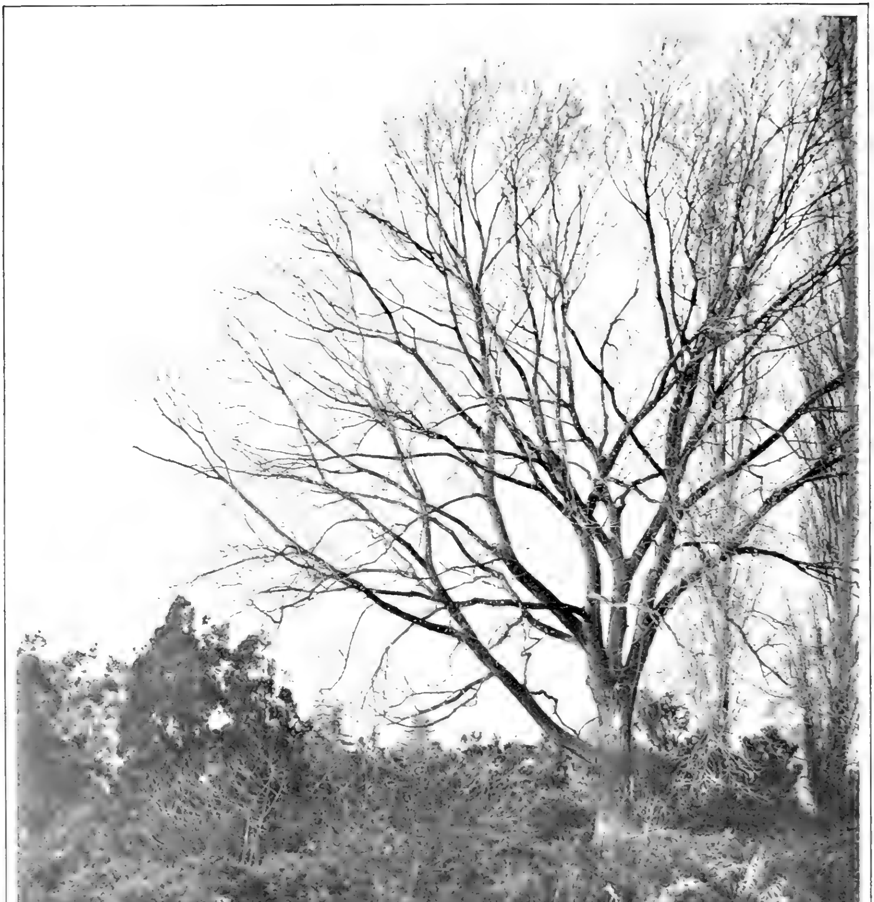

Fig. 208.—CRACK WILLOW—*SALIX FRAGILIS*: WINTER.

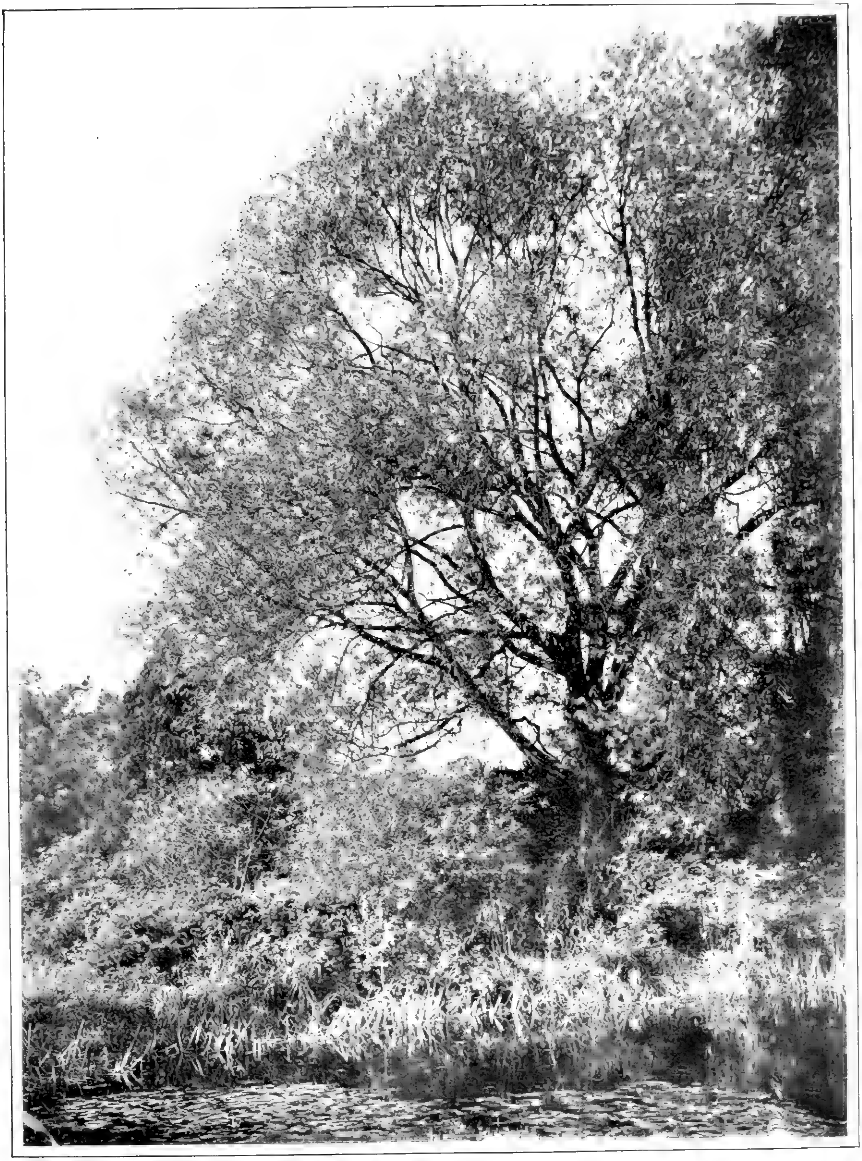

Fig. 209.—CRACK WILLOW—*SALIX FRAGILIS*: SUMMER.

**Fig. 210.—Young Fruiting Catkins of Crack Willow.**

terminates in two stigmas, which are slightly forked at the tip.

Insects, especially bees, attracted by the scent and nectar, transfer the rough-surfaced pollen-grains to the female flower. The fruit is ripe in June; it splits down two lines midway between the vertical rows of ovules, and the two valves curl backwards, thus exposing the fluffy seeds, which agree in structure with those of Poplars.

The Crack Willow is most frequently found in damp soil, in osier beds, and along water-courses.

*Salix alba* (Linn.), the White Willow, is very like the Crack Willow, from which it differs in the following respects: The leaf-blade, excepting when old, has a silvery coating of hairs, particularly on the lower face; the leaf-stalk has no glands; the stipules are narrow, lance-shaped. The ovary has a very short stalk, at the base of which only one nectary occurs. Two other narrow-leaved osier Willows are distinguished from the Crack Willow by the number of the stamens in the male flower. *Salix triandra* (*Linn.*) has three, while *S. purpurea* (*Linn.*) has only one, which is purple and represents two joined stamens, as the anther shows four lobes instead of the usual two. Another narrow-leaved osier Willow, *S. viminalis* (*Linn.*), as well as *S. purpurea*, differs from the White and Crack Willows in bearing no true foliage-leaves on the flowering dwarf-shoots.

## SALIX CAPREA (*Linn.*).—Goat Willow (*Salicaceæ*.)

This species contrasts with the Crack Willow in having broad leaves, also in that its stalkless catkins shoot forth and flower before the leaves emerge (Fig. 213), and in that the flowering dwarf-branches bear no foliage-leaves.

**Fig. 211.—Twig of Goat Willow in Winter.**

The Goat Willow or Common Sallow is a large shrub or small tree, which may be thirty or thirty-five feet in height. Its bark, at first smooth, later on shows a network of shallow fissures. The spreading boughs bear branchlets which are not long, slender osiers, but, being twiggy and knotted, are unsuited for basket-making.

**Leaves.** The spirally arranged leaves vary in form, margin, tip, and even in the distinctness of the stipules, which, when seen, are half-kidney shaped. The blade often continues out into a long tip which may be twisted and bent (Fig. 212). The upper surface, when mature, is pure though dark green, and more or less glossy (contrast *S. aurita*); the lower face may be smooth, or may show a thin cottony (not silky) coating of hairs; and is marked by a network of projecting veins.

**Fig. 212.—Shoot of Goat Willow.**

**Catkins.** The catkins shoot out in March or April from hairless resting-buds borne laterally on twigs produced during the preceding year. The dwarf-shoots they represent are devoid of foliage-leaves, though they bear a few bracts at the base (Figs. 215-6). The long silky hairs on the catkin-scales give a pretty, silvery appearance to the opening catkins, and especially to the male catkins. The catkins are large; the male ones are egg-shaped, and their silver is mingled with the gold of the yellow anthers: while the green female catkins are more slender and less conspicuous.

In general structure the catkins, flower, fruit, and seeds agree with those of the

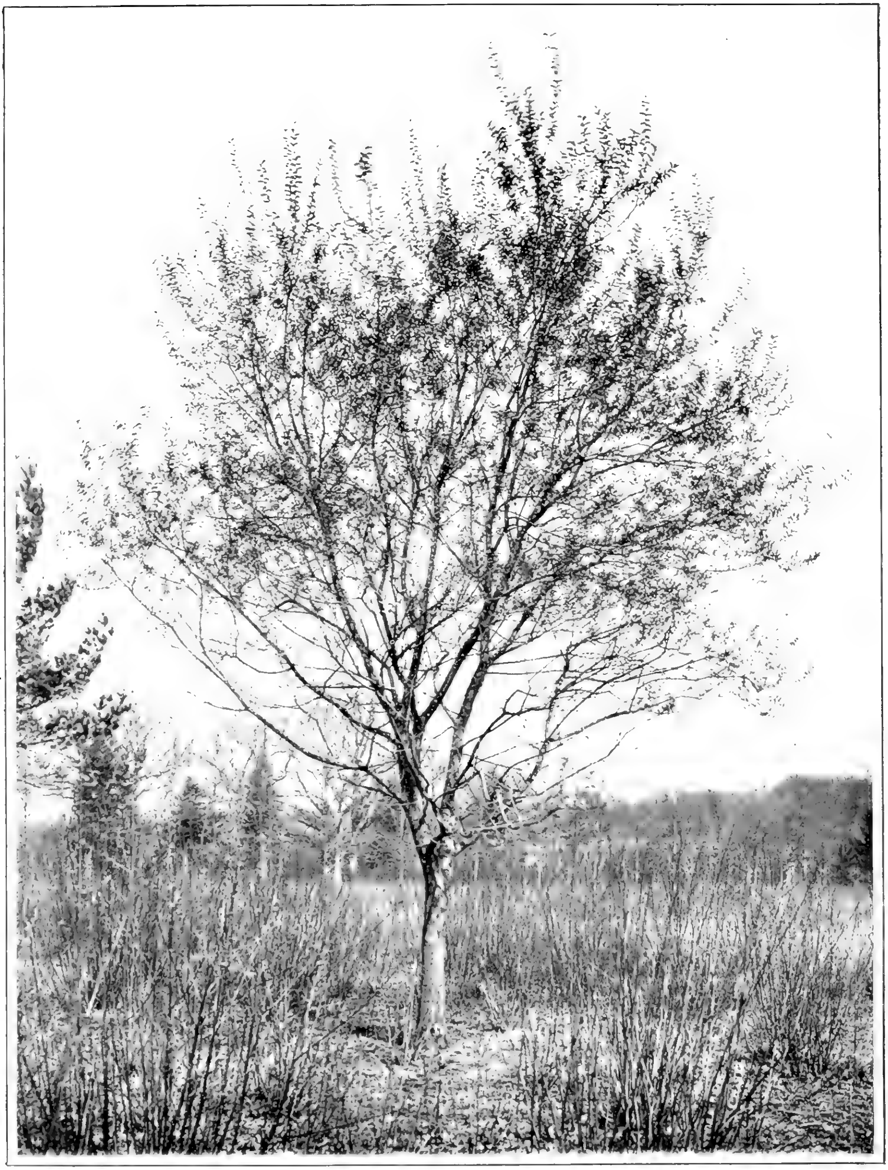

Fig. 213.—GOAT WILLOW—*SALIX CAPREA*: EARLY SPRING.

Fig. 214.—GOAT WILLOW—*SALIX CAPREA*: SUMMER.

Fig. 215.—Female Catkins of Goat Willow.

woods (with Birch and Aspen), and in clearings of the forest.

Among relatively broad-leaved Willows resembling *S. caprea* in habit and many details are three: *S. aurita* (Eared Willow), *S. cinerea* (Grey Willow), and *S. nigricans*. The first two of these agree with the Goat Willow not only in that their catkins terminate unfoliaged dwarf-shoots, and in the frequently large size of their stipules, but also in

Crack Willow, except that there is only one nectary to each flower. [Thus the Goat Willow is easily distinguished from the broad-leaved *S. pentandra* (Linn.), which has five (or four) stamens in each flower.]

Many bees are attracted to the catkins, and are largely responsible for pollination. As early as May the long-stalked fruits open and shed their fluffy seeds (Fig. 217).

The Goat Willow, though it is a short-lived tree, displays a great power of accommodating itself to various soils: for it grows not only on moist or even wet marshy and peaty soils, but also in dry places, on stony soil, and even lodges its roots in the crevices of rocks or ruins. These last situations conform with its shallow root-system. Yet the tree has its limitations, and reflects its imperative demands for light in the rapid growth of its shoots, as well as in the situations that it selects. These are always in open country, or in well-lighted thin

Fig. 216.—Male Catkins of Goat Willow.

the detail that the lower face of each leaf-blade shows a complete network of projecting veins; but they differ from the last-named species in that their leaf-blades are dull on the upper face because of a permanent film of short hairs. The one-year-old twigs of *S. caprea* and *S. aurita* are coated at most with minute down, and are never clad with the grey felt of hairs characterising those of the grey-leaved *S. cinerea*. From all these three species *S. nigricans* differs in that its leaves blacken as they dry, and at no time show any complete network of prominent veins on the lower face.

Very interesting but very different in form are the two tiny Willows found on the tops of high mountains—*S. reticulata* and *S. herbacea* both of which have broad leaves but are reduced to pygmies sometimes only an inch or so in height, and with more or less completely subterranean stems.

These produce an incomplete sward, or extend among stones along the ground, so that one can walk over them and pass them unnoted.

By French and German botanists they are described as "Glacial Willows."

**Fig. 217. Fruits of Goat Willow shedding Seed.**

## FAGALES. Oak and Hazel Families

The natural order comprising the *Fagales* includes the Oak, Sweet Chestnut, Beech, Hazel, Hornbeam, Birch, and Alder.

All these are *woody* plants with alternate, simple, stipulate leaves, and *inconspicuous unisexual flowers*, which are devoid of petals, and are often (almost without exception in the case of the male flowers) arranged in *catkins*. The most obvious difference between this natural order and the *Salicaceæ* lies in the structure of the ovary and fruit. Here the *ovary* is *inferior*, and has *two to three chambers* (usually more in the Chestnut), each of which contains only *either one or two ovules*. The *fruit is dry, one-seeded*, usually a nut, *and does not open spontaneously*. The seed is wholly occupied by the embryo.

The green perianth, which is small or entirely suppressed, is epigynous when present.

The simplest method of regarding the group is to view the constituent plants as having degenerate flowers and inflorescences, whose original types are best preserved in the Sweet Chestnut. The Chestnuts, unlike the majority of other representatives, are best represented in warm countries, even within the Tropics, where they are connected by numerous transitional forms with the Oaks. The remaining members of the *Fagales* are, almost without exception, north-temperate, or if tropical are on mountains. Nearly all the representatives are confined to the Northern Hemisphere, but Beeches provide a striking exception by forming forests in extremely southern lands (New Zealand, the southern extremity of South America and the adjoining islands).

Many points of interest are encountered in the natural order. (1) There are all stages between complete bisexual flowers, ranged in elaborate inflorescences (*e.g.* Chestnut), and simple spikes of naked unisexual flowers; also all stages of reduction of the perianth, and various stages of reduction or modification of the bracts. (2) The flowers of the Chestnut may be insect-pollinated; the others are wind-pollinated. (3) The stamens show all links between perfect ones, and such as are divided completely down the middle into two halves, each with a filament and a half-anther. (4) In the Chestnut at the time of pollination the ovary-chambers and ovules are present, but in a number of other forms at this time there are neither ovary-chambers nor ovules, which first develop as a consequence of pollination. (5) Some of the species open their flowers earlier in the season than the leaves unfold; others send out leaves and flowers simultaneously; in still others the leaves emerge first.

The constituent trees often take a more leading part in forming forests than do the *Salicaceæ*, which are generally marked by their demand for light, and often by their preference for wet soil. More diversity is shown by the *Fagales*. The Beech and Birch represent the limits attained by British broad-leaved (dicotylous) trees respectively in their endurance of deep shade, and demand for direct light; these and the other intermediate types beautifully illustrate the characters of shape, behaviour, and distribution of trees according as they demand much or little light. As regards soil some are versatile: the Birch, for instance, can grow on dry shallow soil, or on soaking peat soil close to the moisture-loving Alder which fringes rivers or pools; the Beech, on the contrary, is killed by a soaking soil, and the Oak is stunted save on a deep one.

The *Fagales* naturally fall into two families:—

(1) *Fagaceæ* (Sweet Chestnut, Oak, and Beech). Here, in each female flower the stigmas and chambers of the ovary number three (or multiples of three), and there are two ovules in each chamber.

(2) *Betulaceæ* (Hazel, Hornbeam, Birch, and Alder). Here, the female flower shows two stigmas and ovary-chambers, each of which encloses only one ovule.

### (I.) FAGACEÆ

In addition to the points already mentioned it may be noted that the inflorescences arise as branches on the twig produced during the current season. *Each fruit or group of fruits is enclosed in a cupule,* which is familiar as the acorn-cup of the Oak, or the four-valved spiny cupules of the Chestnut and Beech. The three genera are easily distinguished :—

(1) *Castanea* (Sweet Chestnut) has erect male catkins, a spiny four-valved cupule enclosing (usually) three fruits, which are rounded in cross-section.

(2) *Quercus* (Oak) has hanging male catkins ; the cupule with scale-like or pointed outgrowths encloses only one fruit (acorn) which is circular in cross-section.

(3) *Fagus* (Beech) has pendent long-stalked male inflorescences, of which the flowers form a rounded tuft ; the four-valved spiny cupule encloses (usually) two fruits which are triangular in cross section.

### (II.) BETULACEÆ

To the characters already given may be added the following details. The open inflorescences are typically attached directly to a stem produced during the previous year. The male inflorescences are always pendent cylindrical catkins. The perianth is often lacking. The stamens are often more or less completely divided into two halves. The fruit is surrounded by a cupule only in the Hazel. The four genera are distinguished most easily by their fruits :—

(1) *Corylus* (Hazel) has the familiar filbert with a cupule round it. (Note also the female inflorescence concealed, except for its red styles, inside a bud.)

(2) *Carpinus* (Hornbeam) has a hanging collection of fruits concealed by large three-lobed scales. Each fruit is a ribbed nut with a large three-lobed scale clinging to it. (Note also the hanging green female catkins and the smooth-barked fluted stem.)

(3) *Betula* (Birch) has a catkin-like cylindrical collection of fruits with flat scales and flat winged fruits : the scales fall off separately and release the fruits. (Note also the erect cylindrical female catkins, and the silvery bark.)

(4) *Alnus* (Alder) has a woody cone-like collection of fruits, whose thick woody scales merely gape asunder, without falling, to release the flat seeds. (Note also the little cone-like female inflorescences, and the stalked resting-buds.)

## CASTANEA SATIVA (*Mill.*).—Chestnut (*Fagaceæ*)

*Castanea sativa* (*C. vesca*, *C. vulgaris*), the Sweet Chestnut, is recognisable by its spiny, four-valved cupule, which encloses from one to three chestnuts; by its long, erect, conspicuous male catkins; and by its long leaves, the teeth and tip of which are sharp-pointed.

**Fig. 218.—Bark of Sweet Chestnut.**

The Chestnut thrives only on a deep soil, as the massive main root as well as the strong lateral roots descend deeply.

**Form and Dimensions.**

The large tree in close forest may show a tall straight trunk unbranched up to a considerable height; but in the open, or in well-lighted woodlands, the Chestnut produces heavy branches and an ample broad crown, below which there may be only a relatively short bole. Though the tree may attain a height of ninety feet, it is thickness rather than length that is the marked feature of the trunk, which is known to attain a diameter of twelve feet. In fact the trunk of the extraordinary *Castagno di cento cavalli* on Etna measured more than 150 feet in girth; but this monstrous stem may have resulted from the fusion of several. The stool and stump of the Chestnut have remarkable powers of sending forth vigorous erect shoots; and boughs dipping on to the ground readily send roots into the soil. The roots, on the contrary, have little or no power of producing suckers.

Fig. 219.—Twig of Sweet Chestnut in Winter.

The bark (Fig. 218) becomes thick and longitudinally furrowed, and acquires a grey to brown colour.

**Leaves.**

The stalked stipulate leaves are arranged spirally on erect shoots, and, to some extent, on vigorous branches, but for the most part they spread out horizontally in two ranks. In the bud the blade is plaited along its parallel lateral nerves, and is ensheathed by the stipules belonging to the same leaf; but the stipules soon fall off when once they have ceased to be of use as bud-protectors. The large, glossy, somewhat leathery blade (Fig. 220) is not unlike a magnified Hornbeam leaf in shape, and is more or less completely hairless when mature.

The short, blunt resting-bud (Fig. 219) shows only two external scales. On the leafless rather coarse twigs the lateral buds may be seen to

Fig. 220.—Leaves of Sweet Chestnut.

stand in the axils of prominent leaf-cushions.

**Flowering Age.**

The Sweet Chestnut commences to bear fruit at an age of from twenty to thirty years in the open, but not until it is fifty or sixty years old in close forest. In well-lighted situations it fruits every year, though good crops succeed only at intervals of two or three years, or even at longer intervals inside the forest.

**Inflorescences.**

The inflorescences and flowers deserve close attention, as they provide a clue to the structure of the simple and, at least partially, degenerate ones of the Oak, Hazel, Birch, Alder, and Hornbeam.

The long erect catkins arise as branches in the axils of foliage-leaves on the current year's-shoot. Their own stems bear no

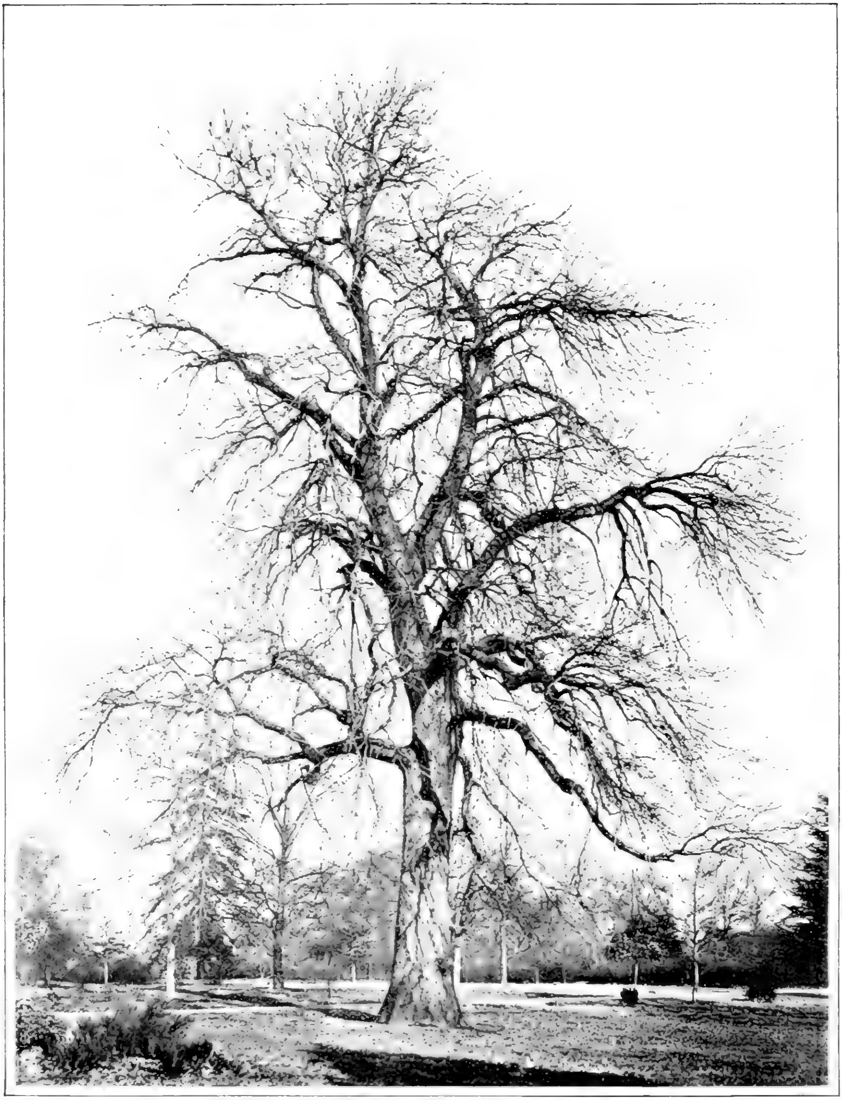

Fig. 221.—SWEET CHESTNUT—*CASTANEA SATIVA:* WINTER.

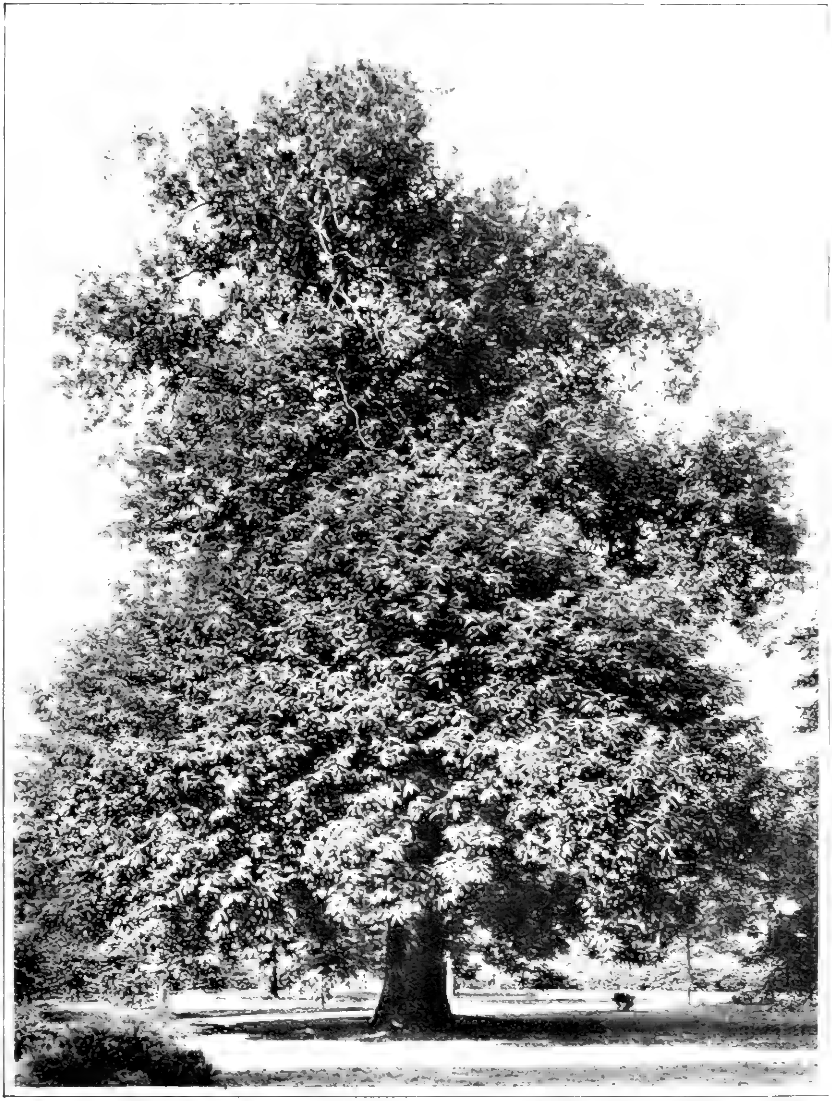

Fig. 222.—SWEET CHESTNUT—*CASTANEA SATIVA*: SUMMER.


Fig. 223. Male and Mixed Catkins of Sweet Chestnut.

(1) Resting-buds. (2) Male catkins (Fig. 223, ♂). (3) Mixed catkins with clusters of female flowers below, and of male flowers above (Fig. 223, ♀ ♂). (4) Resting-buds.

**Explanation of Catkin.**

Both kinds of catkins bear spirally-arranged catkin-scales, with clusters of flowers standing in the axils of these. In order to understand the nature of a single cluster in the axil of a catkin-scale we will, for a moment, imagine the inflorescence that it represents to possess all its stems (which in reality have been suppressed). The cluster would then take the form of an inflorescence (*see* Fig. 224) with a single stem which ends in a flower (Number 1) and bears on its sides two leaves (bractlets I. and II.). In the axils of these last two are two branches, each of which likewise ends a flower (Numbers 2 and 3), and bears two leaves (bractlets III. and IV., V. and VI.). In the axils of these last-named are single flowers (Numbers 4 and 5, 6 and 7). If we now telescope all the stems together we have on the main stem (A) of the catkin, in the axil of a catkin-scale (C), an inflorescence showing not only a central flower, and on each side of it a group of three flowers, but also six scale-like bractlets between them. And this is precisely the constitution of the male cluster of the Chestnut showing

foliage. On weak dwarf-shoots whose leaves are all two-ranked, male catkins arise in the axils of two or three of the lowest foliage-leaves; higher up these dwarf-shoots no other catkins occur. But stronger shoots, whose lower leaves are two-ranked, but whose upper ones are spirally arranged, show in the axils of the successive leaves, commencing from below, the following:

seven flowers and six bractlets. From such a type we can derive all the simpler other types met with in the great group (*Fagales*) including the Oak, Hazel, and others.

For instance, consider the Chestnut's cluster of female flowers, of which there are three in the axil of a catkin-scale: here the four ultimate flowers (4–7) are missing, only the main flower (1) and the first two lateral ones (2 and 3) being present; bractlets I. and II. are visible as scales, one being on each side of the cluster, but in place of the four other bractlets (III. to VI.) there is a cupule which surrounds the three female flowers, and shows many narrow scale-like outgrowths and little bristles. When the fruits are ripe, the cupule is a spiny investment which opens out four valves; these four valves are often regarded as representing the four missing bractlets. But even in the Chestnut there are cluster-inflorescences that include from four to six flowers, and thus represent stages intermediate between the three-flowered and seven-flowered clusters. On the other hand, the female inflorescence in the axil of a catkin-scale may also be reduced to the single central flower (1). Thus on one tree we find stages from an elaborate cluster in the axil of the catkin-scale down to a solitary flower, which may possess all the attendant bractlets of the complete cluster, and thus demonstrate its degeneracy.

**Male Flower.**

Each male flower has a perianth of from six to eight (most frequently six, representing two whorls of three each) sepals, which are joined below. Within these stand from eight to twelve complete stamens, which surround a tiny three-lobed lump that represents the rudimentary remnant of a pistil.

**Female Flower.**

The female flower possesses a perianth consisting of five to eight (most frequently six) joined sepals. Within this there may or may not be some stamens, which are rudimentary as they lack anthers. In the centre rises a tuft of rod-like styles which give the flower a spiky appearance. The inferior ovary, even when the flower first opens, already possesses distinct chambers with two ovules

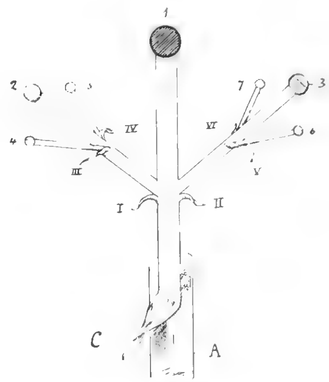


**Fig. 224.**

in each. Styles and ovary-chambers frequently number six, but vary from three to twelve; and it is of interest to note that intermediate stages occur; for instance, three larger alternating with three smaller ovary-chambers and styles.

**Mixed Inflorescences.**

Yet another point of interest is encountered in the mixed inflorescences, in the middle part of which there are clusters and flowers intermediate between the male and female types. Above the female clusters on the main stem of the catkin may be found other clusters, each showing a central female flower and two bisexual flowers. Above these again may appear a cluster of three bisexual flowers with a reduced cupule. Still higher, as the number of flowers in a cluster increases and the cupule dwindles (till only scaly outgrowths on separate bractlets recall it), the stamens become more marked, and the pistil less significant, until the typical male clusters are reached.

All these facts suggest that possibly the


Fig. 225.—Catkins of Sweet Chestnut showing Male (♂) and Female (♀) Clusters.

**Pollination.**

The male catkins are rendered conspicuous by the yellow colour of their envelopes and projecting anthers, also by their length and grouping. They are sometimes scented (perhaps always so in their sunny southern home). The male catkins, too, are erect — not pendent, like those of the wind-pollinated British Oak, Hazel, Birch, Alder, and Hornbeam. Finally, the pollen-grains are stated to cling in groups, and not to separate like powder. All these facts suggest that the flowers are pollinated by insects. Crowds of bees, also some other insects, may be seen collecting pollen; and in creeping about these visitors cannot fail to transfer pollen on to the stigmas of adjacent female flowers. But insects visit admittedly wind-pollinated flowers, and the pollen of the Chestnut is smooth like that of such flowers. What then does the female flower suggest? It is inconspicuous, has neither yellow pollen nor nectar to invite insect visitors, and at least to human beings it is devoid of odour. Its numerous projecting rod-like stigma-bearing styles agree in size and position with the large stigmas of wind-pollinated flowers at least as much as with the relatively smaller ones of insect-pollinated flowers. Thus we find different observers describing the Sweet Chestnut as insect-pollinated and as wind-pollinated.

Apparently the flowers are intermediate between wind-pollinated and insect-pollinated flowers. So that the Sweet Chestnut's ancestor of the Chestnut, and of the whole group to which it belongs, originally possessed bisexual flowers arranged in elaborate branched and stalked inflorescences. If so, that the complete flowers have been reduced to male and female flowers by the more or less perfect suppression of carpels and stamens, which are now functionless relics; while the lateral inflorescences on the stem of the catkin have been condensed into stalkless clusters. And these suggestions receive fresh light from observations on the pollination.

Fig. 226. Fruits of Sweet Chestnut.

ancestors may have possessed conspicuous or strongly scented flowers (or inflorescences) that were regularly haunted and pollinated by insects. Neglect by insects may thus have brought into existence the whole series of degenerate wind-pollinated Oak, Beech, Hazel, and others forming the *Fagales*.

After pollination the ovary enlarges, but all its ovules save one remain small, so that it becomes the glossy edible Chestnut containing one seed. The cupule gradually grows over and ensheaths the three young fruits of one cluster in spiny armour (Fig. 226), but in October it unfurls its four valves and exposes the ripe nuts which are now protected by firm chestnut-coloured walls (Fig. 227).

**Fruit.**

The seed contains only the embryo, which is mainly constituted of two thick massive cotyledons that are filled with food. When the seed germinates the cotyledons remain below ground as subterranean food-reservoirs, and the stem at once produces small foliage-leaves. From the first and for many years the young plant grows rapidly.

**Seed.**

The tree may attain a great age, possibly a thousand years.

The Chestnut comes to us from the warmer south of Europe, and reflects the unsuitability of our climate in the small size and incomplete ripening of its fruits in Great Britain. Apparently as regards demands for light it stands between the Oak and shade-bearing Beech. Its general habit of growth suggests alternately demand for light and endurance of shade: for the tree has a rapid upward growth during youth, and acquires a thick bark; yet, like a shade-bearer, it casts deep shade, thanks to the large size and horizontal extension of its leaves. As regards soil, it shows a marked shyness of lime, and at best grows feebly on soils rich in lime.

**Habitat.**

Fig. 227. Fallen Cupules of Sweet Chestnut, one with a Fruit.

## QUERCUS ROBUR (*Linn.*).—COMMON OAK (*Fagaceæ*)

A Common Oak is recognised by: (1) the acorn which ripens in its first year, and is seated in a cup that shows many overlapping little scales pressed close against the surface; (2) the pendent male catkins with flowers grouped at intervals; (3) the characteristic lobed leaves which are deciduous and have stipules that fall very early.

Under the name *Quercus Robur* are included two sub-species or species—*Q. pedunculata* (Ehr.), the Pedunculate Oak, and *Q. sessiliflora* (Salisb.), the Sessile Oak—which are connected by intermediate forms. In the following description the two will be described collectively under the name of the Oak, and the more important distinc-

Fig. 228. Bark of Common Oak.

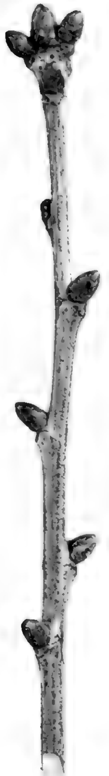

Fig. 229.—Twig of Common Oak in Winter.

tions between the typical forms will be indicated.

The deep and massive nature of the root-system with its large spreading and descending lateral roots accounts for the Oak's sturdy resistance of storms, and for the fact that it flourishes only on deep soil.

**Dimensions and Form.**

Though this largest of British trees may tower to a height of 110 feet, or even 150, the more striking feature in regard to the trunk is the thickness to which it can grow: one mighty English specimen possessed a trunk measuring seventy feet in circumference. From the trunk are emitted great, gnarled and tortuous boughs, whose finer branches are relatively insignificant and short. In the Pedunculate Oak, the trunk, at no great height from the ground, seems to divide into a number of big boughs, producing a relatively low-pitched spreading crown, which is especially low in the open. The Sessile Oak is described as having a trunk distinct up to a greater height, a more regular crown, and more steeply ascending boughs. The bark becomes thick and deeply furrowed (Fig. 228).

**Leaves.**

The lobed leaves are spirally arranged and, towards the ends of the twigs, characteristically tufted because the internodes are short. This feature of thrusting its rosettes of leaves into the light is of special interest when it is noted that the Oak demands a considerable amount of direct light. The lobed leaves are stalked and stipulate, but the stipules fall soon. The leaf of the Pedunculate Oak (Figs. 233, 235) has a short stalk; the blade is practically hairless, and as a rule does not taper at the base. But the leaf of the Sessile Oak (Figs. 234, 236) has a much longer stalk; the blade more frequently tapers towards its base, shows some hairs on the lower face, and is more firm and leathery. The brown or yellow autumnal leaves of the Pedunculate Oak fall before winter, except perhaps from some of the erect younger shoots springing from the base of the old trunk; but the thicker leaves of the Sessile Oak hang longer, and in sheltered places green leaves may be found in winter still attached to shoots emitted from the bole. Thus there is a feeble indication of the evergreen habit that characterises the Holm Oak and many other species of *Quercus*.

**Resting-buds.**

The resting-buds (Figs. 229, 230) show many pairs of scales which represent stipules of leaves whose blades are not developed. But one peculiar feature shown by British and other European Oaks is that the lateral buds are clustered towards the tip of the twigs (because the leaves are likewise so). As the Common Oak demands considerable illumination, only these well-lighted and clustered buds develop as a rule, while those lower down the year's-shoot remain living, but inactive, for many years. The result of this behaviour is double. First, the design of the branching is characteristically tufted; moreover, this tufted

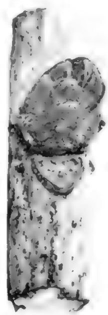

Fig. 230.—Resting-bud of Common Oak.

Fig. 231.—COMMON OAK—*QUERCUS ROBUR:* WINTER.

Fig. 232. COMMON OAK *QUERCUS ROBUR*: SUMMER.

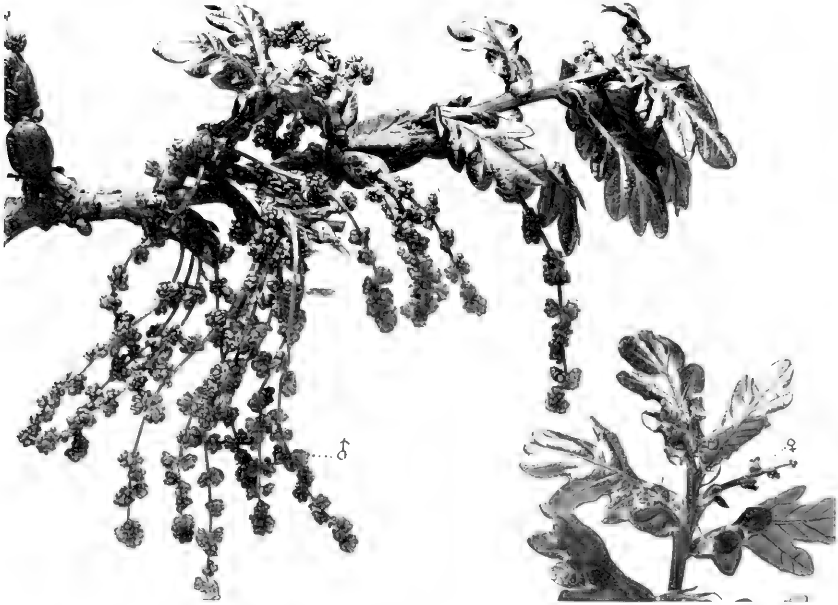


Fig. 233.—Male and Female Inflorescences of Pedunculate Oak.

branching coupled with the occasional death of the terminal bud or end of the shoot is, at least partially, responsible for the curious zig-zag shape of the main branches. Secondly, there remain many resting-buds on the Oak, so that the tree has great power of throwing out shoots from stumps, or from old parts of the trunk after this has been exposed to increased light or after the crown has been lopped. Often, then, Oaks show on their trunks bosses studded with twigs and buds. These little branches arising on the veteran stem, as well as the great boughs springing from it, cause Oak-trees grown in the open to produce timber showing much burr-wood and gigantic knots. But another important peculiarity of the Oak influences its shape. The tree has the habit of emitting a second crop of shoots—the so-called "lammas-shoots"—in one season. In summer the resting terminal and higher lateral buds suddenly awaken into activity, their scales are forced asunder, and there emerge fresh green leaves, which in details differ from those exposed at springtime. Consequently the Oak produces two degrees or generations of branching, instead of one, in a single season.

The tree does not commence to bear good seed until the ripe age of sixty or eighty years. The male and female flowers come out on the same individual, and at the same time as the leaves are emerging, namely in April or May.

**Flowers.**

Both male and female inflorescences arise as branches on shoots produced during the current season. On feebler dwarf-shoots only pendent male catkins arise; but on more vigorous shoots springing from the terminal portions of the previous year's twig both kinds of inflorescences occur.

A resting-bud about to produce a flowering branch is encased in pairs of scales; when it shoots out, the male inflorescences arise in the axils of a few of the uppermost of paired scales. And on male branches the catkins can be seen before the foliage-leaves are revealed (see Fig. 233). When the branch has grown out from the resting-bud, its lower foliage-leaves will be seen to have resting-buds in their axils; furthermore, if the branch be a "mixed one," in the axils of leaves still higher up are the little, erect female inflorescences; and above these again may succeed leaves with resting-buds in their axils.

Both kinds of inflorescence are very simple, and produce only one stalkless flower in the axil of each bract-scale (catkin-scale).

The hanging male catkin bears many spirally, but unevenly, distributed catkin-scales. Each male flower consists of from five to seven sepals joined below, and from five to twelve complete stamens; there is no trace of a pistil.

**Fig. 235. Shoot of Pedunculate Oak.**


**Fig. 234.—Female Inflorescence (♀) of Sessile Oak.**

The female inflorescence shows fewer flowers on its axis, only from one to five. In the Pedunculate Oak the erect inflorescence has a distinct stalk with flowers at its sides (Fig. 233, ♀). So that eventually the acorns are raised upon a stalk, a *peduncle*, longer than the leaf-stalk (Fig. 237). But in the Sessile Oak the female flowers are crowded together apparently in the axil of the foliage-leaf, because the inflorescence-stem is contracted (Fig. 234, ♀); consequently the acorns are not stalked but *sessile* (Fig. 236). Each flower is surrounded by a basin-like scaly cupule, which becomes the woody acorn-cup. The distinctly toothed perianth consists usually of six joined sepals inserted above the minute lump representing the inferior ovary. In the centre rises the three-branched style terminating in three stigmas. At the time of pollination the ovary shows no

Fig. 236.—Fruit of Sessile Oak.

of two large cotyledons; these are flat on their inner (applied) faces, but rounded on the outer. In germination the root emerges, the acorn-wall splits, but the food-containing cotyledons remain below or on the ground. The main stem grows up and produces at first little scale-leaves; thus the young seedling spends its substance nearly entirely in producing a deep, unbranched tap-root, and a long, unfoliaged stem, which shall raise the first green leaves above the adjoining humble vegetation. Thereafter the growth of the young tree is moderate—neither so rapid as that of the Birch, nor so slow as that of the Beech.

**Seed and Germination.**

Fig. 237.—Fruit of Pedunculate Oak.

distinct cavity, still less any ovules, but later it acquires three chambers, each of which encloses two ovules.

After pollination by the agency of wind, the fruit ripens in the same year, so that in October the full-sized mature acorns may be seen in connection with twigs produced during the current year. Nearly always the ovary changes into a one-seeded acorn, though it previously possessed six ovules; yet cases are known in which all six ovules change into seeds, in which case the acorn produces six seedlings. The scales on the cupule overlap and lie flat against the surface.

**Fruit.**

The seed is wholly occupied by the embryo, which is mainly constituted

The tree may attain a great age, probably a thousand years.

The Oak can grow on various kinds of soil, and even endures the vicinity of the sea, though in windy exposed situations it dwindles to a wind-clipped dwarf (Fig. 31). The Pedunculate Oak is said to demand more moisture than the Sessile Oak; at least it is found more abundantly in moister lowland soil than the latter, which often occurs at higher levels on hillsides. The difference in the situation of the two species partly accounts for their difference in form (thickness of leaf) and behaviour (time of sending out foliage). *Q. pedunculata* is generally more common in England, but *Q. sessiliflora* is the more abundant in certain parts of Wales.

**Fig. 239.—Oak Spangle-galls.**

**Fig. 238.—Oak Apple-galls.**

In addition to intermediate forms there are various peculiar cultivated or wild varieties of one or other of the two species; such as columnar and weeping forms, as well as forms with split or narrowed leaves and lobes.

**Galls.**

The Oak suffers from a horde of foes—both fungal and animal. The most familiar effects of these are galls, caused by minute midge-like gall-wasps (*Cynipidæ*), which pierce and deposit eggs in young developing parts of roots, stems, or leaves, and thus cause these to produce distorted members known as galls (Figs. 19, 20, 238-9). The study of these galls is complicated, because: (1) One and the same species of insect at different stages of its life may cause two entirely different, though perfectly characteristic kinds of gall. (2) If we open a gall it may contain—first, the small insect causing it; secondly, other insects that have invaded the gall; thirdly, minute insects whose larvæ are parasitic upon the two preceding types of vegetarians; and, fourthly, still more minute ones whose young are parasitic on the parasites just mentioned.

## QUERCUS CERRIS (*Linn.*).—Turkey Oak (*Fagaceæ*)

*Quercus cerris* is an oak which sheds its leaves every autumn and, in habit, is very like the Common Oak, but is easily distinguished by the persistent stipules, the outer scales of its resting-buds, and scales on its cupule, all of which are narrow, elongated structures which taper to a thread-like end.

**Fig. 240.—Fruit of Turkey Oak—*Quercus cerris*, half-grown—and ripe fallen.**

In the following brief account comparison is made throughout with the Common Oak.

The rough bark is darker, being nearly

black. The leaves vary greatly in form, but usually have more pointed and relatively narrower lobes (Fig. 241); the stipules of the upper leaves may remain attached to the twigs for more than a year as black threads.

**Comparison with the Common Oak.**

The resting-buds, for the most part, show the narrow thread-like ends of the outer scales (*see* the topmost bud shown in Fig. 242).

The flowers and inflorescences (Fig. 46) are designed and arranged as in the Common Oak, but the male catkins, by reason of their length and number, are more conspicuous. The little female inflorescences with short stalks show one to four flowers.

The greatest difference concerns the fruit. After pollination, in April or May, the ovary and cupule grow comparatively slightly in their first season, so that the following spring finds the young fruit represented by a very small juvenile acorn concealed within a little "mossy" cupule (Fig. 46, Ia). In its second season the fruit grows greatly, and ripens, so that the full-sized acorns are connected with the previous year's twig (so-called two-year-old twig).

**Ripening of Acorn.**

The acorn projects from a cupule from which stand out many narrow, elongated, and curled or curved scales that cause this tree to be known as the "Mossy-cupped Oak" (Fig. 240).

The tree is a native of the more southerly parts of Europe, whence it has been introduced into England, where it is by no means uncommon.

**Fig. 241.—Shoot of Turkey Oak.**

**Fig. 242.—Twig of Turkey Oak in Winter.**

Three American species of *Quercus*, *Q. coccinea*, *Q. rubra*, and *Q. Phellos*, occasionally seen in English gardens or parks, agree with the Turkey Oak in having leaves that fall each autumn and acorns that require two seasons for ripening. They differ, however, in that the scales on their acorns resemble those of the British Oaks, and are not "mossy." *Q. Phellos*, a Willow-Oak, is unlike all three others in its leaves, which are narrow, willow-like, and devoid of both teeth and lobes. The leaves of the other three are lobed and not very unlike. In *Q. coccinea*, the Scarlet Oak, the young emerging leaves are vivid red in colour, while in autumn the foliage is blazing scarlet. In *Q. rubra* the young leaves are pink, and the autumn-leaves are orange, brown, or red.

## QUERCUS ILEX (*Linn.*).—Holm Oak (*Fagaceæ*)

The Holm and Cork Oaks differ from the preceding species of *Quercus* in having evergreen leaves, which are leathery and nearly always show on their pallid lower faces a white or grey coating of close-set hairs, as do the young twigs.

The Holm Oak, in this country, is a tree of medium size, with a relatively short trunk surmounted by a rounded, often wide, crown. Its rough, brown or grey, bark is divided into small scales by numerous fine longitudinal and transverse fissures (Fig. 243); in this it contrasts with the rather similar Cork Oak (*Q. suber*), whose trunk is invested in a very thick, deeply furrowed covering of cork (Fig. 245).

Fig. 243.—Bark of Holm Oak.

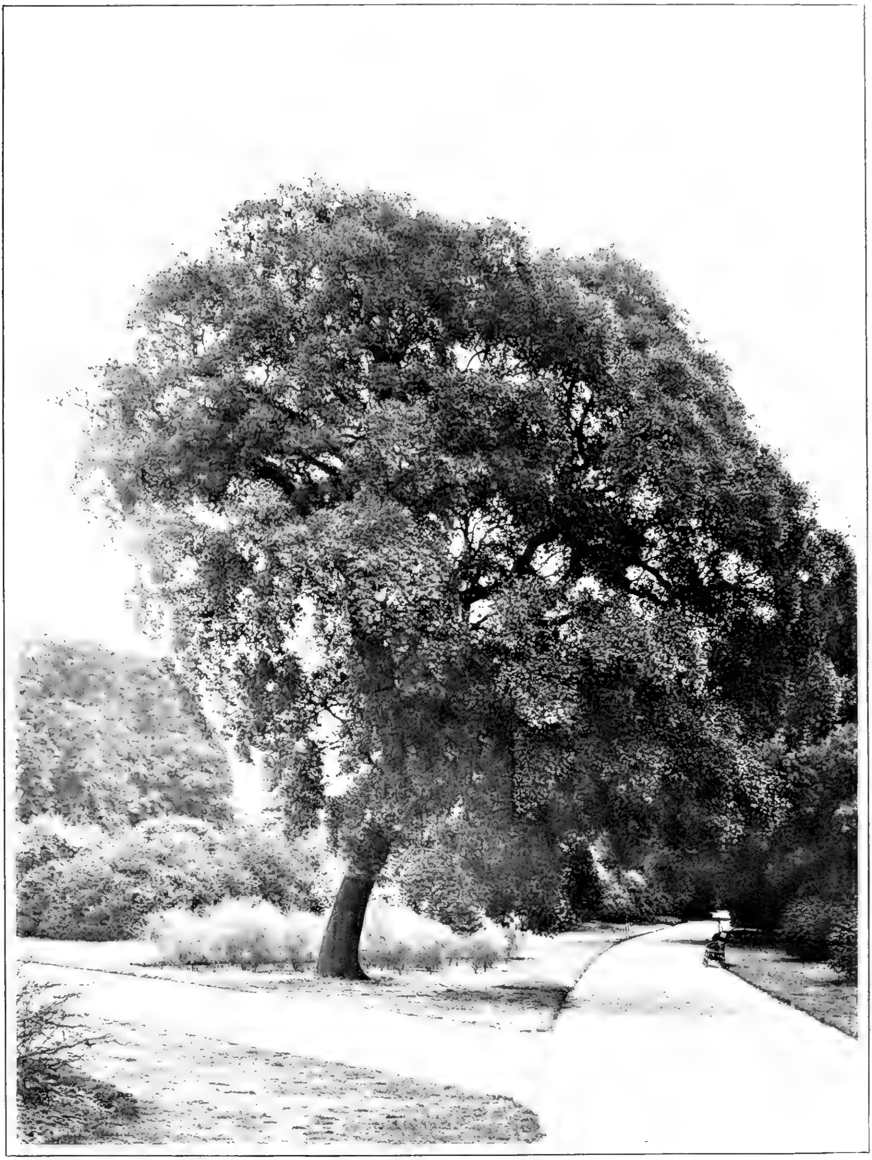

Fig. 244.—HOLM OAK—*QUERCUS ILEX.*

**Leaves.**

The spirally arranged leaves (Fig. 21) are extremely variable in form, showing an even or a toothed margin; they last for two complete seasons, but their stipules are short-lived. It is interesting to absorb water rapidly from the cold soil, yet the evaporation of water from the shoot may be favoured by dry air and winds; consequently, leaves retained during winter require special protection from desiccation.

Fig. 245.—Bark of Cork Oak.

compare the nature of the leaves of the evergreen species of Oak with those of deciduous species. The former are thicker and more leathery—and the same is true of species of *Prunus* (*see* p. 340). One reason for this is that during winter the roots cannot

**Flowers and Fruit.**

The tree bears seed quite early in life, at an age of eight or ten years. The flowers open in April or May, and the resultant acorns ripen in September of the same year. Inflorescences, flowers, and fruits are arranged

Fig. 246.—Withered Male Catkins and Young Acorns of Holm Oak.

and designed much as in the Common Oak, the fruits being inserted on shorter or longer stalks. (Figs. 6, 246-7.)

The Holm Oak belongs to the south of Europe, where it can grow on dry open places. Thus the thickness and hairiness of the leaves must also be associated with the dryness of soil, and dryness of summer, which often prevail where the Holm Oak naturally lives. The Cork Oak, too, belongs to the south of Europe, where it often forms woods near the coast.

The evergreen Cork Oak likewise has variable leaves, which may or may not possess well-marked teeth. Apart from its bark, it differs from the Holm Oak in that the scales of the acorn-cup project outwards at their tips, whereas those of the latter tree are closely pressed against the surface. When these two species have toothed leaves they somewhat resemble the evergreen *Quercus coccifera*, but the acorns of this tree do not ripen before their season, and the acorn-cup is beset with projecting, hard-pointed scales.

Fig. 247.—Fruits of Holm Oak.

## FAGUS SYLVATICA (*Linn.*).—BEECH (*Fagaceæ*)

The Common Beech is recognisable by its smooth bark, its stalked, rounded, male and female inflorescences, its three-angled fruits arranged in pairs within a four-valved spiny cupule, the silvery fringe of hairs on its younger leaves, and finally by its spreading, long, narrow, chestnut-coloured resting-buds which show many scales.

**Fig. 248.—Bark of Beech.**

The root-system, as a whole, is not deep-seated, but rather possesses very extensive shallow lateral roots which are continuous with ridge-like buttresses up the base of the trunk (Fig. 248).

**General Habit.**

The tree is a large one, sometimes 110 feet or even more in height, and may have a trunk six feet in thickness. The trunk is cylindrical in type, not being fluted as is that of the likewise smooth-barked Hornbeam. In dense forest it remains distinct and straight up to the top of the crown, which is egg-shaped and may not commence until sixty feet above the soil; but in the open the trunk may soon be lost among a number of spreading and ascending large boughs, which form an ample, wide crown that may reach nearly to the ground. The dense branching and close arrangement of the leaves cause the Beech to cast a deep shade (Fig. 1). The deep shade exterminates seedlings of all light-demanding trees, as well as all herbs, save those which are shade-lovers; so that in a Beech-wood the relatively poor but characteristic vegetation on the ground contrasts with the wealth of herbs found in well-lighted woods, where Aspen, Birch, and perhaps Scots Pine may be found growing together. Even in the shade of clumps of Beeches or of a solitary tree the obvious vegetation is meagre (Figs. 1, 248).

The bark (Fig. 248) remains thin and smooth till the tree is very old; it usually seems to be of a light grey colour, owing to the presence of various lichens, but sometimes is greyish black. Occasionally trees may be found showing the bark raised into rough stony lumps. But, quite apart from such rough-barked "She-Beeches," very old trees may show at the base furrowed rough bark.

**Leaves.**

The stipulate, stalked leaf (Figs. 253–7) varies in size and shape of blade, which, however, always has a marginal fringe of silvery hairs when young. The upper part of the pointed blade is toothed, but the lower parts are usually not so. In autumn the leaves show colours varying from light yellow to deep rusty-brown, and the autumnal beauty is often prolonged because of the tardy shedding of the dead foliage, which may remain attached to young Beech-trees all through winter and early spring.

Fig. 249.—Resting-bud of Beech.

The leaves are arranged in two ranks, along the sides of the horizontal or inclined stems; by twisting their stalks they place their upper faces perpendicular to the light. There are two different kinds of shoots — long-shoots and dwarf-shoots.

**Branches.**

The latter kind (*see* Fig. 255) have very short internodes, are unbranched, and bear very few leaves, so that old dwarf-shoots (say fifteen years of age), showing many close-set rings marking the places of fallen leaves, may be much shorter than a long-shoot only a month old. By the mingling of dwarf-shoots and long-shoots, the foliage is arranged in a dense pattern (Fig. 255). It is the long-shoots with longer internodes that provide branches and carry the leaves farther out into the light. When accident brings a dwarf-shoot into a well-lighted place, or kills the long-shoots above, the dwarf-shoot may develop into a long-shoot. On an inclined long-shoot the leaves are inserted nearer to the lower face than to the upper face of the stem, but the lateral buds do not share this peculiarity. Consequently the buds are not exactly in the axils of the leaves or leaf-scars, but only obliquely so (Figs. 249, 250). As the leaves and lateral buds spring from the two sides of a branch, the branching is in one plane, which, of course, is

Fig. 250.—Twig of Beech in Winter.

Fig. 251.—BEECH—*FAGUS SYLVATICA*: WINTER.

Fig. 252. BEECH—*FAGUS SYLVATICA*: SUMMER.

Fig. 253.—Opening Buds of Beech, early stages.

horizontal in the case of a horizontal branch. At the conclusion of the active season the terminal bud often persists, but it may die and be replaced by the topmost lateral bud.

**Buds.**

The glossy, chestnut-coloured resting-buds (Figs. 249 and 250) are of a narrow spindle shape. Standing out from the stem, they show numerous scales which are arranged in four ranks because they are the paired stipules of bladeless leaves that are two-ranked. The highest buds on the year's-shoot grow out into long-shoots, those lower down into dwarf-shoots, while the lowest remain dormant. As the dormant buds do not retain their proper connection with the wood of the stem for more than about twenty years, the Beech has but few old dormant buds. Consequently we do not see any young branches sprouting out from the old trunk; even when felled the Beech has specially to manufacture new buds that sprout from its stump.

The various stages of sprouting shown by a resting-bud when aroused into activity are illustrated in Figs. 253 and 254. These show the pleated foliage-leaves emerging from its tip. Silvery hairs fringe the young blade and coat the nerves on its lower face, especially at the angles of these, also clothe the long shining white stipules which invest the infantile blade, and adorn the leaf-stalk which eventually emerges. And Figs. 255 and 256 continue the story by showing the slightly older twig that has shot forth; the

Fig. 254.—Opening Buds of Beech, later stage.

stipules have been shed or hang down, because they have performed their duty of protecting the young leaves, while the hairs on the older leaves have shrivelled or fallen.

**Flowering Age.**

The Beech does not bear seed until it has reached the ripe age of sixty or eighty years in forest, or from forty to fifty in open country. Though it can produce flowers every year, rich crops of seed occur only at intervals of five, six, or even more years. The flowers open at the same time as the leaves come out, in April or May ; the fruit ripens in September of the same year, and is released in October.

**Flowers.**

The male and female flowers are arranged on long-stalked, almost globular inflorescences, which arise in the axils of leaves on short branches of the current year. The feebler flowering branches, distant from the tip of a shoot, may bear only male inflorescences (Fig. 255, ♂) : but the more vigorous and exposed ones have in the axils of their lower foliage-leaves male inflorescences which are pendent on long, slender stalks, and in the axils of their higher leaves female inflorescences which have shorter, stouter stalks that enable them to stand erect (*see* Fig. 256). Both types of inflorescences may bear

**Fig. 255.—Branch of Beech showing completed Year's-shoots, and Inflorescences.**

**Fig. 256.—Male (♂) and Female (♀) Inflorescences of Beech.**

Fig. 257. Fruits of Beech in Cupules.

nuts are thus encased in one cupule, which becomes hard and woody at the same time as its outgrowths change into stiff bristles or spines. In October the four valves of the cupule open out and permit the nuts to escape.

The seed is wholly occupied by the embryo, which has two broad, folded cotyledons. At the commencement of germination the root emerges from the nut and pierces the soil; and soon afterwards the nut, still concealing the cotyledons, is raised above the soil by the stem (hypocotyl). The opening cotyledons throw off the cracked nutshell, and, being still folded, show their white, hairy, lower faces; subsequently the cotyledons open out, bend down, and thus acquire a horizontally extended pose (Fig. 27). The stem grows and at once produces foliage-leaves. During the first five years of its life the young plant grows in height very slowly; and even up to twenty or thirty years the growth in height of this shade-bearing tree is slow. The little shaded plant has a problem to face. Its leaves are arranged in two ranks, so that if the main stem were to grow erect, and the leaves were to preserve their natural positions, the latter would shade each other seriously. Hence in its early life the little plant adopts an admirable plan for collecting light. The end of the leading shoot inclines and arches over, and the leaves on its sides twist so as to place their faces horizontal. In the following year it is not the bud at the end of the drooping shoot that grows up, but

**Germination.**

on their stalks one or two narrow scales, and a few more immediately below the head-like groups of flowers.

The male "head" consists of a number of short-stalked flowers arranged in a tuft. Each small flower has an unequal-sided, bell-like, hairy perianth showing from four to seven teeth, which denote as many joined sepals. Within the perianth stand from eight to twelve complete stamens, whose long filaments thrust the anthers well out of the flower. In the centre may be a tiny rod-like vestige of a useless pistil.

The female "head" consists solely of two female flowers situated within a four-lobed cupule, which is externally coated with many soft narrow outgrowths that have long thread-like ends. Each hairy flower has a perianth with from four to nine (often six) teeth; it includes no stamens. In the centre rises the deeply three-branched style which surmounts the three-chambered inferior ovary; in each ovary-chamber are two ovules.

**Fruit.**

After wind has conveyed pollen to the stigma the ovary changes into a three-angled, three-sided nut which contains only one seed. Two Beech-a bud produced nearer the top of the "arch," and the resultant new leading shoot behaves in the same manner as its predecessor. In addition branches arise on the flanks so that the juvenile beech exposes more or less horizontal fan-like expanses of foliage to the strongest light (Figs. 2, 3). Thus the little plant does not grow swiftly up towards the light; its policy is to spread its foliage and utilise to the best advantage the dimmed light in which it lives.

The dominant character influencing the Beech-tree's distribution is that it can endure more shade than any other broad-leaved (dicotylous) British tree. And its shade-bearing quality is reflected in its smooth thin bark, in its form, in the density of shade it casts, and in its slow rate of growth in height (at least up to an age of twenty years). As regards composition of the soil the Beech is complaisant. On dry soils it is naturally stunted, but on heavy soaking soils it refuses to grow. Owing to the power of producing long and extensive, shallow, lateral roots it can live on shallow soil.

Among the more obvious diseases from which the Beech suffers is one revealed in brown patches on the leaves; these patches are caused by the burrowing larvæ of a certain weevil (*Orchestes fagi*) which locally excavate the interior of the leaf.

Among several varieties of the Beech, possibly the Weeping Beech (Fig. 258) is the most interesting, because it represents merely an exaggeration of the young Beech's mode of growth, and of the mature tree's habit of producing twigs more or less drooping at their ends. But more familiar is the Copper Beech (analogous dark red-leaved varieties of Hazel, and Cherry, also occur). Finally, varieties of the Beech occur with narrow or divided leaves, the latter being foreshadowed by the deeply-toothed leaves displayed by some ordinary specimens of this tree.

**Fig. 258.—Weeping Beech.**

## CORYLUS AVELLANA (*Linn.*).—Hazel (*Betulaceæ*)

The Hazel is instantly recognisable by its fruits, or by those buds from which crimson styles project in tufts at the same time as the male catkins hang on the leafless bush. Additional features to note are the stipulate leaves arranged in two ranks (except on the suckers or stool-shoots), the hairy one-year-old twigs, and the characteristic bark.

**Fig. 259.—Stems of Hazel.**

**Roots.** The root-system of the Hazel shows no true main root; its place has been usurped by a strong lateral one. Many of the roots are shallow and horizontal, and can send up foliaged suckers. By decay of the parts of the roots connecting the main plant with the suckers, the latter may become separate individuals.

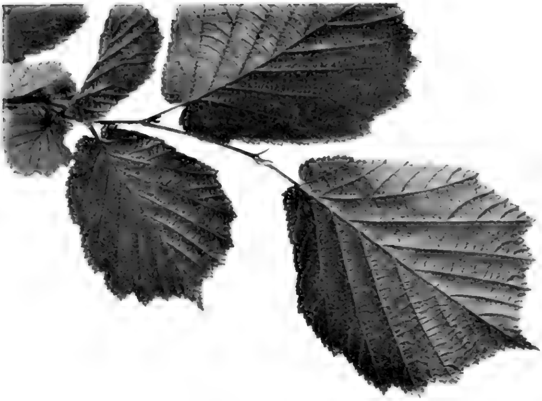

Fig. 260.—Leaves of Hazel.

The Hazel is a bush rarely exceeding twelve feet in height, and has, in place of a main trunk, a number of strong branches springing from its base. The shrub owes its form to the limited growth in length of all the shoots, and to the habit of throwing out from the roots or stool vigorous erect shoots (Fig. 259), which in one season may attain a length of six feet.

The bark (Fig. 259) remains smooth for years, and is marked by thin transverse lines (lenticels) which recall those of the Cherry; eventually at the base a furrowed scaly bark may be formed.

**Leaves.**

The stalked, simple, stipulate leaves are arranged spirally on the long erect suckers and stool-shoots, but on the other long-shoots and dwarf-branches which are not erect they form two rows along the flanks (Fig. 260). In shape the long-tipped blade varies considerably, for the leaves on vigorous erect shoots tend to become lobed and to show three tips. The blade is not perfectly symmetrical, the one half being slightly larger at the base; its margins are indented with double or single saw-like teeth. In the bud the blade is simply folded along the mid-rib—that is to say, its right half is applied flat against the left half. Though the blade when young is coated with silvery hairs, it becomes nearly hairless when mature. The bud-protecting stipules (Fig. 260) may fall soon or hang on till late in summer.

**Resting-buds.**

The resting-buds (Fig. 261) are slightly compressed, and externally show brown overlapping scales, within which lie two ranks of leaves, the lowest of these latter being represented only by pairs of silvery stipules, and the higher ones by pairs of stipules with the young blades already between them. The buds are naturally arranged on the ordinary branches in two rows, and incline slightly to the upper face of the branch, while the leaves (or leaf-scars) are slightly displaced towards the lower face. This feature in horizontal branches is shown still more clearly in many other trees. If, in late spring and afterwards, we watch the behaviour of a leafless hairy twig produced during the previous year, we see the topmost bud opening, growing out to a long-shoot, which in summer dries up at its end and sheds the terminal bud. The place of this is usurped

Fig. 261.
Twig of Hazel in Winter.

Fig. 262.—HAZEL—*CORYLUS AVELLANA*: WINTER.

Fig. 203. HAZEL—*CORYLUS AVELLANA*: SUMMER.


Fig. 264.—Male (♂) and Female (♀) Inflorescences of Hazel.

by the topmost lateral bud, which is so displaced as to present the false appearance of being truly terminal (Fig. 261). The other lateral buds, for the most part, develop into dwarf-shoots bearing a few foliage-leaves.

The Hazel begins to bear flowers and filberts quite early in life, at the age of ten years; in well-lighted situations it blossoms every subsequent year, but in shady woods allows intervals of three or four years to pass without flowering. Among native trees and shrubs it is the first to flower; often in January and sometimes even in December its catkins open long before the leaves

**Time of Flowering.**

unfold. This early flowering is possible, thanks to preparations made during the preceding summer.

Going back to this summer, the shoot produces some lateral buds destined to develop into foliaged dwarf-branches, and others destined to produce inflorescences. Buds of the former nature remain inactive until the following year, as do those enclosing the female inflorescences; but the buds responsible for the production of the male inflorescences grow out in the year of their production, and give rise to branched dwarf-shoots. Each dwarf-shoot of this last kind ends in a male catkin, and bears at its sides from one to four others; moreover, near its base may be one or more resting-buds that will produce in the following year female inflorescences or vegetative branches. Thus in July or August may be seen on dwarf-shoots groups of little cylindrical male catkins. These rest naked during the winter, but, even when the soil is frozen, they may be aroused into activity by a day or two's direct sunlight, and thus cause the shrub to blossom in mid-winter. When growth commences the axis of the male catkin elongates, becomes flaccid, droops over, and the yellow pollen is shed; while on the same bush the tufts of red stigmas are thrust forth from the female buds.

**Male Catkin.**

The pendent, cylindrical male catkin (Fig. 264, ♂) shows a number of green bract-scales spirally arranged on a long axis. Each concave green catkin-scale bears on its (true) upper face, towards the sides, two little scales, and towards its centre seemingly about eight stamens. These stamens represent a single stalkless flower, which is thus devoid of any perianth. The stamens are peculiar in structure, for each short filament terminates in a one-lobed anther, which is capped by a tuft of hairs, so that the anther represents only half a complete anther. Some of the stamens are often approximated in pairs, sometimes two of their filaments are joined at the base, and rarely one filament (occupying the place of two) bears at its top two anthers. It is therefore supposed that the eight apparent stamens with half-anthers really represent four stamens, divided down their centres into eight halves, and this view is confirmed by comparison with other representatives of the Hazel Family.

The female inflorescence at flowering time is mainly concealed within a bud which closely resembles an ordinary resting-bud, but shows, projecting from its tip, from sixteen to twenty-four curled crimson threads, which are the stigma-bearing styles (Fig. 264, ♀). Dissection of this bud reveals successively:

**Fig. 265.—Fruits of Hazel.**

brown scales, pairs of silvery stipules, then from three to five tiny stipulate leaves (in two ranks), and finally several spirally-arranged, silky, white bracts (catkin-scales) in whose axils are the female flowers. To anticipate for a moment: as the fruits are ripening the axis of the bud will elongate, the tiny foliage-leaves grow out, and the minute flowers change to nuts. Thus in reality the female inflorescence is catkin-like in design, and terminates a foliaged dwarf-branch.

**Female Inflorescence.**

The female inflorescence itself has from four to six bract-scales. In the axil of each of these stand two female flowers which are extraordinarily simple and immature in structure. The flower consists of two long crimson styles joined at the base, round which there is the merest trace of a ring representing the future perianth. Beneath this is a minute, hairy, white, cup-like envelope which will become the cupule, but is now shallow and may already show from four to six very minute teeth. Of ovary or ovary-chambers there is scarcely a trace, and of ovules no sign whatsoever. Yet this is the condition of the flower at the very time when pollen is conveyed by wind to the stigmas. Not until six or eight weeks later does the flower reveal its true structure. By this time the perianth has become distinct as a very small, toothed fringe; below it the swollen inferior ovary has grown and now shows two chambers, each with one ovule; while surrounding the base of the ovary is a clearly-lobed young cupule. [The two female flowers represent a stalkless forked inflorescence, of which the terminal flower is missing and only the two lateral flowers (2 and 3 in Fig. 224) are formed; sometimes the middle (terminal) flower actually does appear.]

**Fruit.**

In the whole female inflorescence only few flowers will develop into complete nuts, and there is a further waste of ovules in that usually only one of the two ovules in an ovary gives rise to a seed (though sometimes a hazel-nut includes two seeds). The ovary-wall becomes hard and woody, forming the nut-shell, which, when young and green, still shows the circular line marking the former insertion of the perianth. The seed, being thus adequately protected, has only a thin papery shell of its own. The fruits are not ripe before October or November, at which time the green cupule is very evident (Fig. 265).

The fruits are dispersed by animals, especially by squirrels which apparently either forget where they have stored the nuts or die before exhausting their store.

**Seed.**

The seed contains no food-material outside the embryo, which mainly consists of two large cotyledons that are gorged with oil and starch. In germination the hard shell cracks, but the cotyledons, being reservoirs of food, do not come above ground, so that the first green leaves are foliage-leaves.

The Hazel can endure a certain amount of shade, and can grow on very various kinds of soils, though it is shy of thoroughly wet ground.

One interesting disease from which the filbert suffers is that caused by a weevil, *Balaninus nucum*. The female beetle possesses a slender snout, which is nearly as long as her body and is designed to aid her in thrusting an egg into the deeply concealed ovary. The egg develops into the maggot so familiar in ripe filberts.

## CARPINUS BETULUS (*Linn.*).—Hornbeam (*Betulaceæ*)

This tree is recognised by its hanging catkins of ribbed fruits concealed by large three-lobed bracts, its thin smooth bark is distinguished from that of the Beech by its broadly-fluted character (Fig. 266). The tree rarely in this country attains a

**Fig. 266.—Bark of Hornbeam.**

and fluted trunk, as well as by its pendent male and female catkins, which flower at the time when the leaves emerge.

From the usually shallow root-system there rises a smooth-barked trunk which height exceeding seventy feet, or a diameter of trunk greater than three feet. The trunk may or may not remain straight and distinct up to a considerable height; in any

**Dimensions and Form.**

Fig. 267. HORNBEAM *CARPINUS BETULUS:* WINTER.

Fig. 268. HORNBEAM—*CARPINUS BETULUS*: SUMMER.

case, relatively low down it gives off many rather slender boughs which ascend sharply and give to the crown, when leafless, a besom-like appearance.

The bark remains remarkably thin and smooth, and is universally described as being of a light grey colour ; but frequently, at least, the greyness is due to lichens, and the bark is often of a very dark shade, recalling by its markings black watered silk. Associated with the behaviour of its bark is the exceeding longevity of the resting-buds, which may remain living and attached to the stem for eighty years. It is largely due to these aged buds that the Hornbeam can emit new branches from old parts of its bole or stump.

**Leaves.**

The alternate, stipulate, stalked leaves (Fig. 269) are arranged in two ranks as in the Hazel. Their narrow form, sharp tips, and, above all, their sharp double teeth, are noticeable. Hairs are absent from their upper faces, though some are present near the nerves on the lower faces. The folding of the leaf in the bud is entirely different from that in the Hazel, as the blade is not folded along the mid-rib, but is plaited along its lateral nerves, which are parallel (Fig. 271). The bud-protecting stipules soon fall. One peculiar feature the Hornbeam shares with the Beech : the autumn-tinted, rusty-yellow leaves to a large extent are apt to remain attached to the twigs all through the winter.

Fig. 269. Shoot of Hornbeam.

**Resting-buds.**

The narrow, elongated resting-buds somewhat resemble those of the Beech, but differ from these in being shorter and in that the lateral ones are pressed against the stem (Fig. 270). Though the Hornbeam bears numerous leaves, and consequently numerous axillary buds, it often produces between the leaf-scar and the true axillary bud an additional ("accessory") bud. To the presence of these the Hornbeam largely owes its power of forming dense hedges when clipped (and the persistence of the dead leaves during winter still further adapts it for this use). But, quite apart from these peculiar buds, the Hornbeam has a great power of throwing out shoots from parts above ground or under ground, and of thus withstanding browsing animals or pollarding.

Fig. 270. Twig of Hornbeam in Winter.

**Flowers.**

Flowers appear on the tree before it has reached an age of twenty years, and thereafter they occur nearly every year, both male and female flowers being seen on the same individual tree. The Hornbeam, in fact, shows extremely abundant flowers, so that in spring the hanging male catkins may give to the as yet feebly-foliaged tree the appearance of a fountain whose spray shimmers with silver and has the faint gleam of pure yellow gold; while at a later period of the year the large three-lobed bracts of the ripening fruits may be so bountiful as to take no small share in forming green foliage.

The male and female inflorescences are solitary catkins, which emerge at the same time as the leaves. They form the terminations of dwarf-shoots, and develop from buds on shoots that were produced during the preceding year.

The male inflorescence lies young and hidden within a resting-bud all through the winter (contrast the Hazel). From such a bud there develops a short stem bearing at its base a few scales and very rarely a couple of feeble foliage-leaves, and terminating in a pendent male catkin, which shows many spirally-arranged green and red catkin-scales (Fig. 272, ♂). The concave, rather large and broad, catkin-scale supports on its upper face nothing beyond from four to twelve characteristic stamens. The stamen consists of a deeply-forked filament, and each of the two arms of the fork ends in a half-anther which is capped by hairs. Though at first glimpse there seem to be from eight to twenty-four stamens, it will be evident that the stamens are not so completely divided as in the Hazel.

**Fig. 271.—Opening Buds and Emerging Catkins of Hornbeam.**


**Fig. 272.—Male (♂) and Female (♀) Catkins of Hornbeam.**

**Catkins.**

The female catkin usually springs from a lateral or terminal bud higher up the twig. The bud develops into a dwarf-branch, on which scales and foliage-leaves precede the very slender, pendent, and loose, female catkin that ends the little branch (Figs. 271-2). Thus the whole design of the dwarf-branch is like that of the Hazel, but there are two points of difference in reference to its behaviour: first, the catkin completely emerges from the bud; secondly, the foliage shoots forth at the same time. In the axil of each narrow green catkin-scale, and embraced by its base, are two flowers, which agree in structure with those of the Hazel, inasmuch as each shows two long red stigmas, and eventually a two-chambered ovary surmounted by a four- or five-toothed little perianth, which is very distinct in the fruit. But beneath each flower there is no cupule; in place of this is seen a narrow, silver-haired scale with two tiny lateral lobes at its base. The two three-lobed scales, respectively belonging to the two flowers on a catkin-scale, stand within the latter and are placed right and left of it. The catkin-scales soon fall, but the three-lobed scales (bractlets) subsequently become very large.

**Fruit.**

After pollination has been effected by the agency of the wind the ovary develops into a ribbed, dry, one-seeded fruit, which is partly concealed by the large three-lobed bractlets. Thus the pendent fruiting catkins present a unique appearance (*see* Fig. 273). When the fruit falls, in November or in spring, it carries with it the big bractlet, which acts as a sail and thus facilitates its dispersal by the wind.

**Seed.** The seed only contains the embryo, in whose large cotyledons the food (oil and starch) is stored. In germination the shell of the fruit splits into two valves, but remains below ground, whereas the green cotyledons force their way out of the soil and are succeeded by foliage-leaves.

**Fig. 273.—Fruits of Hornbeam.**

**Requirements.** The Hornbeam is, first of all, a shade-enduring tree, as might be surmised from its low-pitched branching, its smooth bark, the denseness of shade cast by it, and its slow rate of growth. The seedling actually seems to demand shade, but this may be at least partly to avoid desiccation. As regards soil the Hornbeam is not exacting, though it avoids very heavy or dry, as well as marshy or peaty, soils. Altogether the Hornbeam forms a sharp contrast to the light-loving Birch.

## BETULA ALBA (*Linn.*).—Silver Birch (*Betulaceæ*)

Silver Birches are recognised by the thin, white, silvery bark, which is smooth and shows dark transverse lines; by their slender twigs; by their cylindrical male and female catkins; also by their catkin-like collections of flat winged fruits.

Fig. 274.—Bark of Common Birch.

*Betula alba* includes two sub-species or should be divided into two species, *B. pendula* (Roth) [or *B. verrucosa* (Ehr.)], the White Birch, and *B. pubescens* (Ehr.) [or *B. alba* in the narrow sense], the Common Birch. These in turn include and are connected by a number of forms, varieties, and crosses that are difficult to distinguish. Hence, in the following description of these variable species

**Varieties.**

Fig. 275.—SILVER BIRCH—*BETULA ALBA*: WINTER.

P

I shall give the common and easily-observed characters usually distinguishing the two.

The root-system is both weak and shallow. The Birch is stated to possess the peculiar quality of producing on its roots resting-buds which can remain passive for years before shooting up into vigorous suckers. The possession of these buds is of particular importance, because the resting-buds on the stem are limited in number, as they live only perhaps ten years, after which they are cast off with the peeling bark.

Fig. 276.—Rough Bark at Base of White Birch.

**Resting-buds.**

**Dimensions and Form.**

The slender trunk, which continues distinct to the tip, usually attains only a height of from forty to fifty feet and a thickness of less than a foot. The relatively slender boughs ascend and give rise to a more or less egg-shaped crown; they and their branches fray out at their ends into fine twigs, which in the White Birch are so thin as more or less to hang down, as do the young thin branchlets. The Common Birch lacks this graceful, fountain-like pattern of growth, as its more close and spreading branches rarely droop at their extremities. Another distinction concerns the surface of the slender one-year-old twigs, which are pubescent (clothed with hairs) in *B. pubescens*, but show more numerous clear glandular lumps in the White Birch.

**Bark.**

The bark (Fig. 274) is silvery white and marked by long transverse lines (lenticels). As it regularly flakes off in delicate papery scales it remains thin. But rough, deeply-furrowed, dark-coloured bark shows itself at the base of the trunk of the White Birch up to a height of four or more feet (Fig. 276). This rough basal bark is lacking or feeble in the Common Birch, which also differs in that its bark is sometimes brown, especially in wet situations.

**Leaves.**

The long-stalked stipulate leaves (Fig. 277) are spirally arranged, though on the inclined shoots they, as well as the branches, tend towards a two-ranked arrangement. The variable leaves are doubly-toothed, and prolonged into a point that is longer (*B. pendula*) or shorter (*B. pubescens*). When mature they are hairless (*B. pendula*), or show hairs on blades and stalks (*B. pubescens*). It is worthy of note that on the hanging stems their blades are vertical, and therefore cast but little shade.

Fig. 277.—Shoot of Silver Birch.

The little resting-buds (Fig. 278) have spirally-arranged scales. Some grow into dwarf-shoots and others to long-shoots, and as a rule it is the topmost lateral bud on the latter that continues the growth in length, while the true termination of the long-shoot dies.

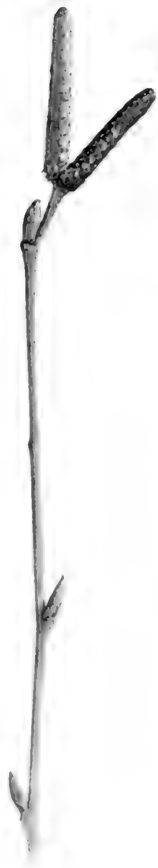

Fig. 278.—Twig of Silver Birch.

**Time of Flowering.**

The Birch blossoms at an age of ten years, and thereafter with annual regularity. The catkins open with the leaves in April. Male and female catkins occur on the same individual tree; both are cylindrical and bear spirally-arranged catkin-scales.

The male catkins are already visible in the late summer in groups of from one to three at the ends of twigs, one being terminal and the others lateral (Fig. 278).


**Fig. 279.—Male (♂) and Female (♀) Catkins of Silver Birch.**

In this naked, closed condition they pass the winter, and when they open and droop by the elongation of their axes they still remain stalkless and devoid of foliage-leaves (Fig. 279, ♂). Each catkin-scale bears on its upper face: (i.) two little scales forming lateral lobes; (ii.) three other little scales, which represent single sepals of three flowers; (iii.) three groups of stamens, each consisting of two which are divided completely into four half-stamens (with half-anthers devoid of hairs); (iv.) on the reverse side of stamens there may also be three minute scales representing three additional sepals. In such a case each flower consists of two sepals and two divided stamens. Thus a catkin-scale apparently bears twelve stamens, each with a one-lobed anther.

**Catkins.**

The female catkins arise from lateral buds that are inserted on a shoot produced in the preceding year. Though the catkins are already prepared during the previous summer, they remain concealed within resting-buds during the winter. In spring the bud shoots forth, produces from one to three foliage-leaves, and terminates in a slender erect green catkin (Fig. 279, ♀). Each catkin-scale has at the base of its upper face two tiny lateral scales (so that in the fruit these three together form a three-lobed scale). In its axil stands a stalkless inflorescence consisting of three flowers. The flower is utterly devoid of any perianth, and consists eventually of two styles surmounting an ovary, which is divided into two one-ovuled chambers.

**Fig. 280.—Fruiting Catkins of Silver Birch.**

After pollination by the agency of wind, the ovary develops into a little, one-seeded, dry, flat fruit which has its two sides continued into delicate transparent wings.

**Fruit.** Three such three-lobed fruits lie on the upper face of each catkin-scale. The cylindrical catkin-like collections of fruits (Fig. 280) may hang on for months after ripening in late autumn; but eventually the scales tumble off separately and release the winged fruits, which are blown about by the wind.

The seed is wholly occupied by the embryo. On germination two small green cotyledons are raised above the soil, and

**Seed.** are succeeded by green primary leaves, which differ from the later foliage-leaves in having single teeth and in being more hairy (but the vigorous suckers of the mature tree also possess permanently hairy leaves). The growth of the seedling and young plant is very rapid; in extreme cases the seedling may attain a length of one foot in its first year.

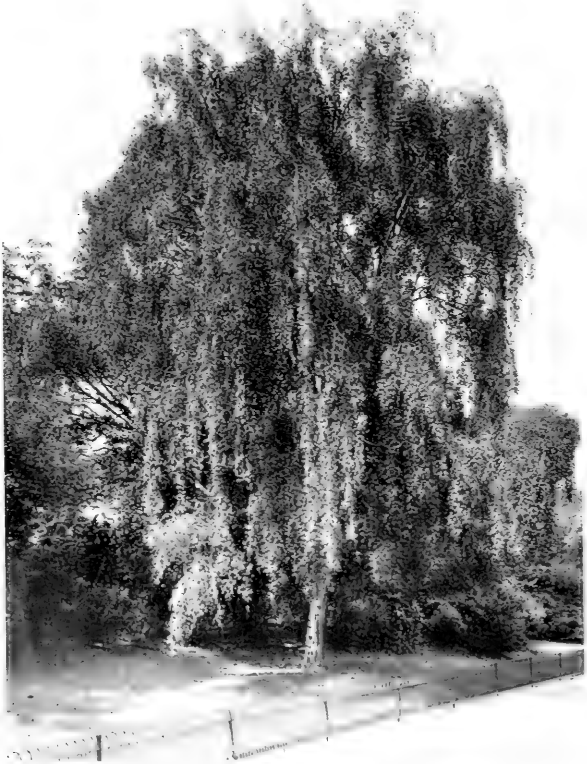

Fig. 281.—Weeping Silver Birch.

Fig. 282.—"Witch's Broom" on Silver Birch.

**Requirements.** As regards requirements, the dominant feature of the Birch is that it demands more light than any other British forest-tree. This demand is reflected in its excessively rapid growth, frequently in the relatively considerable length of its bole, in its loose branching, and the feeble shade that it casts. The bark, though not thick except at the base of one species, is nevertheless white and thus reflects light. It is interesting to note that *B. pubescens*, which is stated to endure more shade than *B. pendula*, has usually little or no thick bark at its base, and casts a deeper shade than the latter tree because of its closer branching and horizontally (not vertically) extended leaf-blades. The Birch is most accommodating as regards soil, as it can grow on rather dry, light, sandy soil and dry heaths, or on marshy ground and in soaking moors that are sour with peat. In unfavourable soils or climates it dwindles to a shrub or dwarf, so that in Finland a little centenarian "tree" was observed to have a stem less than three feet in height and four inches in thickness. The Silver Birch extends very far north in Europe and Siberia.

A very common and obvious disease from which the Common Birch suffers manifests itself in the form of "witches' brooms." These are due to a fungus, *Exoascus betulinus*, whose threads permeate the young growing twigs, causing them to remain short but to branch repeatedly in all directions, and thus to produce large, irregular, nest-like complexes (Fig. 282).

By an exaggeration of the natural tendency of *B. pendula* there has arisen the Weeping Birch (Fig. 281).

## ALNUS GLUTINOSA (*Gaert.*).—Alder (*Betulaceæ*)

The Common Alder is recognised by its woody cone-like collections of fruits, cylindrical brown male catkins, small cone-like female inflorescences, and stalked resting-buds, as well as by its leaves.

The variable root-system shows one marked peculiarity, in the form of obvious local swellings caused by micro-organisms which live inside these. The microscopic organism, which is a very simple fungus or a bacterium, probably confers upon the Alder a very exceptional power of utilising the free nitrogen of the atmosphere as a source of food.

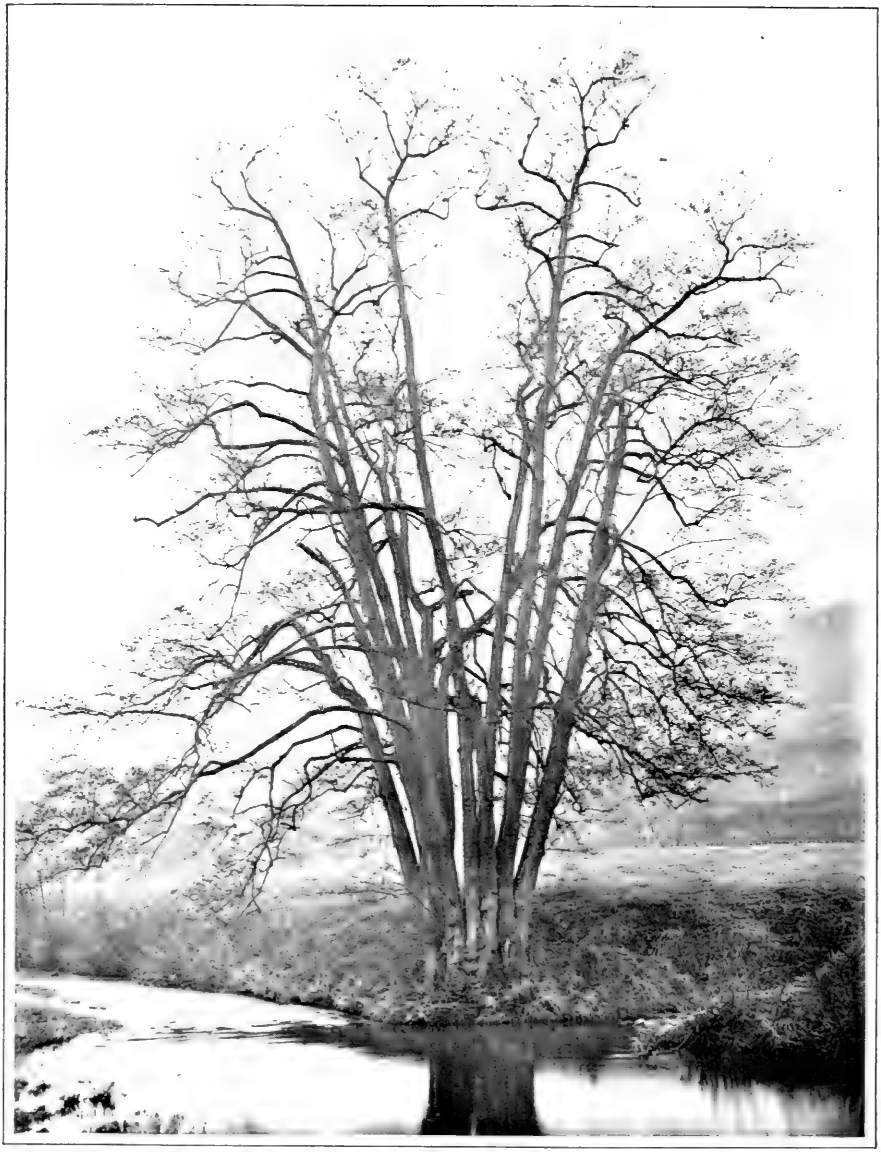

Fig. 283.—ALDER *ALNUS GLUTINOSA*: WINTER.

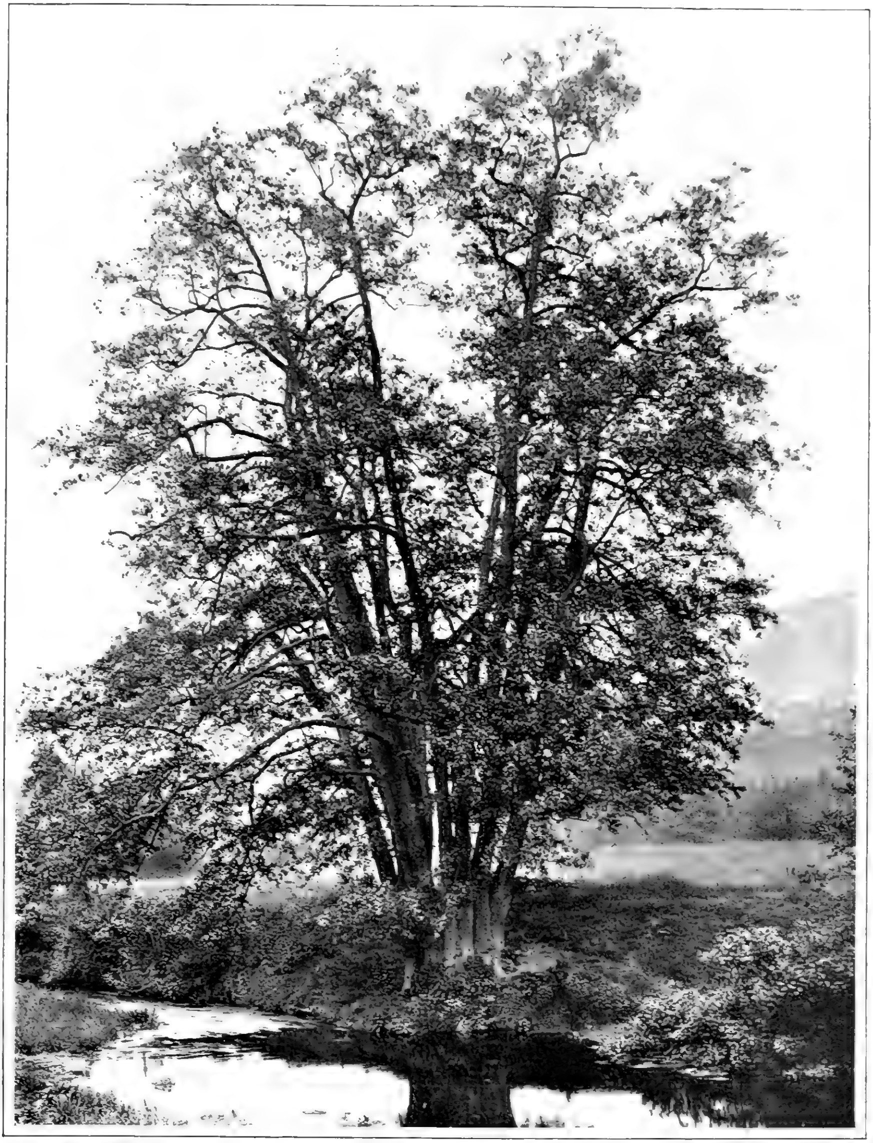

Fig. 284.—ALDER—*ALNUS GLUTINOSA*: SUMMER.

The Common Alder varies alike in shape and stature, being a bush or a tree, usually from twenty to forty feet in height (rarely as much as seventy or ninety feet), and possesses a trunk only one or two feet in

**Dimensions and Form.**

Fig. 285.—Bark of Alder.

diameter. It has a great power of throwing out vigorous shoots from the base of its trunk or from its stool or stump. This partly accounts for the frequently shrub-like habit (the tree shown in Figs. 283–4 owed its several trunk-like stems to stool-shoots). Such shoots arise largely from resting-buds, and to little or no extent from the roots.

The bark (Fig. 285) eventually becomes nearly black, also furrowed and scaly.

**Leaves.**

The spirally-arranged, simple, stipulate leaves vary in form (Fig. 286). The leaf-blade is usually broad, and broad-ended with a distinct notch in place of a tip, yet it may taper to a

Fig. 286.—Shoot of Alder showing Young Collections of Fruits.

distinct point. One general feature is that near its base the blade is devoid of teeth, but elsewhere possesses double indentations. Though hairless for the most part on both faces, the blade shows on its under face in the angles of the larger lateral nerves little tufts of hairs. Among these are often to be found minute mites which, for inadequate reasons, have been supposed to act as health-officers that keep the leaves free from infectious fungal spores. In the bud the blade is folded along its side-nerves and when it emerges is sticky (glutinous), as are the young twigs.

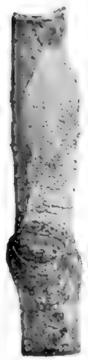

Fig. 287. Stalked Resting-bud of Alder.

**Resting-bud.** The resting-buds show one character that is nearly unique among our woody plants: they are stalked (Figs. 287–8). The relatively large and blunt reddish-brown bud generally shows a white bloom on its surface (as do the twigs). It presents the false appearance of being clothed by only one scale. In reality there are two or three visible on the outside, and these are really stipules of the lowest two leaves. The projecting leaf-cushions give to the leafless stems of the dwarf-shoots a knotted appearance.

**Flowers.** The Common Alder first bears flowers at the age of from fifteen to twenty years in the open or in coppice, but not till riper age (perhaps forty years) in high-forest. The flowers open in February or March, one or two months before the foliage is revealed. As in the Hazel, they owe their appearance early in the season to long preparation; for the male and female inflorescences are not only in existence, but are actually visible, at the end of the preceding summer. Both kinds pass the winter in a naked condition, and may be seen close together on the bare shoots, with the cylindrical male catkins occupying the terminal part of the shoot (Fig. 289), and the female cone-like inflorescences standing close beneath them.

Fig. 288. Twig of Alder in Winter.

**Catkins.** The stalked male catkin droops over as it opens, and has many spirally arranged catkin-scales

(Fig. 290, ♂). Each catkin-scale is shaped like a broad-headed nail, and is brown on the outer face, so that the catkin is of a characteristic brown or rusty colour. The catkin-scale bears on its upper face two pairs of little scales, and an inflorescence comprised of three flowers. The flower consists of four green sepals joined at the base, and four complete stamens exactly opposite to (not alternate with) the four sepals. Thus, as seemingly in the Birch, the catkin-scale shows on its upper face twelve stamens, but in the


**Fig. 290.—Male (♂) and Female (♀) Catkins of Alder.**

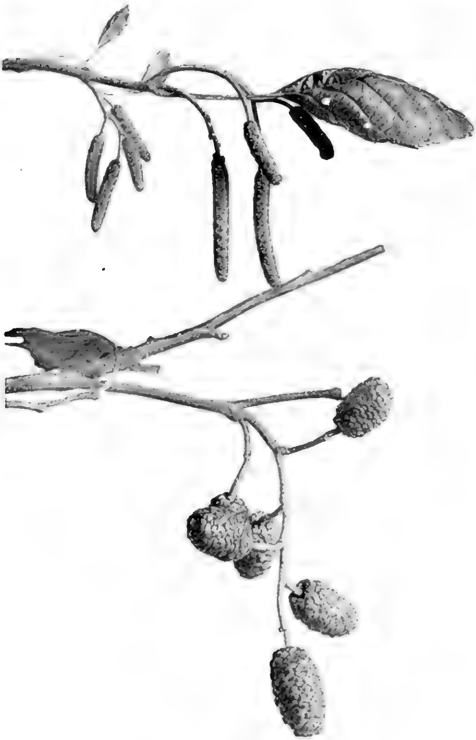

**Fig. 289.—Alder in Autumn, showing next year's Male Catkins (above) and closed ripe "Cones" (below).**

Alder the stamens are provided with whole anthers.

The small stalked cone-like female inflorescence (Fig. 290, ♀) remains erect, or often tends to become so. Each of its spirally-arranged catkin-scales is flat, and bears on the upper face two pairs of little scales and two flowers. The female flower is like that of the Hazel, except that there is no perianth, and agrees even in the absence of ovules or any distinct ovary chamber at this time.

After pollination by the aid of the wind the two-chambered ovary

**Fruit.**

changes into a light-brown flat fruit which is one-seeded and dry, and for a time preserves traces of the two styles. But in the interim great changes have also overtaken the female inflorescence as a whole. It has attained the size of a filbert; every catkin-scale has acquired a stalk and become brown and woody, as have the little scales perched on it; so that each hard fruit-scale evinces signs of being composed of five scales joined together, and carries two flat fruits on its upper face. This cone-like collection of fruits, though ripe in September or October (Fig. 289), usually remains closed during the ensuing winter. In spring the scales gape asunder but do not fall (Fig. 291), and the little flat closed fruits are blown about by the wind. The empty cones may remain attached to the tree for many months, but sometimes as they are opening the twig bearing them becomes brittle and is easily snapped by the wind.

The seed is wholly occupied by the embryo. In germination the tiny seedling sends its cotyledons above ground.

Fig. 291.—Open "Cones" of Alder.

**Habits.**

In regard to its habits the most marked feature is the Alder's selection of moist situations; for it is usually found on the banks of rivers, streams, or pools, or growing in or near marshes and bogs; yet the tree is capable of existence on drier soils so long as the air is sufficiently moist.

# JUGLANDACEÆ

The Juglandaceæ differ from the Salicaceæ, Fagaceæ, and Betulaceæ in structure of ovary, which is one-chambered with one ovule, also in having the usually compound leaves devoid of stipules. The characters of the family are sufficiently illustrated by the single representative common in this country—the Common Walnut.

## JUGLANS REGIA (*Linn.*).—Walnut (*Juglandaceæ*)

The Walnut tree itself is recognisable by its familiar fruit, its thick male catkins and simple terminal female inflorescences, its alternate compound leaves, and peculiar,

Fig. 292.—Bark of Walnut.

large, chambered pith. The last character renders the Walnut unmistakable among common trees.

**Trunk and Bark.** The short trunk breaks up into large ascending and spreading boughs, which with their

Fig. 293.—Twig of Walnut in Winter.

branches are tortuous, and give rise to an ample broad crown. Even the smallest twigs have a coarse appearance.

The rough bark (Fig. 292) is furrowed often in a net-like manner, and is frequently of a light-yellowish ashen colour.

**Leaves.** The exstipulate stalked leaves (Fig. 294) show from four to nine leathery, hairless leaflets, usually arranged in opposite pairs with an odd terminal leaflet; the leaflets are not toothed at their margins. The leaves are spirally arranged, so that the Walnut is easily distinguished from the opposite-leaved Ash.

**Resting-buds.** The resting-bud (Fig. 293) displays only few scales—in fact, two large scales often nearly conceal the others. The terminal bud is much larger than the lateral buds, beneath each of which there is often a second smaller one.

The broad core of the thick young twig is divided into a series of compartments, because the wide pith is broken up into separate transverse partitions, so that the pith is described as being "chambered" (Fig. 295).

Fig. 294.—Leaf of Walnut.

**Flowers and Fruit.** The Walnut blossoms late in April or in May at the same time as the young russet-tinted leaves emerge. Good crops of fruit succeed about every alternate year, and ripen late in September or in October.

**Catkins.** The pendent male catkins are in the axils of fallen leaves on the twig of the preceding year, while the erect female inflorescences terminate shoots produced during the current year. The difference in position of the two

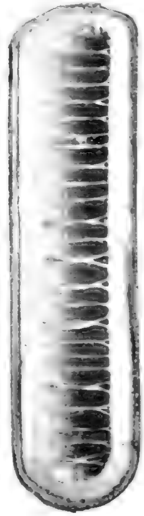

Fig. 295. Chambered Pith of Walnut.

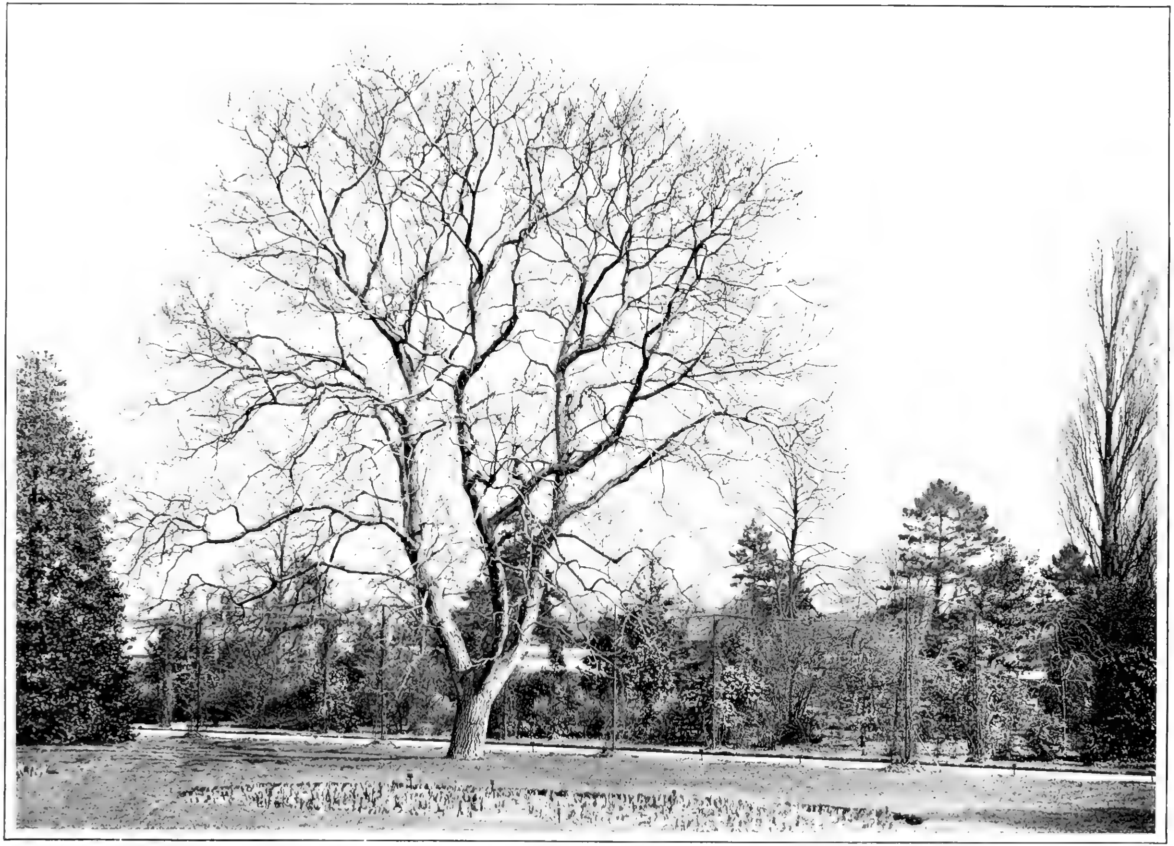

Fig. 296.—WALNUT—*JUGLANS REGIA:* WINTER.

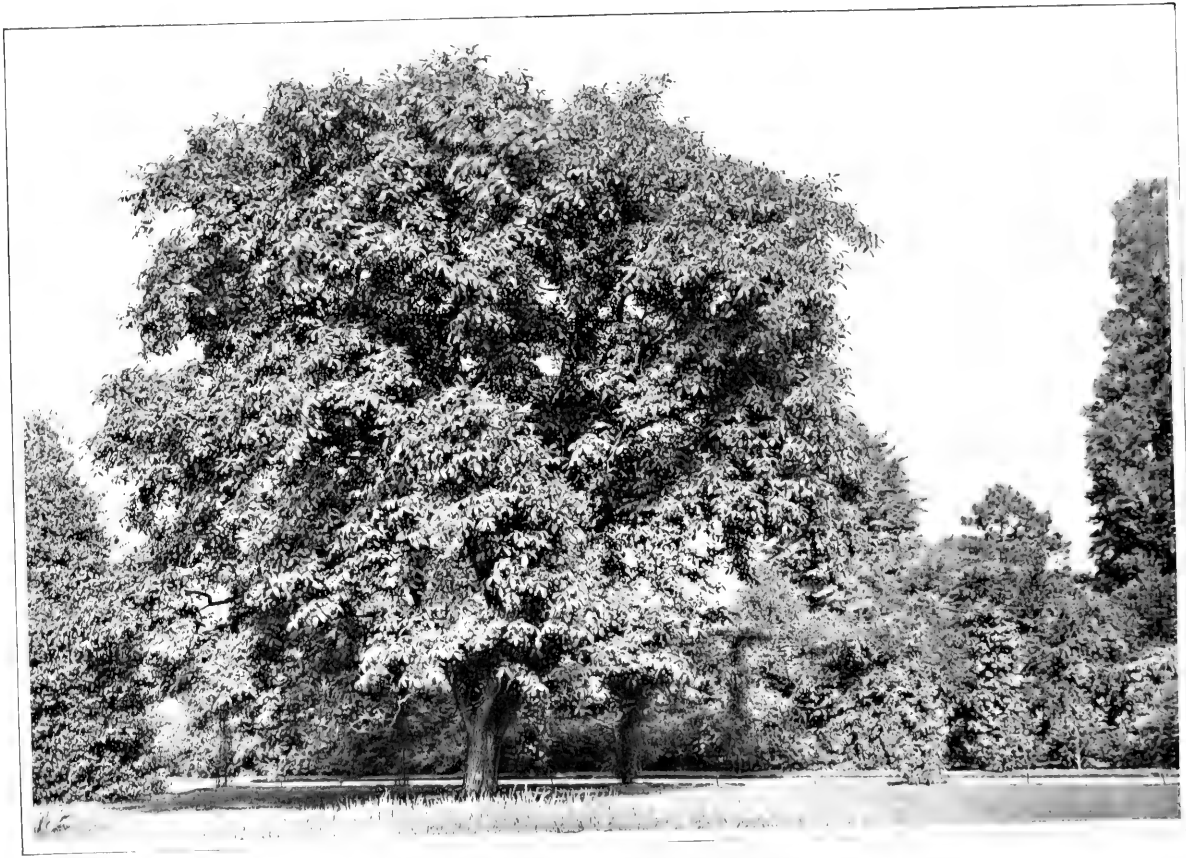

Fig. 207. WALNUT *JUGLANS REGIA*: SUMMER.


**Fig. 298. Male (♂) and Female (♀) Inflorescences of Walnut.**

kinds of inflorescences seems less remarkable when the matter is re-stated as follows: Both kinds arise from resting-buds produced during the preceding season; the lateral buds concerned grow out into dwarf-branches—the male catkins—bearing no foliage-leaves; the terminal buds concerned develop into dwarf-branches bearing foliage-leaves, and terminating in a simple "spike" of female flowers.

**Male Catkin.**

The thick, cylindrical, green, male catkins (Fig. 298, ♂) bear many catkin-scales and flowers. Each catkin-scale shows on its upper face two lateral scales, as well as from four to two scale-like segments representing the perianth. Within the latter stand from six to twenty stamens. There is no trace of a pistil.

**Female Inflorescence.**

The female inflorescence (Fig. 298, ♀), like the male, is a simple "spike," but is erect, and includes only from one to four flowers. The flower has a single inferior one-chambered ovary, containing one ovule attached to its base; it is surmounted by two stigmas, as well as by a perianth consisting of four scale-like sepals. But attached below and outside the perianth is an envelope with minute red teeth

Fig. 299.—Fruits of Walnut.

resembling an outer perianth but representing fused bractlets; and below this, still attached to the ovary, is the catkin-scale.* So that we can only theoretically speak of the single flower as being in the axil of the catkin-scale.

After the breeze has carried pollen on to the stigma, the flower develops into a peculiar fruit (Fig. 299) which is not a nut, but is intermediate between an opening fruit and a stone-fruit. The wall of the fruit has an outer green, somewhat fleshy, layer which splits open spontaneously yet irregularly, and an inner woody layer ("stone") which is familiar as the two-valved shell of the walnut brought to the dessert-table.

**Fruit.**

The seed consists of a thin seed-coat and a peculiar embryo; the latter is mainly constituted of two coarsely wrinkled thick cotyledons, which are two-lobed because two incomplete partitions projecting inwards from the woody "shell" partly divide each cotyledon.

**Seed.**

When germination takes place the two valves of the nut-shell are forced apart, and the food-containing cotyledons remain below ground.

The Walnut is not a native of Great Britain; it has been introduced into Europe, probably from Asia Minor.

* As the ovary is inferior, both stem and carpels take part in the construction of its wall, but the minute bractlets are perched high up the ovary, and the catkin-scale springs from it, so that these leaves contribute to its formation. Thus the fleshy part of the fruit is to some extent comparable with the cupule of the *Fagales*.

# MORACEÆ

## MORUS NIGRA (*Linn.*).—BLACK MULBERRY (*Moraceæ*)

THE Black Mulberry-tree is recognised by the structure of its inconspicuous uni-

Fig. 300.—Bark of Black Mulberry.

sexual flowers, and by its blackberry-like collections of fruits, as well as by its male catkins and plumper female inflorescences.

The tree attains a height of forty to fifty feet, and acquires a thick, rough bark (Fig. 300).

**Leaves.** The alternate, simple, stalked leaves have stipules that soon fall. The dark-green, tough, rough-surfaced blade shows at its characteristic base three veins that suggest an inclination for the blade to become lobed (as it rarely is); the margin is coarsely and unequally toothed (Fig. 301).

Fig. 301.—Shoot of Black Mulberry.

The scaly resting-buds (Fig. 303) grow out into long-shoots or dwarf-shoots.

Fig. 303. Twig of Mulberry in Winter.

**Flowers.** The tree blossoms in April or May. The inflorescences arise (seemingly though not truly) in the axils of leaves on shoots of the current year, the male catkins being at the base of the shoot (Fig. 302, ♂), and the shorter-stalked plumper female ones tending to occur higher up the shoot on the same individual tree (compare Fig. 302, ♀) which is of the White Mulberry). Each inflorescence shows an axis bearing a number of flowers on its sides.


Fig. 302.—Male Inflorescences (♂) of Black Mulberry, and Female Inflorescences (♀) of White Mulberry.

**Male Flower.** The male flower has a single perianth formed of four sepals; inside and opposite to these are four stamens; and in the centre may be a minute

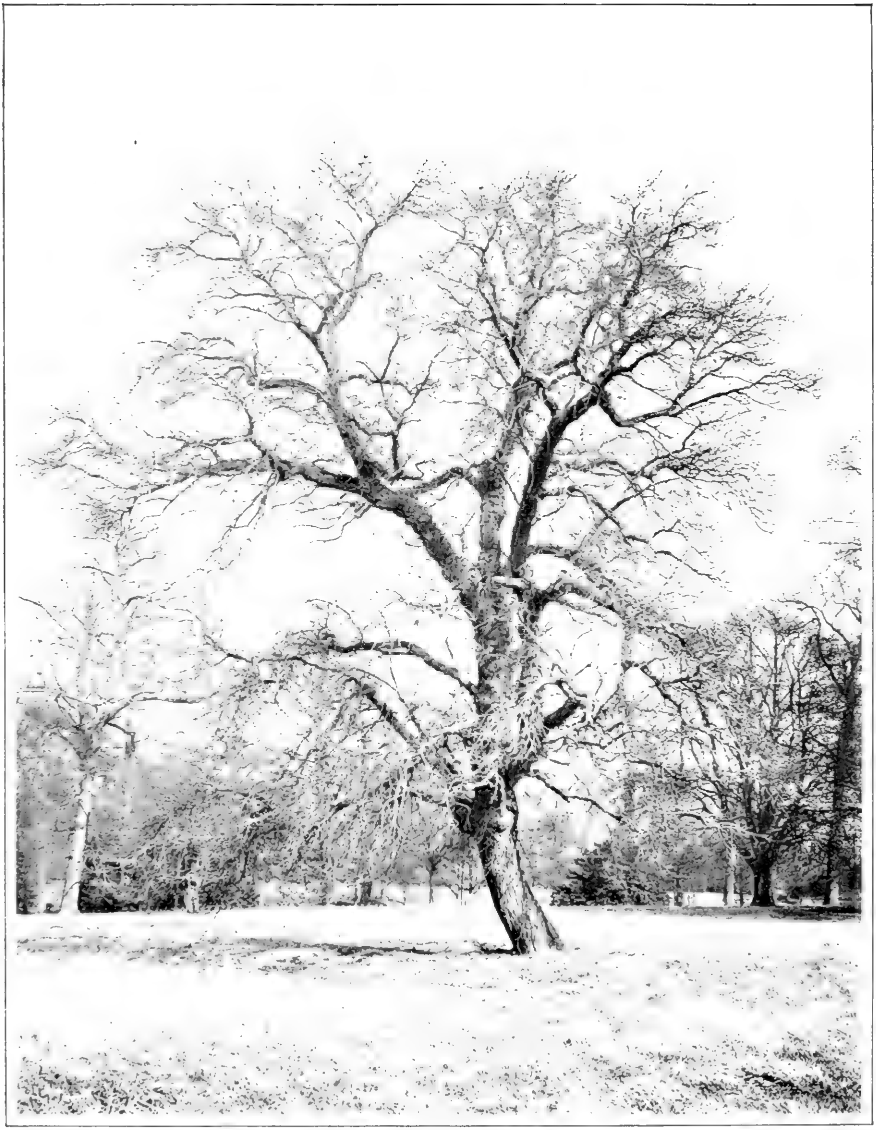

Fig. 304.—BLACK MULBERRY—*MORUS NIGRA:* WINTER.

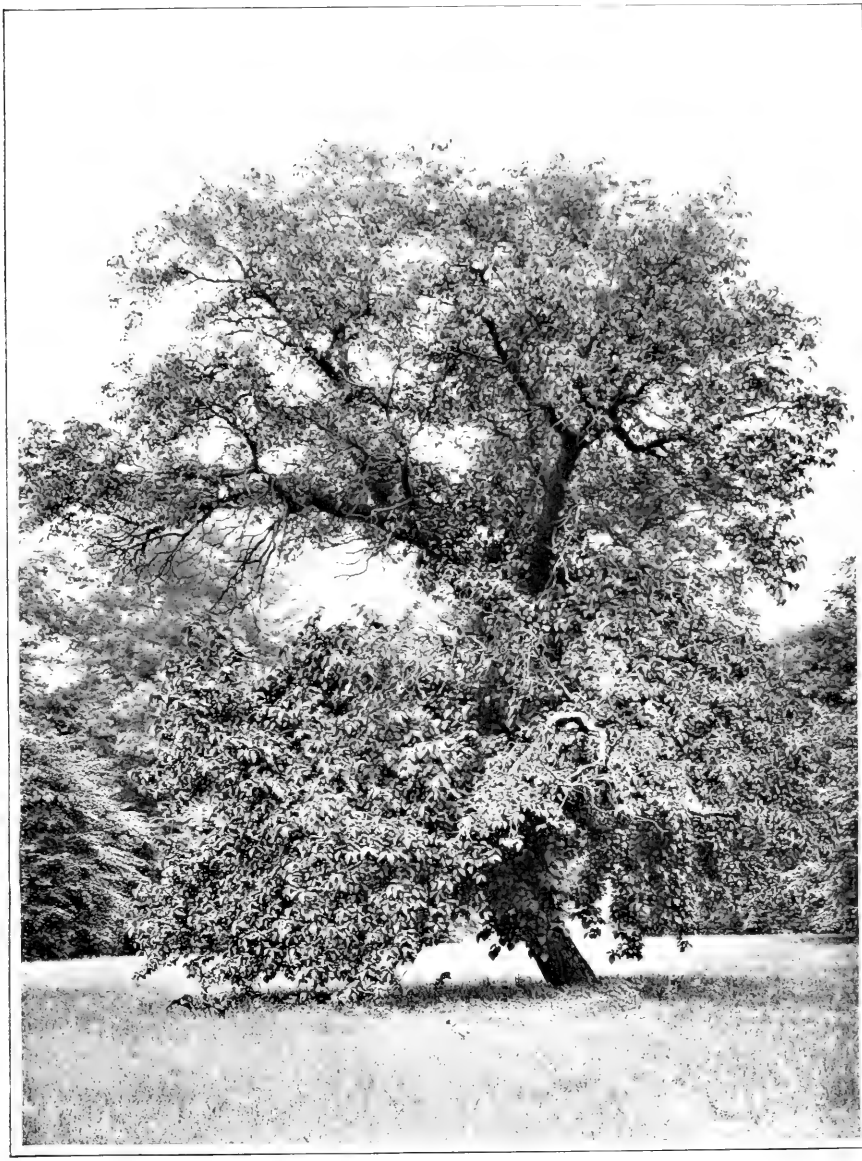

Fig. 305.—BLACK MULBERRY—*MORUS NIGRA:* SUMMER.

Fig. 306.—"Mulberries" of *Morus nigra*.

protuberance representing the vestige of a pistil.

**Female Flower.** The female flower likewise has a perianth formed by four sepals, and in the centre is a single pistil. When young the single ovary has two chambers, but only one of these chambers grows and produces an ovule, so that the mature ovary is one-chambered. That the ovary is formed by two carpels is shown also by the fact that the style divides low down into two long stigma-bearing branches. Traces of four stamens often (always in youth?) occur as four lumps in the female flower.

**Fruit.** The flowers are wind-pollinated. The female inflorescence gives way to a black collection of fruits which resembles a blackberry but is formed by a number of flowers. The calyx of each flower grows over the ovary and becomes black and pulpy; the ovary itself changes into a stone-fruit which has only a thin fleshy layer. Thus the mulberry-fruit is a collection of stone-fruits, each of which is encased in a fleshy calyx.

The White Mulberry (*Morus alba*) differs in having thinner, light-green, smoother leaves, and longer-stalked, smaller collections of fruits; moreover, the leaf-blade is unequal-sided at the base (see Fig. 302).

# ULMACEÆ. ELM FAMILY

Two kinds of Elm-trees represent the Ulmaceæ in Great Britain. They are recognised by the unfoliaged tufts of nearly stalkless green *bisexual* flowers, which shoot out, before the leaves, from buds on twigs of the preceding year; moreover their tufts of flat, winged fruits, as well as their leaves and bark, aid identification.

Each flower has a bell-shaped green perianth, with from four to eight teeth; opposite to these are from four to eight stamens; and in the centre is the *two-chambered superior ovary*, which is crowned by two thread-like stigmas and contains one ovule in each chamber.

The dry, one-seeded fruit, which is obviously adapted for dispersal by wind, does not open spontaneously. Its actual apex is at the base of a deep notch.

Both trees are rough-barked, and have great powers of throwing out shoots from the stump, stool, and bole.

The simple stipulate leaves are arranged alternately in two ranks; the blade is unequal-sided at the base and double-toothed at the margin.

## ULMUS GLABRA (*Huds.*).—Wych Elm (*Ulmaceæ*)

*Ulmus glabra* (*U. montana*) is distinguished from the Common Elm (*U. campestris*) by having the opaque seed-chamber at the centre of the fruit; moreover its flowers often have more numerous (five to eight) perianth-teeth and stamens, and its leaves are usually larger.

**Height and Form.**

The large tree may attain a height of 110 feet and has an ample crown, which is broader and often has more spreading branches than in the Common Elm; indeed the branches are often horizontal or even drooping, and thus prepare us for the existence of a "Weeping Elm" (Fig. 5).

The bark is thick and rough (Fig. 310), but not so deeply furrowed as that of the Common Elm.

**Leaves.**

The coarse leaf-blade is rough on the upper face, shows collections of hairs at the angles of the nerves on the lower face, and is continued into a long point (Fig. 8). The stipules soon fall.

Fig. 307.—Inflorescences of Wych Elm.

Fig. 308.—WYCH ELM—*ULMUS GLABRA:* WINTER.

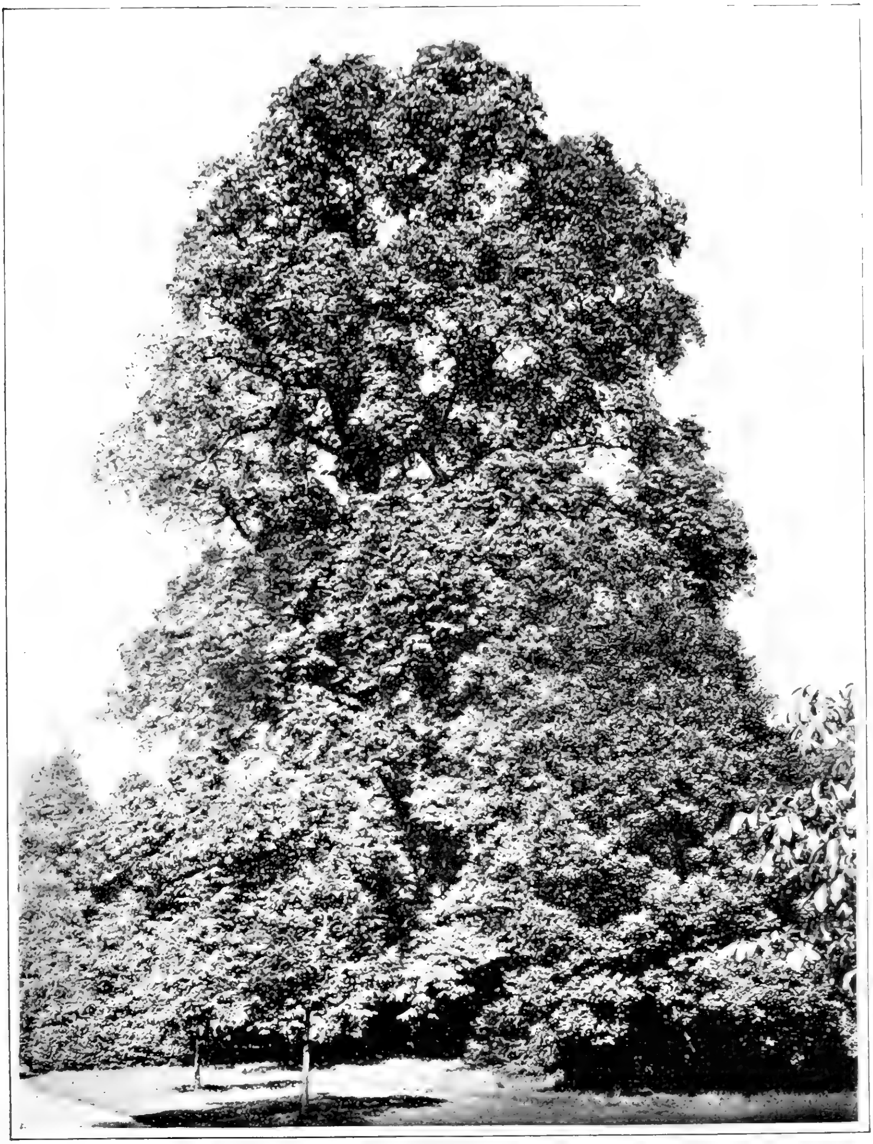

Fig. 309.—WYCH ELM *ULMUS GLABRA*: SUMMER.

The resting-buds are of two kinds—spherical buds that produce inflorescences (Fig. 49), and pointed ones, situated higher on the year's-shoot, that develop into foliaged shoots (Figs. 49, 312).

**Buds.**

Fig. 310. Bark of Wych Elm.

Each of the latter buds shows two ranks of scales. On the inclined branches the buds are not accurately axillary, so that the resting-buds stand very obliquely above the scars left by the fallen leaves (Figs. 311 and 312). At the conclusion of each growing season the terminal bud dies off, and the highest axillary bud takes its place. The lateral buds develop into long-shoots or dwarf-shoots.

The flowers open in March or April, and are wind-pollinated. The stigmas are receptive before the stamens are ripe, so that when the flower opens its long red stigmas project beyond the five to eight purple anthers, which at this stage are attached to short

**Flowers.**

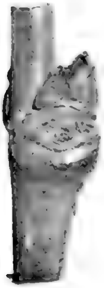

**Fig. 311. Resting-bud of Wych Elm.**

filaments. The filaments subsequently elongate greatly, and eventually overtop the stigmas, and their pollen may fall upon the latter, thus causing self-pollination. The flowers of an inflorescence open successively (see Fig. 307).

**Fruit.** The fruits (Fig. 52), which are larger than those of the Common Elm, become brown and ripe in May or June. The seed is wholly occupied by the embryo, which in germination sends its two green cotyledons above ground.

The Elms are well suited to illustrate the mode of life of Bark Beetles (Scolytidæ), which feed and breed in tunnels that they have excavated in the bark of various trees. The common Elm Bark Beetle, *Scolytus Geoffroyi* (Goetze), which attacks Elm trees in England, is a brown little beetle only about one-sixth of an inch in length. The female commences operations by boring a tunnel straight through the bark, thus making an "entrance aperture," which resembles a shot-hole in shape and size. After pairing, she bores a tunnel along the length of the stem at the junction of the wood and bark, scoring both these in the process. This tunnel, the "mother-tunnel," is even in calibre throughout (as the beetle does not increase in size) and short, often only one inch long. From this the beetle may occasionally pierce a little shaft through the bark so as to ventilate the tunnel, the position of each shaft being denoted on the outside by a "ventilation aperture." At intervals along the sides of the tunnel the beetle hollows out minute niches, in each of which she deposits an egg, until there are, thirty, forty, or even a hundred eggs thus lodged. After these labours the tiny creature dies. From the eggs there hatch out minute, white, legless maggots, which possess powerful jaws. The maggots at once begin to tunnel at right angles to the mother-tunnel at the junction of wood and bark. As the maggot feeds on the material that it excavates it grows, and therefore as it burrows along it constantly makes an increasingly wide tunnel. The "larval tunnels" thus constructed, therefore, widen out towards their ends, also gradually diverge from their original direction, and attain much greater lengths than the uniform mother-tunnel. Eventually the full-sized (full-fed) maggot rests for a time (throughout the whole winter), and thereafter becomes an inert "pupa," which, casting off its outer skin, emerges as a mature beetle. This burrows straight outwards through the bark, emerging through an "exit-hole" that it has pierced. Consequently to each single entrance aperture of the mother there correspond many exit apertures of the progeny. In England the beetle emerges and flies in May or June; the maggot is full-fed in July, and usually remains resting in the tunnel until the following spring, when it changes into a pupa. But in warm summers the full-fed maggot in July may develop rapidly into a beetle which emerges in August, and gives rise to a second brood of young; these hibernate within the tunnels during winter.

**Fig. 312. Twig of Wych Elm in Winter.**

Different species of Bark Beetles attack Pines, Oaks, Birches, Ash-trees, and others; each species producing its own pattern of tunnels ("galleries") on wood or bark or both. Some species are polygamous, and show star-like radiating "mother-tunnels," each of which corresponds to one wife.

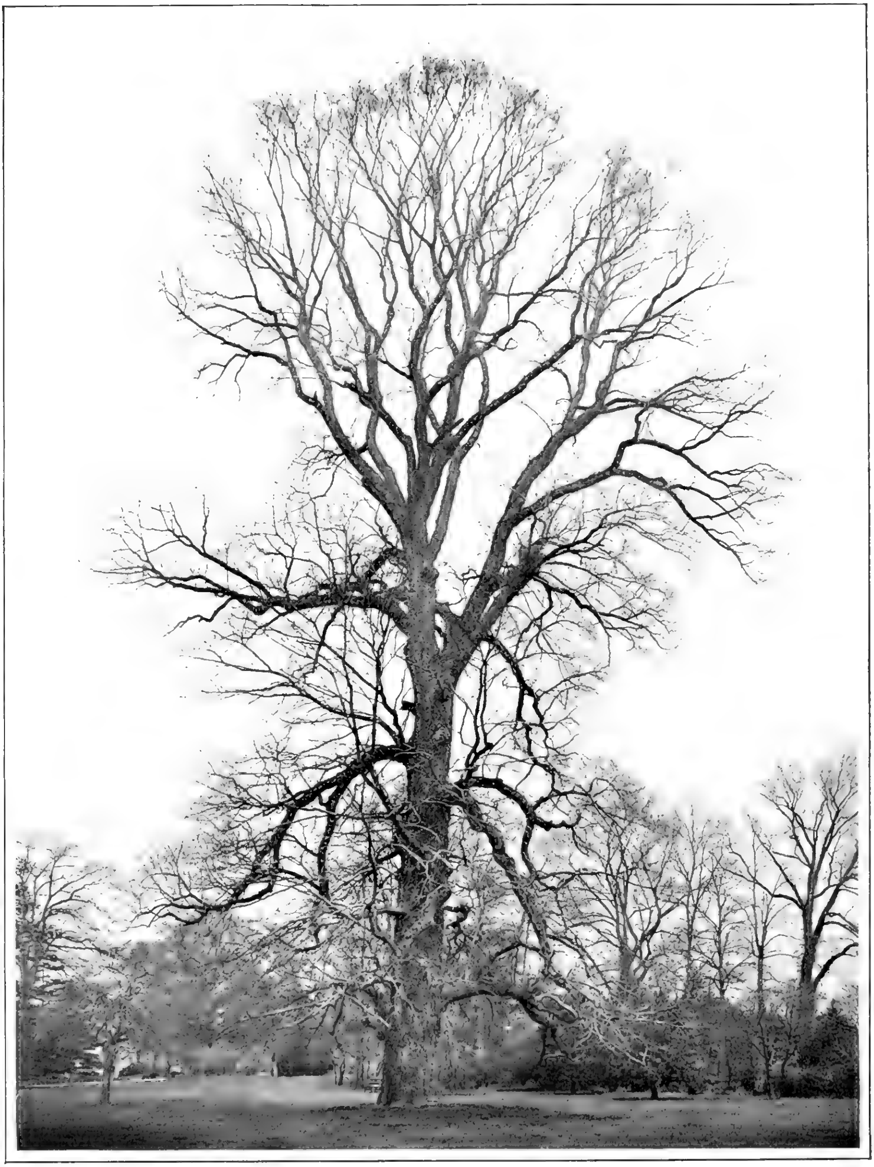

Fig. 313.—COMMON ELM—*ULMUS CAMPESTRIS:* WINTER.

Fig. 314.—COMMON ELM—*ULMUS CAMPESTRIS*: SUMMER.

## ULMUS CAMPESTRIS (*Linn.*).—Common Elm (*Ulmaceæ*)

This tree differs from the Wych Elm in that the seed-chamber is near to the top of the fruit (being only separated by a distance equal at most to one-third of its length). Moreover, the fruits, leaves, and flowers are smaller, and often there are only four or five perianth-segments and stamens in each flower.

Fig. 315.—Bark of Common Elm.

The Common Elm may become a huge tree 125 feet in height, and its trunk may be twelve feet in diameter near the base. Like the Wych Elm, the trunk usually is devoid of branches for a considerable height (so that the trees figured in this work are not quite typical). Its crown is narrower,

**Dimensions and Form.**

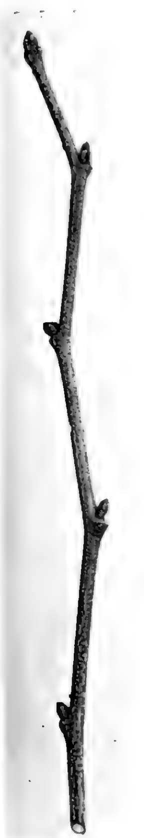

Fig. 316.—Twig of Common Elm.

and its boughs in the crown ascend more steeply.

The bark becomes thick and very deeply furrowed (Fig. 315).

**Leaves and Buds.** The leaves are usually smaller than those of the Wych Elm, and less rough on the upper face; often they do not taper to a long pointed tip (*see* Fig. 7). The twigs and buds (Figs. 316 and 318) are very like those of *U. glabra*, but in one variety, *U. campestris* var. *suberosa*, conspicuous wings of cork give to the twigs a very characteristic appearance (Fig. 317).

Fig. 317.—Cork Wings on Twigs of *U. campestris* var. *suberosa.*

**Fruit.** The pollination and behaviour of the flowers are as in the Wych Elm. One peculiar feature regarding the Common Elm is that in this country the fruits rarely, if ever, produce seeds that germinate. This is less surprising when it is remembered that the Common Elm is not a native of Great Britain.

**Suckers.** To atone for this defect the tree has a great power of throwing up suckers from long, shallow, horizontal roots. Thus the Common Elm can gradually travel from place to place, and can form extensive hedges or lines of trees.

Fig. 318.—Resting-bud of Common Elm.

# PLATANACEÆ

## PLATANUS ORIENTALIS (*Linn.*).—Plane (*Platanaceæ*)

The Platanaceæ include only one genus *Platanus*, so that the characters of the family are sufficiently indicated by *Platanus orientalis*, which is easily recognised as a Plane-tree by its alternate, palmately-lobed, simple leaves which have tubular stipules; by its ball-like inflorescences and collections of fruits attached to slender hanging stems; and by its light-coloured bark that flakes off annually in large thin plates.

Fig. 319.—Bark of Plane.

The deeply-rooted tree may attain large dimensions, not so much by reason of its

**Dimensions and Form.** height, though this may be ninety feet, as by reason of its immense crown which is formed by a number of irregular, bent, tapering boughs and finer branches. The

**Bark.** more than ten feet in thickness, and at its base may show some persistent small-scaled rough bark (Fig. 320). But the bark is generally thin because every year it casts off large thin plates, and

**Fig. 320.—Old Bark of Plane.**

trunk usually is bare up to a height of thirty or even sixty feet, and often remains distinct to the summit, so that our illustrations (Figs. 321 and 322) by no means represent a typical tree.

The rapidly thickening trunk may become

the patches thus laid bare are very light-coloured (Fig. 319).

**Leaves.** The foliage is somewhat Maple-like. But the Plane is easily distinguished from the Sycamore and Maples by the fact that its palmately-lobed leaves

Fig. 321.—PLANE—*PLATANUS ORIENTALIS*: WINTER.

Fig. 322. PLANE *PLATANUS ORIENTALIS*: SUMMER.

Fig. 323.—Twig of Plane in Winter, and one Fruit (upside down).

are alternate, and have characteristic stipules and leaf-stalks. The two stipules of a leaf are represented by a tube which surrounds the stem and therefore leaves a ring-like scar after its early fall (*see* Figs. 323 and 324). The leaf-stalk is dilated and excavated at its base to form a chamber which encloses and conceals the axillary bud (Fig. 325), so that when the leaf falls the conical resting-bud is revealed for the first time, and is partly surrounded at its base by the leaf-scar. The blade shows five or seven lobes and is hairless when mature, though, when first exposed, it and the bud-protecting stipular sheath are clothed with hairs coloured like old gold.

**Resting-buds.**

The conical resting-bud (Figs. 323 and 324) is apparently invested by a single sheath, which, however, divides into two scale-like halves when the bud opens. The resultant shoot may be a slightly zig-zag long-shoot (Fig. 323); or a foliaged dwarf-shoot; or a dwarf-shoot bearing three or four foliage-leaves, and terminating in a slender hanging stem that has usually three or four lateral, stalkless, globular inflorescences.

**Flowers.**

The spherical inflorescences, which open in April or May, are of two kinds, male and female; both kinds occur on the same tree, but on different branches. Each inflorescence consists of many small stalkless flowers crowded together on the rounded end of a short inflorescence-stem.

The female inflorescence (Fig. 327, ♀) is easily distinguished by the thread-like projecting styles; it includes many one-chambered ovaries, each of which (subsequently) acquires a single ovule and is topped by a slender style and stigma.

The male inflorescence (Fig. 327, ♂) displays many crowded erect stamens, each of which has a short filament and an anther that is capped by a thick continuation of the connective; in the closed male inflorescence these densely-packed shield-like expansions of the connectives form a protective covering. Among the stamens and ovaries are little scale-like and other outgrowths.

The structure of the flowers is difficult to observe, and more difficult to interpret. The stamens are arranged in groups of from three to six; each group is surrounded by an inner circle of a few club-like

Fig. 324. Resting-bud of Plane in Winter.

Fig. 326.—Leaves of Plane.

bodies, and an outer circle of from three to six hairy scales; all these compose one flower. The pistils are similarly arranged in groups of from four to eight; each group is surrounded by two or even three circles of scales and club-like bodies; these, with the grouped separate four to eight pistils, constitute a female flower.

Pollen is conveyed by wind to the female inflorescence which gives rise to the larger spherical collection of fruits from which the persistent styles project (Fig. 328). The soft tissue of the hanging stem that bears these spiky balls disintegrates and leaves behind merely a loose strand of coarse hair-like threads. It is not until the following spring that the ball-like, closely packed collections of fruits commence to loosen and set free the separate fruits. Each fruit (Fig. 323, above) is shaped like a four-sided club: at its broader bulging tip is the style: on its sides are short, deep-golden hairs which at its base become long, stiff, outstanding hairs that form a device for dispersal by the wind. The one-seeded fruit remains closed, like a nut, until the time of germination. But many of these nut-like fruits are sterile in Great Britain, for this tree belongs to the warmer south (extending from Greece to Afghanistan).

**Fruit.**

Fig. 325.—Resting-bud of Plane in Summer, concealed by Leaf-stalk.

There are several varieties of *Platanus orientalis*, but one Plane known as *P. acerifolia* requires brief notice, as it is not uncommon in England, and is usually erroneously regarded and described in books as being the American

**Varieties.**

Plane (*P. occidentalis*), which is exceedingly rare in Europe. *P. acerifolia* may be a hybrid between *P. orientalis* and *P. occidentalis*, and differs from the former in that the leaf has broader, relatively shorter, and usually fewer (often three, sometimes five) lobes, also in that the inflorescence-stem bears only one (rarely two) spherical collection of fruits.

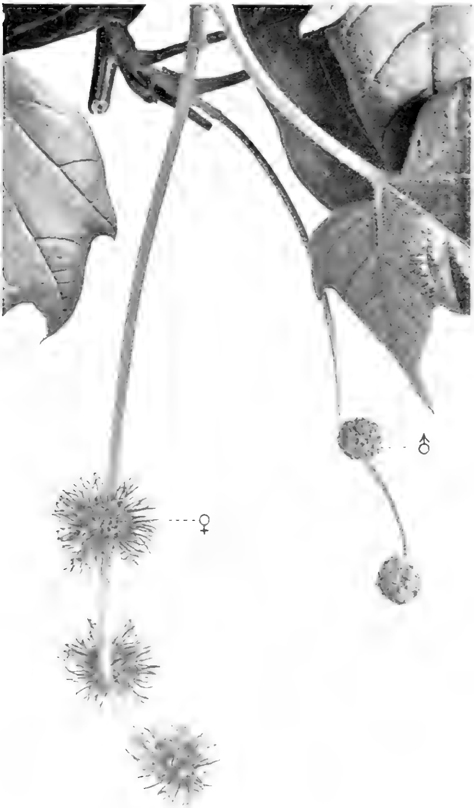

**Fig. 327.—Male (♂) and Female (♀) Inflorescences of Plane.**

**Fig. 328.—Collection of Fruits of Plane.**

[Fig. 327 and possibly Fig. 326 represent *P. acerifolia*, whereas Fig. 328 certainly represents *P. orientalis*.]

# BUXACEÆ

## BUXUS SEMPERVIRENS (*Linn.*).—Box (*Buxaceæ*)

The evergreen Box displays a strong likeness to the Privet. For its simple green

Fig. 329. -Bark of Box-tree.

leaves are opposite, and the successive pairs alternate. But the Box differs from the Privet in that the four-ranked arrangement of the leaves is associated with the four-sided (not cylindrical) form of its twigs, as there is a leaf-ridge continued down the internode from each leaf. In flower and fruit the two plants are easily distinguished; the Privet


Fig. 330.—Inflorescences showing Male Flowers of Box.

the blade is more oval than in the Privet, and often has a notched tip.

The scale-clad resting-buds are particularly small. The young four-angled twigs bear hairs, especially at the margins of the leaf-ridges.

**Flowers.** The axillary dense clumps of stalkless flowers open in April or May, and stand out from the green shoots as little

has stalked terminal inflorescences of creamy bisexual flowers which give way to black berry-like fruits; whereas the Box has crowded axillary clusters of unisexual flowers devoid of petals, and the central female flower of the cluster gives rise to a dry fruit that opens by three valves.

**Dimensions.** The Box is a closely-branched shrub or small tree not commonly exceeding eight or twelve feet in height, though sometimes it is as much as twenty feet. The trunk may acquire a thickness of eighteen inches, and has a light-yellowish scaly bark (Fig. 329).

**Leaves.** The short-stalked leaves are devoid of stipules. The leathery, hairless blade is deep-green and glossy on the upper face, but paler and duller on the lower; it is not only free from teeth, but has lateral nerves so fine as to be indistinct; finally,

Fig. 331.—Inflorescences showing Female Flowers and Unopen Male Flowers of Box.

Fig. 332.—BOX-TREES—*BUXUS SEMPERVIRENS.*

light-coloured patches. Each cluster (Figs. 330–1) arises from a bud in the axil of a leaf formed in the preceding year. It includes a number of small scales (bracts) with single male flowers in their axils, and terminates in a rosette of scales ranged round a solitary female flower. As the female flower opens

**Fig. 333. Open Fruits of Box.**

at a time when the males are closed and bud-like (Fig. 331), cross-pollination is at first favoured (sometimes the female flower is absent from the cluster).

The male flower consists of four sepals, with four stamens opposite to them, and a central lump which pours out nectar and may represent the vestige of a pistil.

The point at which the female flower exactly commences is not easily determined. There is a small perianth-like collection of scales, the inner ones of which probably represent a perianth. Apart from this the flower consists solely of an ovary surmounted by three styles which are two-lobed at their ends. Alternating with the three styles on the roof of the ovary are three lumps from which drops of nectar exude. The ovary is three-chambered, and in each chamber hang two ovules.

Pollination is often accomplished by the aid of insects, especially flies, which sip the nectar, and are doubtless attracted by the disagreeable scent of the flowers, as well as by the projecting light-coloured anthers. But to some extent wind may aid in pollination, especially as male flowers are more numerous than female.

**Fruit.**

The ovary and styles give rise to a characteristic dry fruit which usually contains six black seeds. When the fruit is ripe the outer part of its wall separates from the inner and splits longitudinally down the three styles, thus producing three two-horned valves (Fig. 333); but the inner part of the ovary-wall suddenly splits longitudinally down six lines and flings the seeds to some distance. The Box has an explosive fruit.

**Habits.**

The Box-tree is often found growing on dry sloping ground, and in this country frequently on chalk hills. It casts a deep shade, grows very slowly, and can form the underwood of forest, so that it probably should be classified as a distinctly shade-enduring species.

Again, in connection with this tree we note the tough, thick nature of foliage that is evergreen in this country (compare Firs, Holly, the evergreen species of Oaks and of *Prunus*).

Fig. 334.—Young Box-trees on Box Hill.

# TILIACEÆ

## TILIA EUROPÆA.—Lime-tree (*Tiliaceæ*)

The Lime-tree is most easily recognised by its characteristic stalked inflorescences and collections of fruits which seem to be affixed to elongated bracts; as well as by the greenish-yellow regular flowers with separate petals and numerous stamens; but the resting-bud is also quite distinctive, as it presents a humped appearance, because it shows only either two or three scales of which the bulging outermost one is considerably the shortest.

The Lime-tree may be seventy or more feet high, its trunk rising bare and unbranched to a considerable altitude in forest, but being branched close to the ground in the open. The very shady oval crown is closely branched and heavily foliaged. The tree has a marked faculty of throwing out shoots from the stool or bole (Fig. 336), so that the trunk is apt to be raised into large bosses where shoots were formerly attached (*see* Fig. 337). Often the thick base of the trunk (sometimes six feet in diameter) is raised into thick broad ribs or ridges.

**Height and Form.**

The bark remains smooth for from twenty to thirty years, but subsequently becomes longitudinally fissured, and eventually rough and thick (Fig. 335).

The alternate, stalked, simple leaves are ranged in two ranks (Fig. 339). Each has two well-developed long stipules which fall as the leaf opens. The blade is more or less strongly unequal at the base, where its veining is distinctly palmate in suggestion; the margin has saw-like teeth, and the tip is sharp; on the lower face there are tufts of hairs at the angles of the larger nerves (*see* page 235 for the significance of these tufts).

**Leaves.**

The resting-buds seen in winter are all lateral because the true termination of every twig dies during the previous summer. Each bud shows an outermost small bulging scale, and a larger inner one that either encloses the whole of the other bud-structures or is succeeded by a still larger innermost one that does so (Figs. 340–1). The topmost axillary bud, which has pushed itself into a terminal position, continues the growth of the shoot. The branches are either long-shoots or dwarf-

**Resting-buds.**

**Fig. 335.—Bark of Lime.**

shoots, and, as the leaves are ranged in two lines solely on the flanks of a branch, the branchlets lie in one plane (a horizontal plane when the shoot is horizontal). The opening bud usually bends slightly down-

Fig. 336.—Shoots at Base of Lime-tree.

wards, shoots out its leaves which shed their large scale-like stipules as they expand, and the gradually unfolding young leaves form sunshade-like or roof-like, arched, screens over their juniors (Figs. 24 and 25).

The Lime-tree commences to flower at the age of twenty or twenty-five years. The forked inflorescences arise in the axils of foliage-leaves on shoots of the current year. Close to the base of the inflorescence, and (only) seemingly in the axil of the same leaf, is a resting-bud which in the following year may sprout to produce a foliaged branch. The main stem of the inflorescence is joined for some distance upwards to the yellowish-green, tongue-like bract, and terminates in a

**Flowers.**

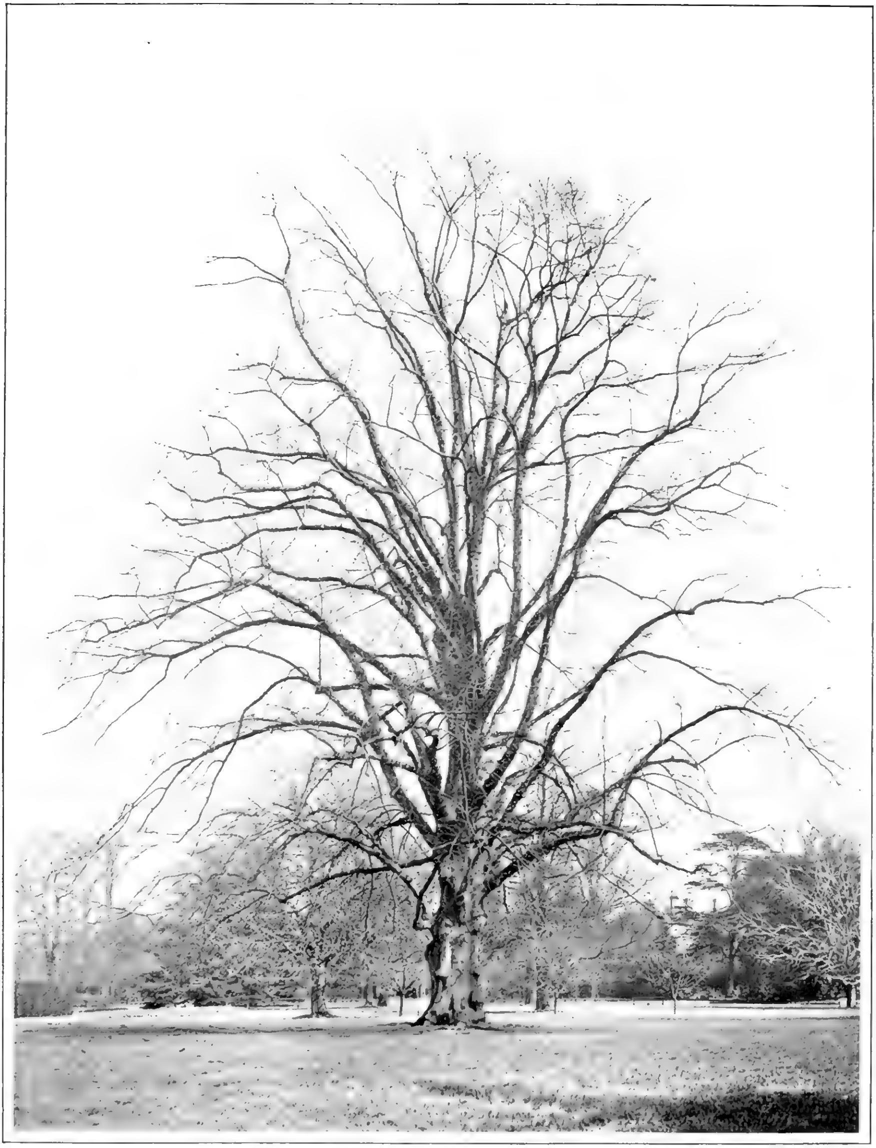

Fig. 337. LIME *TILIA EUROPÆA*: WINTER.

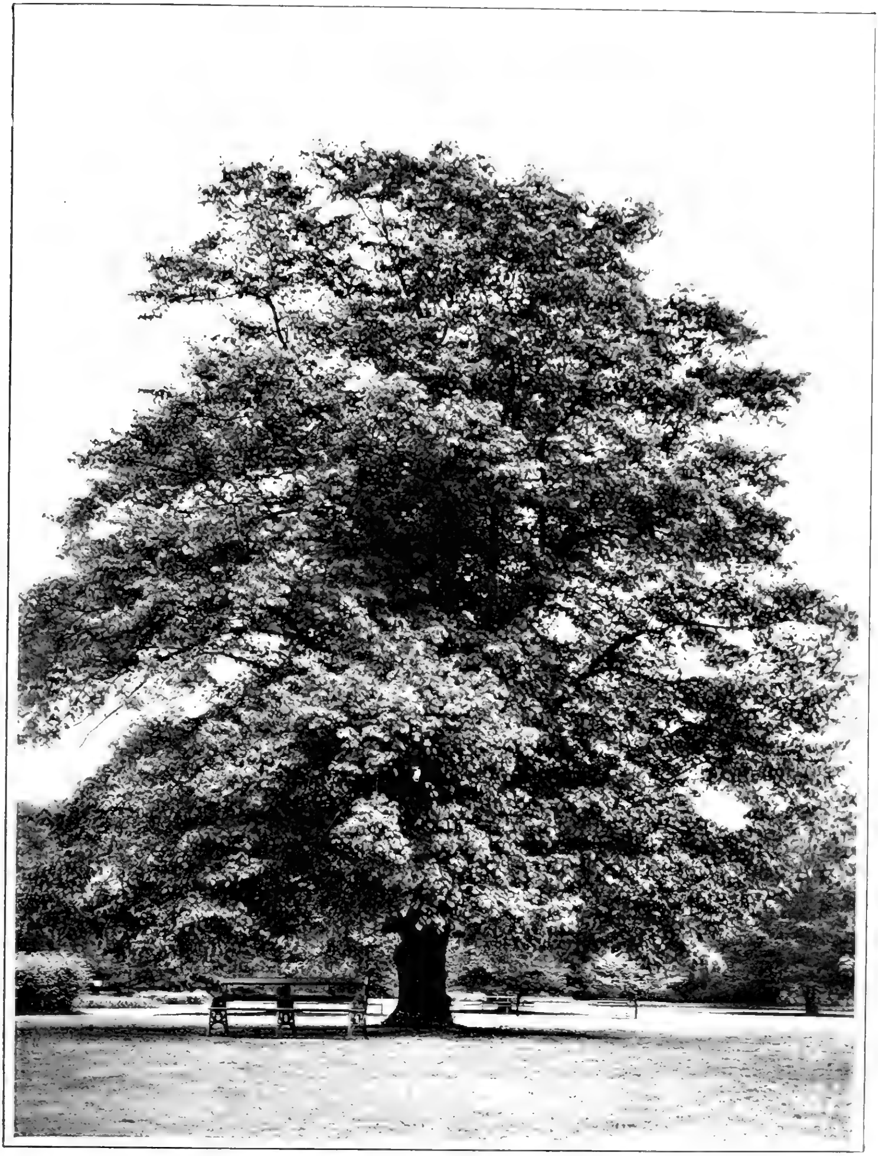

Fig. 338.—LIME—*TILIA EUROPÆA*: SUMMER.

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more or less flat-topped inflorescence, which includes only a few (from two to eleven) stalked flowers. The Lime does not open its flowers before the middle of June or July.

The flower is regular and bisexual. The five green sepals, five separate, light-yellow petals, and the numerous stamens are all attached below the single white-haired ovary: the flower is therefore hypogynous. Despite of the fact that each sepal bears two nectaries at its base and is hollowed to act as a sugar-receptacle, the sepals soon fall from the open flower. The pistil consists of a single superior ovary which contains two ovules in each of its five chambers, also of a single style capped by five distinct stigmas.

The scented nectar-laden flowers, hanging under the leaves, attract crowds of bees which cause cross-pollination. Self-pollination is nearly impossible because the anthers open before the stigmas are ready to receive the pollen; moreover, when the inflorescence is pendent, the position of the anthers renders it well-nigh impracticable for the pollen to fall directly on the stigmas of the same flower.

Fig. 339.—Leaves of Lime.

Fig. 341.—Twig of Lime in Winter.

Fig. 340.—Resting-Bud of Lime.

**Fruit.** The ovary ripens into a rounded, one-seeded, one-chambered nut, in which it is difficult to detect traces of the other four almost obliterated chambers. The wind blows away the whole collection of fruits attached to one bract, which thus acts as a sail.

**Seeds.** Within the rounded seed lies not only the embryo, but also, outside this, a store of food-material (endosperm). At the time of germination the nut-shell splits open, and the two cotyledons project out of the soil, raising aloft the food-material and continuing to absorb it by their tips.

Fig. 342.—Inflorescences of Lime.

bluish tinge, shows no scattered hairs, but has tufts of rusty red hairs at the angles of the veins.

**Small-leaved Lime.**

The inflorescence is often erect, and usually includes a larger number (from four to eleven) of smaller flowers. The thin fragile wall of the fruit is almost or completely devoid of projecting ribs. The resting-bud has only two scales visible from the outside.

Not until they have taken in the food thus available do the cotyledons unfurl and reveal their exceptional five-lobed palmate shape.

Under the general name *Tilia europæa* I include *T. platyphyllos* (Scop.), the Large-leaved Lime-tree, *T. vulgaris* (Hayne), the Common Lime-tree, and *T. cordata* (Mill.), the Small-leaved Lime-tree. Of these the two extreme forms—the Large-leaved and the Small-leaved—are easily distinguished: while the third form is intermediate in character.

The leaf of the Large-leaved Lime is large; its lower face is light green in colour, and shows hairs generally scattered over it, as well as collected in whitish or greyish tufts at the angles of the veins. The pendent inflorescence includes only few (from two to seven) relatively large flowers. The fruit has a thick woody wall which is marked by five more or less projecting ribs. The resting-bud has three external scales.

**Large-leaved Lime.**

The leaf of the Small-leaved Lime is smaller; its lower face has a pale

Fig. 343.—Fruits of Lime.

**Common Lime.**

The Common Lime is intermediate in the character of its fruit, inflorescence, and the lower face of the leaf, which is green and has greenish-grey hairs only at the angles of the veins. The leaf-stalk of the Common Lime is scarcely half as long as the leaf-blade, whereas, on the other hand, in the Small-leaved Lime the former is nearly as long as the latter.

## ACERACEÆ. SYCAMORE AND MAPLE FAMILY

The Sycamore and Maples are woody plants with *opposite*, stalked, *simple leaves*, which are *devoid of stipules*, are *palmately veined*, and often *palmately lobed*. (The Plane has very similar leaves, which, however, bear

**Fig. 344.—Fruits of Norway Maple.**

stipules, and are alternate. One familiar species of Maple has pinnately compound leaves.) The *flowers* are small, regular, often greenish, and usually *hypogynous*. In each flower there are five or four sepals, five or four *separate petals*, and usually *eight* (from four to twelve) *stamens*. A thick *disk* is usually present, and often glistens with nectar; the stamens are frequently inserted in little pits on the disk. The pistil consists of two carpels joined to form a somewhat *flattened, two-chambered ovary*, which contains two ovules in each chamber; from the summit of the ovary rise the two style-branches. The *fruit* is dry, *two-winged*, and *breaks into two separate one-winged halves, whose single closed chambers contain as a rule one seed each.*

Although many species of *Acer* are in cultivation, in this country only two are very common—the native Field Maple, and the naturalised Sycamore—and two are fairly common—the Norway Maple and *Acer Negundo*. The last-named is easily distinguished from the others because it has pinnately compound, often variegated, leaves, and its flowers are devoid of petals. The other three can be readily distinguished by their inflorescences, leaves, and fruits, as will be explained in detail.

Among the points of special interest exhibited by species of *Acer* are :—

1. The origin of unisexual flowers by more or less incomplete suppression of the stamens or carpels.

2. The intermediate stages shown between male and female individuals.

3. The gradual decline in conspicuousness of the petals as shown by yellowish-green petals, green petals, and finally no petals.

4. The characteristic "breaking fruit" which is adapted for dispersal by wind.

## ACER PSEUDO-PLATANUS (*Linn.*).—Sycamore (*Aceraceæ*)

The Sycamore is recognised by its pendent tassel-like inflorescences; its opposite palmate leaves, whose blades are pallid bluish-green on the lower face, and show very narrow acute angles between the lobes; and finally by the character of its fruits, whose seed-containing parts are nearly globular, and whose wings diverge obliquely (not in a straight line), and taper from above downwards.

**Distinctive Features.**

Fig. 345.—Bark of Sycamore.

The Sycamore, which may attain a height of sixty feet, shows a crown of variable form. Its bark remains smooth for a long time, but finally becomes rough and flakes off in larger or smaller scales (Fig. 345).

The successive pairs of opposite leaves stand at right angles to one another, so that

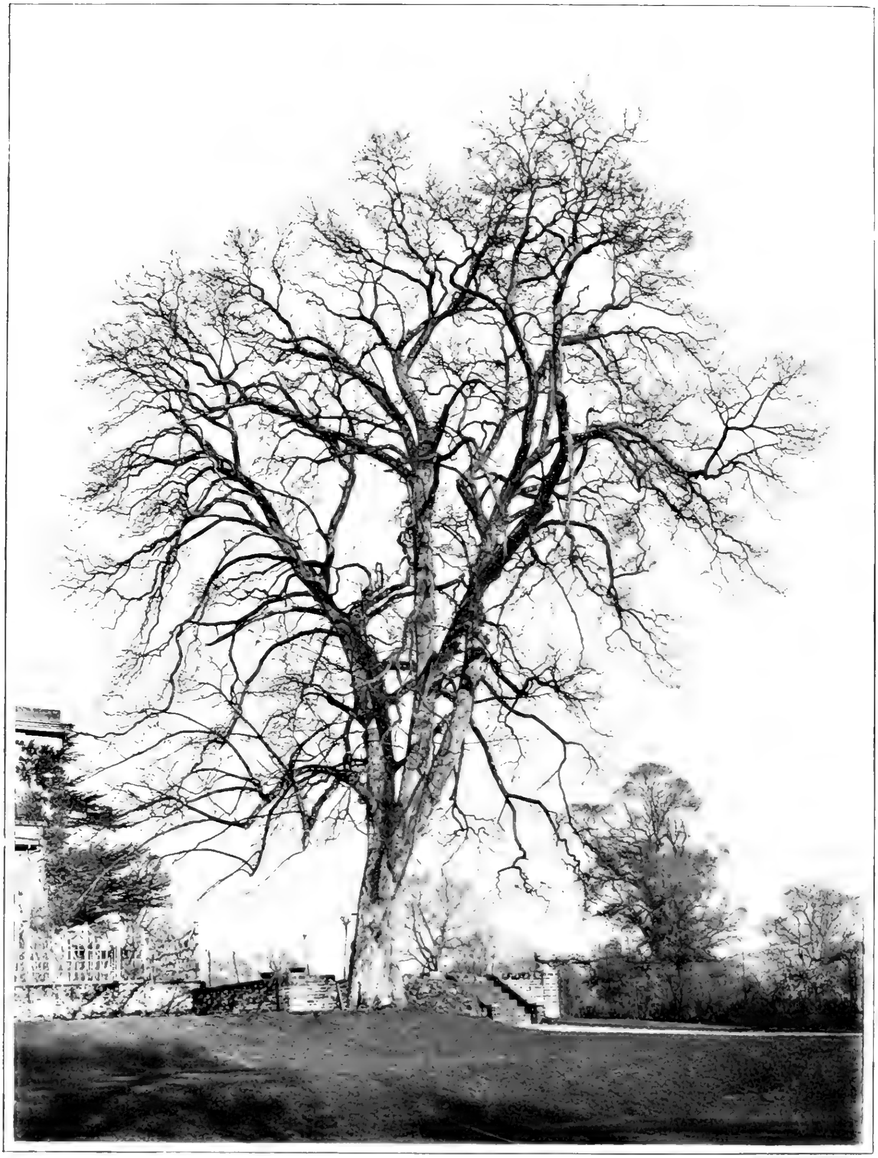

Fig. 346.—SYCAMORE—*ACER PSEUDO-PLATANUS:* WINTER.

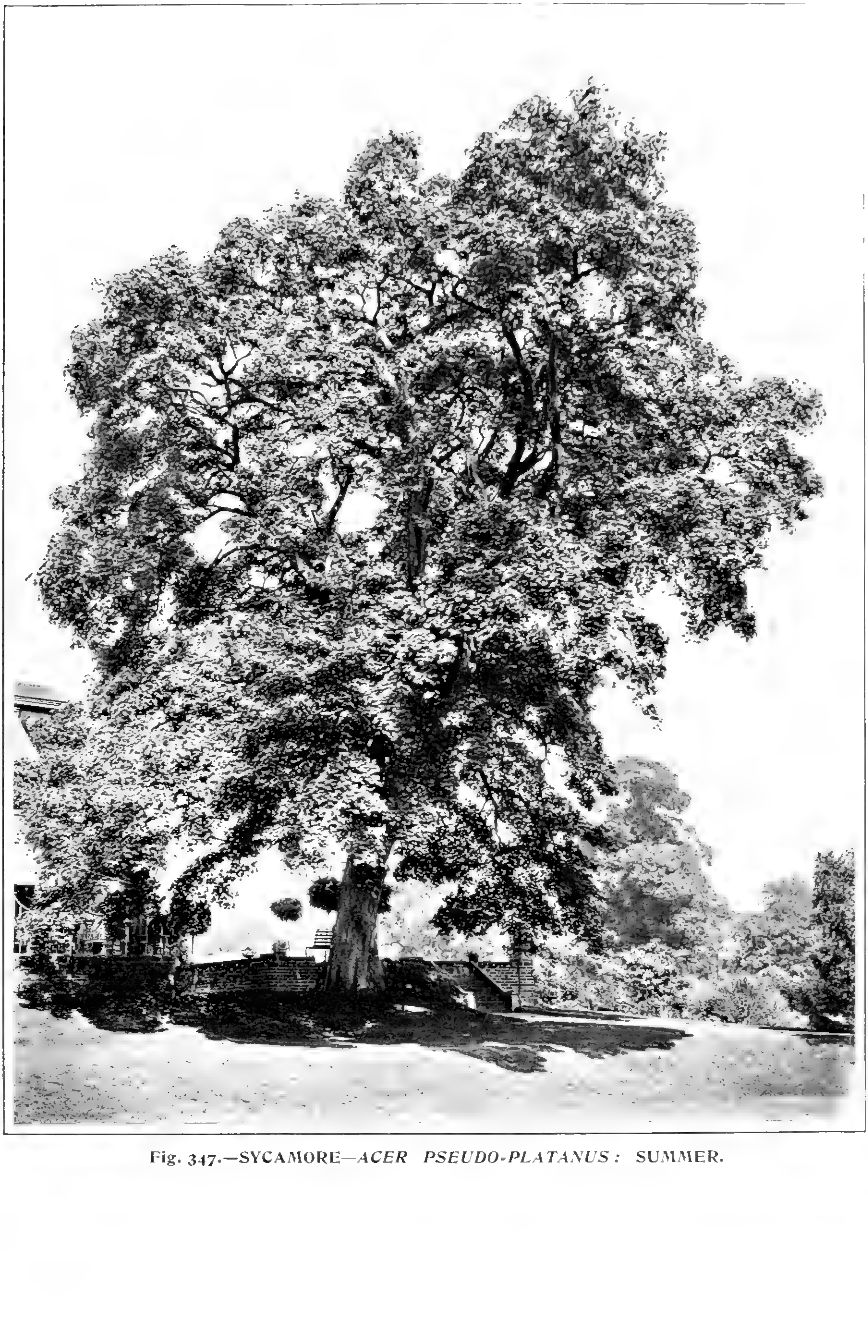

Fig. 347.—SYCAMORE—*ACER PSEUDO-PLATANUS:* SUMMER.

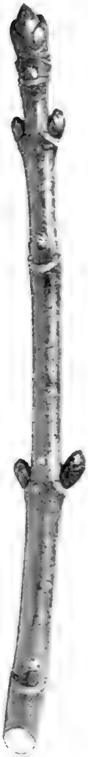

Fig. 348.—Twig of Sycamore in Winter.

**Leaves.**

there are four ranks of leaves. The leaf possesses no stipules, but shows a broad base which extends so far round the stem as to meet that of the opposite leaf. The long, often red, leaf-stalk terminates in a blade that is usually five-lobed, and is from four to eight inches in diameter. The lobes are shortly pointed, indented with blunt teeth, and separated by narrow (acute) angles (Fig. 349). The blade is glossy and dark green on the upper face, but dull and of a light bluish-green on the lower face, so that this play of colour renders the tree recognisable at a considerable distance. Though the young leaf shows white hairs fringing the larger veins, the hairs ultimately vanish except in the angles at which the larger (secondary) nerves meet the largest (primary), where they form tufts ("domatia") comparable with those of the Alder and Lime.

Fig. 349.—Shoot of Sycamore.

On a horizontal or inclined branch there are naturally two ranks of leaves along the sides, and one rank along the upper face and another along the lower face. The stalks of the two latter series elongate to different degrees, and bend so that the blades fully expose their upper faces to the

Fig. 350.—Opening Buds of Sycamore, early stages.

light; moreover the leaves inserted on the lower face have larger blades than those on the upper face.

The leaves become particularly stiff when mature; their autumnal tint is yellow.

Fig. 351.—Opening Buds of Sycamore, later stages.

**Buds.** The large resting-buds (Fig. 348) display several pairs of scales arranged at right angles. The lateral buds of the Sycamore stand out from the twig, and are not applied close against the latter as in the Norway Maple. When the bud becomes active (Figs. 350–1) the innermost scales behave somewhat like foliage-leaves by elongating considerably, and often show at their tips distinct little leaf-blades. A still smaller leaf-blade is shown by each of the outer scales in the form of a discoloured narrow tip. The buds at the end and on all four faces of the inclined branches may grow out, but the branches on the upper and lower faces are usually small and short-lived, so that older inclined shoots merely bear branches on their flanks (just as if the leaves were two-ranked); on erect shoots vigorous branches spring from all four faces.

At an age of twenty or thirty years the Sycamore produces flowers which open in May after the leaves have appeared. The inflorescence is prepared during the previous year, but during winter re-

**Inflorescence.** mains concealed within a large resting-bud. Such a bud grows out into a shoot bearing two or four foliage-leaves, and a many-flowered pendulous green inflorescence (Fig. 351–2). The inflorescence shows several interesting features: (1) At its base it is branched, and the branches themselves may be ramified, their

Fig. 352.—Inflorescences of Sycamore.

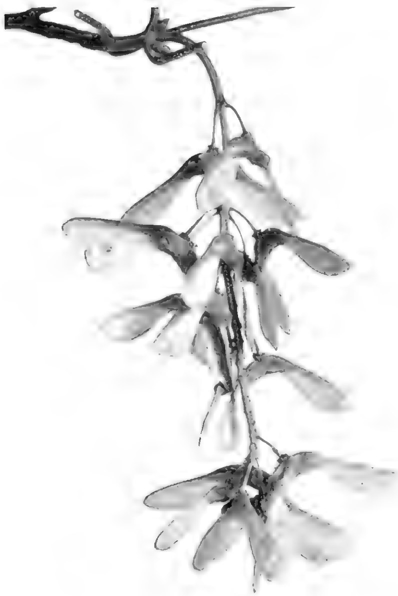

Fig. 353.—Fruits of Sycamore.

ultimate branches being flowers; but as the main inflorescence is ascended its branches become shorter and simpler, until towards the top they are merely stalked flowers. Thus this inflorescence shows a gradual transition from a branched one to a simple one. (2) Low down the main inflorescence bracts are to be seen as very small scales, but elsewhere they are wanting except possibly in the form of minute lumps subtending the individual flowers. (3) The main inflorescence ends in a flower that is the first to open. (4) Some individual trees bear exclusively male flowers, and therefore produce no fruit; others possess both male and female flowers.

**Flowers.**

Each lateral flower has a long stalk. Its perianth consists of five narrow green sepals, and five narrower green petals. Directly within lies a yellowish fleshy cushion surrounding the centre of the flower—this is the *disk*, which glistens with drops of nectar. The stamens are inserted singly in pits on the upper face of the disk. All the flowers show the characters so far described, but there are male and female flowers.

**Male Flower.**

The male flower includes from eight to twelve stamens, whose filaments are long enough to thrust the anthers beyond the petals. In the centre is a green, hairy, sterile lump, which is the only trace of a pistil.

**Female Flower.**

The female flower possesses only eight smaller stamens, which have filaments so shortened that the anthers do not project beyond the petals. These anthers contain pollen, yet they never open: here, then, is a remarkable case of a now useless organ which nevertheless preserves much of its original structure. In the centre of the flower are the two united carpels forming a superior pistil that extends completely across the flower. The two-celled ovary is laterally compressed and contains two ovules in each chamber. The single style divides into two branches which diverge and curl outwards. Thus the female flower presents the deceptive appearance of being bisexual, because its functionally paralysed stamens are still preserved.

The flowers are pollinated by the aid of insects. Though the flowers are individually inconspicuous, yet massed together they form noticeable yellowish-green tassels that hang clear of the leaves; moreover, the yellow disk advertises the easily accessible superficial nectar. The flowers are visited by bees and flies. Cross-pollination is favoured by the separation of the male and female flowers not only in space, but also in time, for the male flowers mature before the stigmas are receptive.

**Fruit.**

After pollination the sepals and petals close over the ovary which develops into the characteristic fruit (Fig. 353). This, when ripe, has two wings which taper from apex to base, and are not extended horizontally in a straight line. One ovule in each chamber has enlarged to produce a rounded seed which fills the globular fruit-chamber. When fully ripe the two halves of the fruit break apart without opening, so that there are now two closed one-winged, one-seeded half-fruits. These, when dropped from a height, descend slowly with a spinning movement, and are evidently designed for dispersal by wind.

**Seed.**

The seed is wholly occupied by the embryo, which is green even inside the seed. In germination the long strap-like cotyledons unfold and appear above the ground, but the half-fruit is often raised aloft while they are still partly inside it. The cotyledons are succeeded by toothed but unlobed primary green leaves.

Its dead and dying yellow leaves in autumn often show black patches; these are caused by an internal fungus (*Rhytisma acerinum*) which ripens its infecting spores in the fallen dead foliage; so that the Sycamore may be protected from infection by burning the leaves in autumn. Little, hollow, red, erect outgrowths are very common on the leaf, and are due to a mite (*Phytoptus*).

## ACER PLATANOIDES (*Linn.*).—Norawy Maple (*Aceraceæ*)

**Distinctive Features.**

The Norway Maple differs from the Sycamore in the following respects: the leaf-blades are of the same colour on both faces, their lobes are separated by wide open angles and are long-pointed, as are the teeth; the inflorescences are erect; the two wings of the fruit are directed apart, nearly in a straight line, and do not taper markedly to the base; moreover, the seed-containing part of the fruit is flattened (not globular).

The tree is Sycamore-like in form, but its bark instead of becoming scaly is eventually scored with relatively fine longitudinal furrows (Fig. 357).

The large leaves (Fig. 354), which show five or seven lobes, are hairless and glossy on both faces. They are arranged as in the Sycamore.

The resting-buds are also similar to those of the Sycamore, but the lateral ones are closely applied to the stem (Fig. 358).

Fig. 354.—Shoot of Norway Maple.

**Flowers.**

The erect inflorescences, which appear in April or May before the foliage is visible, terminate shoots of the current year. They are richly branched and the constituent stems elongate so as to bring all the blossom up to a gently curved surface (Fig. 359). The inflorescence may consist wholly of male or female flowers, or of both together.

Fig. 355.—NORWAY MAPLE—*ACER PLATANOIDES:* WINTER.

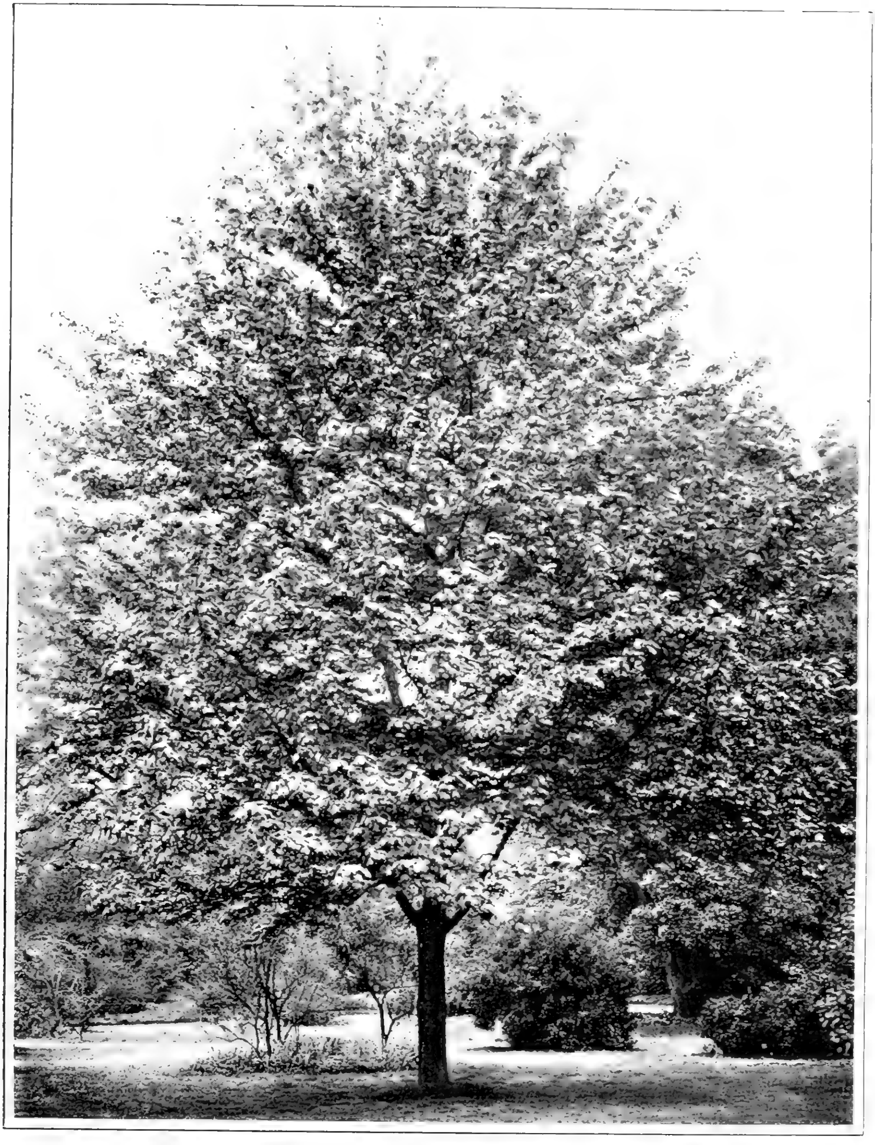

Fig. 356.—NORWAY MAPLE—*ACER PLATANOIDES*: SUMMER.

and as a rule all the inflorescences on a single tree are of the same type; consequently male, female, and bisexual trees occur. The terminal bud which gives rise to the inflorescence behaves much as in the Sycamore, so that foliage-leaves ultimately unfold on the year's-shoot, below the inflorescence. As the terminal growth of this flowering-shoot is arrested by the inflorescence, often one of its lateral buds develops in the same year into a foliaged branch, and thus atones for that arrest.

In structure and behaviour the flowers agree with those of the Sycamore, though there is a greater difference between the sepals and petals as regards form.

Fig. 357.—Bark of Norway Maple.

As the masses of yellow-green flowers appear before the leaves they are conspicuous and give to the Norway Maple an unequalled freshness of appearance in spring. Bees are responsible for cross-pollination.

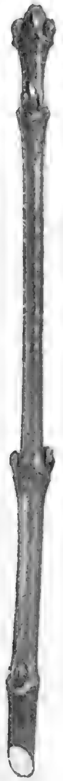

Fig. 358. Twig of Norway Maple in Winter.

**Fruit and Seed.**

In general structure of fruit and seed, as well as in type of germination, the Norway Maple agrees with the Sycamore, though it exhibits the already-mentioned differences in shape of fruit (Fig. 344), and other differences in shape of the primary leaves. (Occasionally, especially in young trees, the wings of the fruit incline upwards, and are not horizontal; but in this case their shape and the flat form of the seed-containing part are unmistakable.)

*Acer platanoides* is not a British tree. Its leaves, with long "dripping-tips" from which water rapidly drips, suggest at once to the expert what is the fact, that it will endure a very moist atmosphere.

Fig. 359. Inflorescences of Norway Maple.

Two other exotic Maples, occasionally seen in English gardens, are *Acer saccharinum* (Linn.) and *A. rubrum*, which belong to Canada and the United States. Like the Norway Maple, they open their flowers in spring before the leaves are visible; but in fruit they rather recall the Sycamore. But one interesting and distinctive feature is that their inflorescences spring laterally from twigs produced during the immediately preceding year. *A. saccharinum* has reddish or greenish-yellow sepals, but usually no petals; its deeply five-lobed leaves become yellow in autumn. *A. rubrum* possesses petals, and deserves its name of "Red Maple" because of its reddish flowers, and scarlet or orange autumn-tinted leaves.

Fig. 360.—COMMON MAPLE—*ACER CAMPESTRE:* WINTER.

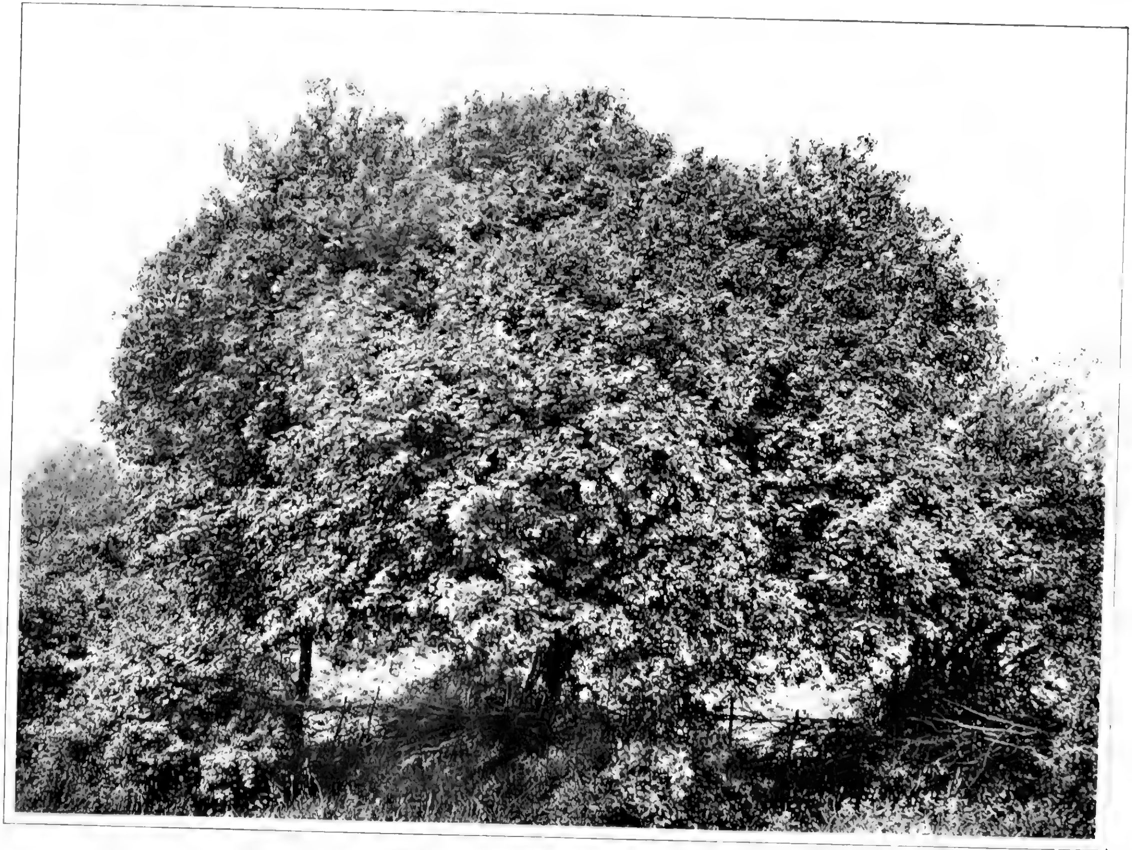

Fig. 301. COMMON MAPLE *ACER CAMPESTRE*: SUMMER.

## ACER CAMPESTRE (*Linn.*).—Common Maple (*Aceraceæ*)

The Field Maple differs from the two preceding species in the smaller dimensions of the whole tree, and of its leaves and fruits. In shape of inflorescence and fruit it agrees with the Norway Maple, but differs in its small blunt-lobed leaves, which serve also to distinguish it from the Sycamore as their colour is the same on both faces.

**Fig. 362.—Bark of Common Maple.**

**Height.** The tree rarely exceeds a height of thirty-five feet, and much more commonly reaches only from ten to twenty feet. It has spreading branches, and often assumes a shrub-like form when growing in hedges.

The bark (Fig. 362) is divided into scales by numerous fine fissures.

Fig. 363. Twig of Common Maple in Winter.

The small leaves (Fig. 12), only two to four inches in diameter, show three or five lobes, which are scarcely glossy. They are arranged as in the two preceding species. The lateral resting-buds are applied closely to the stem (Fig. 363).

The erect greenish-yellow inflorescences (Fig. 364) appear in May after the leaves have expanded; they are arranged and shaped like those of the Norway Maple, but are smaller and include fewer flowers. The flowers agree in type with those already described. The fruits (Fig. 365) have horizontal or even downwardly-curved wings; they differ from the similar fruits of the Norway Maple in smaller size, and in less flattened seed-containing parts.

**Flowers and Fruit.**

Fig. 364.—Inflorescence on Common Maple.

The Common Maple is a native of England and Ireland.

Fig. 365.—Fruits of Common Maple.

## ACER NEGUNDO (*Linn.*).—Ash-leaved Maple (*Aceraceæ*)

This American tree owes its popular names of "Ash-leaved Maple" and "Box Elder" to its pinnately compound leaves, each consisting of three or five leaflets. The leaves, together with the characteristic maple-fruits, and the completely unisexual flowers which are devoid of petals, render recognition of the tree an easy matter.

The low-branched tree may attain a height of from sixty to seventy feet, and acquire a rough scaly bark at the base of its trunk (Fig. 366), which sometimes attains a diameter of four feet. The wide-spreading boughs bear overhanging branches whose drooping habit gives to the tree a very graceful form.

Fig. 366.—Bark of Ash-leaved Maple.

**Leaves.** The opposite pinnate leaves exhibit the shapes illustrated in Figs. 58 and 367, but sometimes the leaf has only three leaflets. Each separately-stalked leaflet, when young, is coated with an obvious covering of hairs, which are more or less completely cast off as the leaf matures. One detail worthy of note is the conspicuousness of the leaf-scars when the yellow autumn-leaves and bud-scales have fallen (Fig. 23).

Fig. 367.—Leaves of Ash-leaved Maple.


Fig. 368. Male (♂) and Female ♀ Inflorescences of Ash-leaved Maple.

**Flowers.** The inflorescences spring from the shoots in a manner very different from that habitual to the Sycamore, Norway Maple, and Common Maple, as they are lateral in position. Certain resting-buds on the sides of the long-shoots develop into pendent, flowering dwarf-shoots, which take the form of tufted male or loosely branched female inflorescences (Fig. 368). The male and female flowers are usually on different individual trees, and open before or when the leaves expand.

The peculiar feature in the flowers is the absence of petals and of a disk. In both kinds there are five (occasionally three or four) sepals. The male flowers hang from long slender stalks; and each has a bell-shaped calyx, within which are only five (occasionally three or four) stamens that project far beyond the sepals, but there is no vestige of a pistil. The female flower includes no traces of any stamens, but contains a pistil which protrudes far beyond the small sepals.

Fig. 369.—ASH-LEAVED MAPLE—*ACER NEGUNDO:* WINTER.

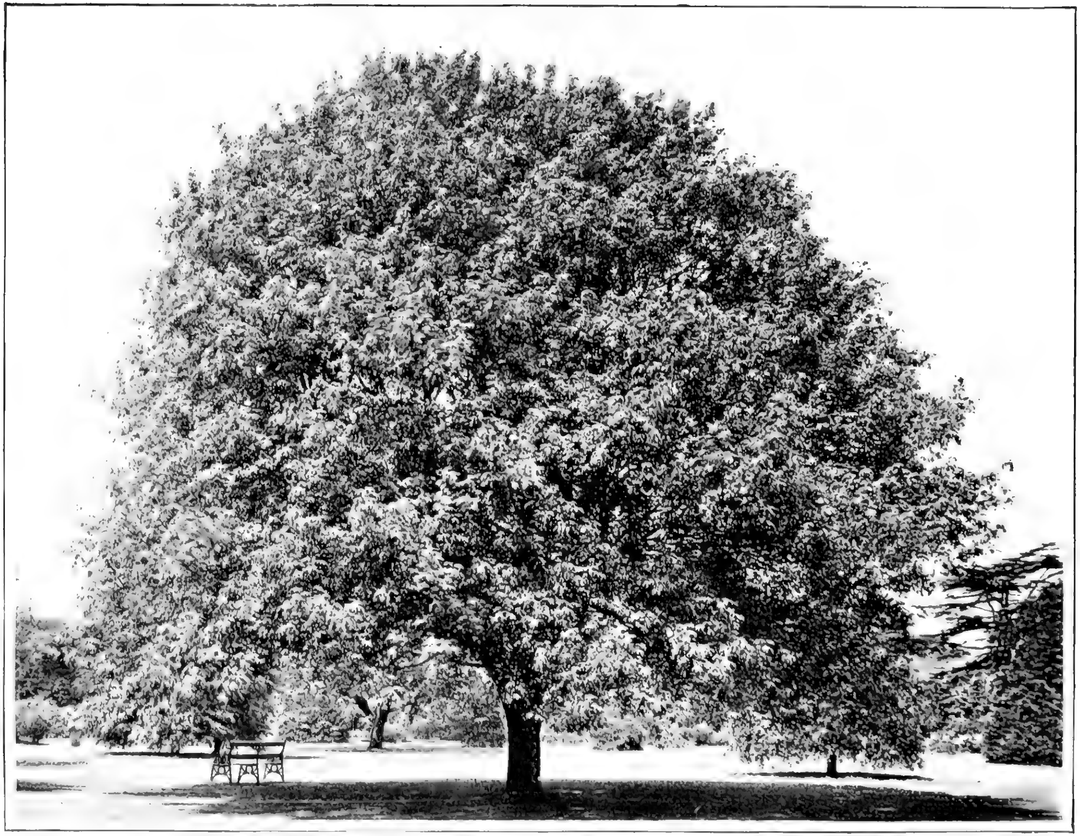

Fig. 370. ASH LEAVED MAPLE *ACER NEGUNDO*: SUMMER.

Fig. 371.—Fruits of Ash-leaved Maple.

The two wings of the fruit are directed nearly vertically (Fig. 371).

It may here be mentioned that a "variety" with partly white leaves is a very decorative tree, common in gardens. The ancestral type of the Ash-leaved Maple is, of course, the entirely green form: accordingly, shoots of the variegated tree often "throw back" or revert to the original form in such a way that the same individual tree displays many branches bearing variegated foliage, interspersed with a smaller number of green-foliaged shoots.

# HIPPOCASTANACEÆ

## ÆSCULUS HIPPOCASTANUM (*Linn.*).—Horse Chestnut (*Hippocastanaceæ*)

The Hippocastanaceæ agree with the Aceraceæ in many characters, but differ in that the opposite *leaves* are *palmately compound*, the *flowers irregular and showy*, the *ovary three-chambered*, and in that the *fruit spontaneously opens by three valves*. The general characters of the family are sufficiently indicated by the Horse Chestnut.

The tree is recognised by the family characters already enumerated, by its large, glistening sticky buds, its beautiful erect conical inflorescences, its spiny green fruits, and characteristic large seeds each marked by a large scar.

**Form.** The tree rises to a height of perhaps sixty feet, showing a very shady oval-pyramidal crown that may extend nearly to the ground. From the base of the bole may rise recent young shoots. The bark remains smooth for many years, but eventually becomes furrowed and scaly (Fig. 372), and may clothe a trunk one yard in diameter.

**Leaves.** The large palmately compound leaves are opposite, and in four ranks (Fig. 381), those of the horizontal branches being on the two flanks, and on the upper and lower faces. The leaves inserted on the lower face of a branch possess larger blades than the others. The leaf has no stipules; its broad base narrows above into a long leaf-stalk, at the somewhat widened summit of which are attached the latter, and by adjustment of the angle at which they stand in reference to it. In autumn the leaflets show tints ranging through green and yellow to red, and may fall off separately.

**Fig. 372.—Bark of Horse Chestnut.**

from three to nine leaflets. The leaflets themselves are stalkless, have double saw-like teeth and a sharp tip, and are broadest towards their ends; they acquire a horizontal position fully exposing them to the light, by variations in the length and direction of the leaf-stalk, by twisting of

**Buds.**

The large resting-bud exhibits four ranks of balsam-coated, glistening scales, which are ranged in pairs at right angles. On the leafless coarse twigs in winter (Fig. 375) the lateral buds stand in the axils of very large leaf-scars, which, unlike those of the coarse-twigged

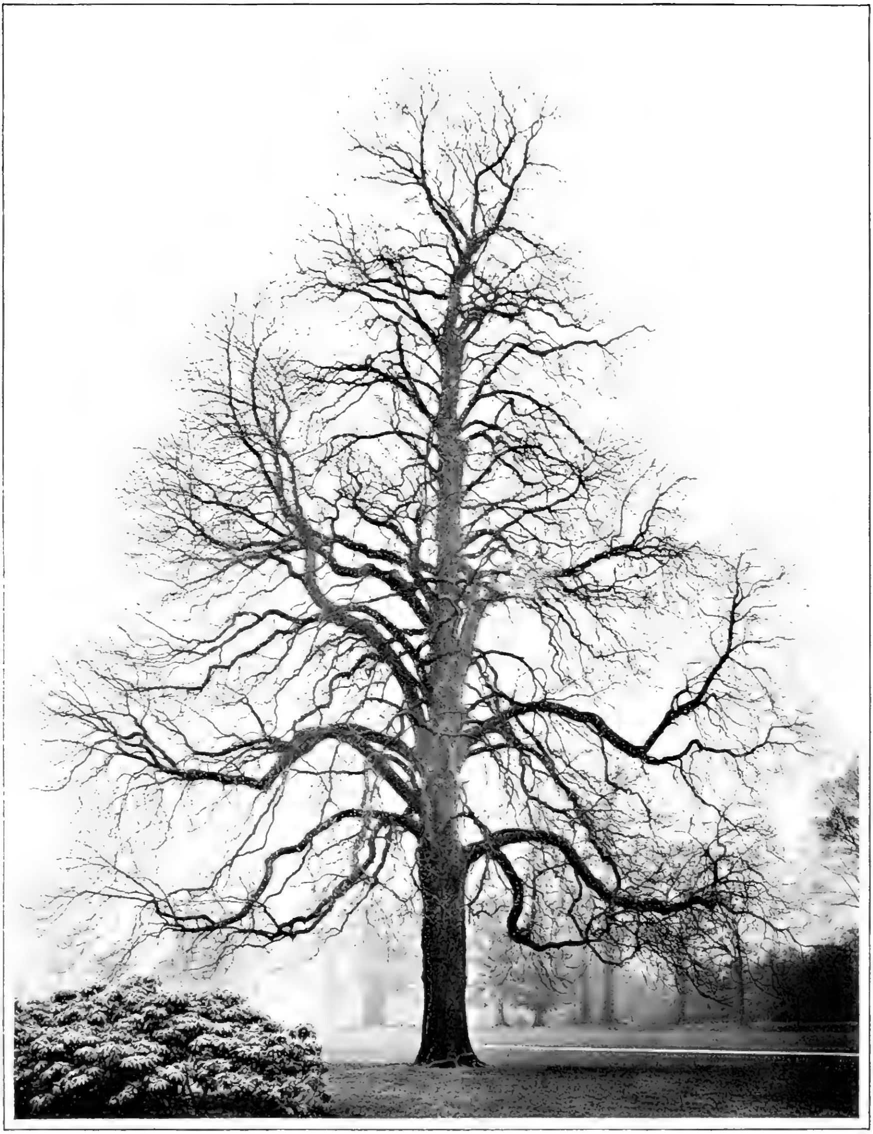

Fig. 373.—HORSE CHESTNUT—*ÆSCULUS HIPPOCASTANUM*: WINTER.

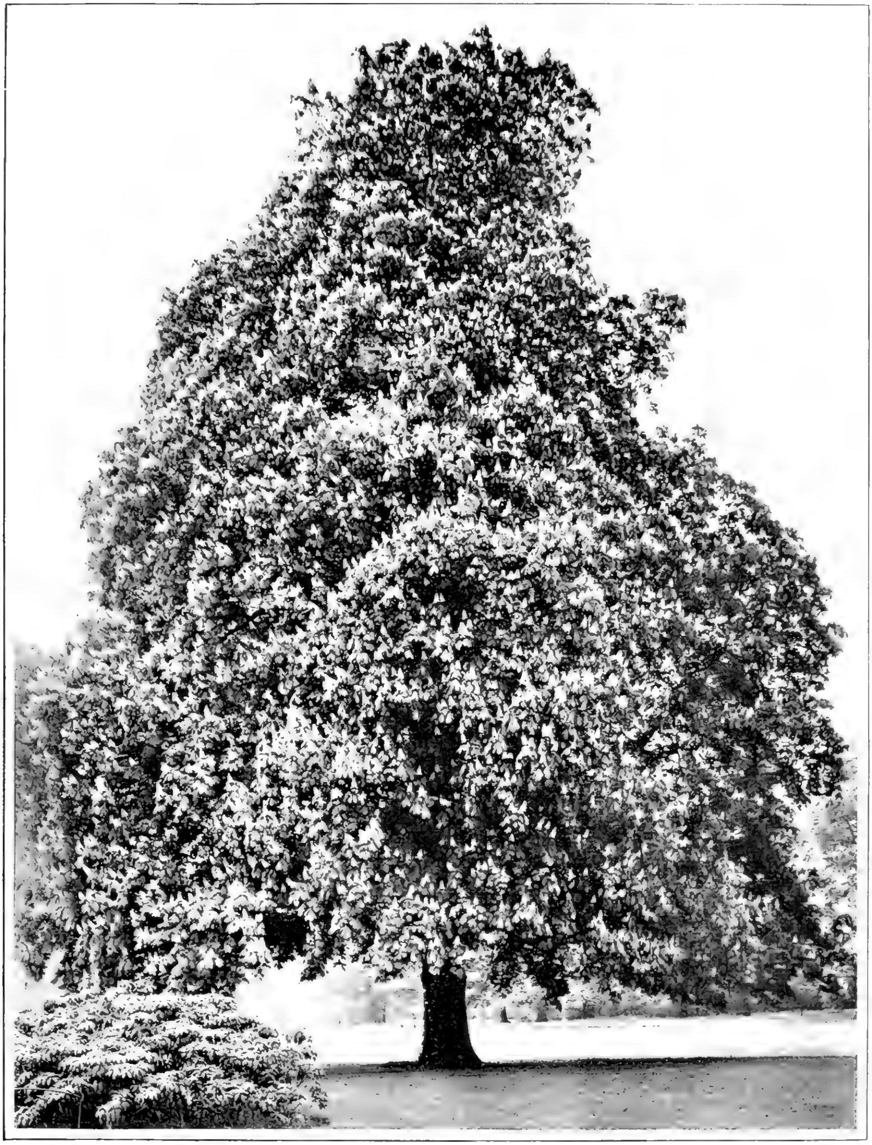

Fig. 374.—HORSE CHESTNUT—*ÆSCULUS HIPPOCASTANUM*: SUMMER.

Ash, are not raised above the general surface.

The terminal resting-bud encloses a number of scales, also some foliage-leaves which are densely clothed in white woolly hairs, and perhaps a young completely modelled inflorescence.

**Opening Buds.**

Figs. 376–79 show stages in the opening of a bud. As the bud opens its inner scales grow greatly in length and bend back; at the same time the young little foliage-leaves perched on short erect leaf-stalks emerge with their erect leaflets closely folded along the middle and side nerves (Fig. 376). As the leaf-stalk lengthens the leaflets gradually spread open and bend down, so as to acquire a horizontal (Fig. 377) and subsequently a drooping pose that causes the young leaf to present the appearance of a half-closed umbrella (Figs. 378 and 379). Afterwards the leaflets rise up, completely smooth away their creases by spreading fully open, and acquire their final horizontal pose (Fig. 381). In the meanwhile the white hairs clothing the young leaves have shrivelled, become rust-coloured, and are then detached, so that the general coating of hairs is represented only by a few rusty hairs remaining at the widened tip of the leaf-stalk.

**Branching.**

The year's-shoot which thus develops from a bud may bear foliage alone or also flowers. Terminal and lateral buds may grow out into purely vegetative branches; in such a case the lateral ones on horizontal branches spring almost exclusively from the flanks, for the buds on the upper and lower faces generally remain dormant or give rise to feeble little shoots which soon die. Only large terminal resting-buds enclose inflorescences. Such a bud produces a shoot that bears a few foliage-leaves and terminates in an inflorescence (Fig. 379). Thus the terminal growth of the shoot concerned is henceforth impossible, but this disadvantage is atoned for by the activity of a bud which arises in the axil of a foliage-leaf close beneath the inflorescence, and which shoots out, even bearing foliage-leaves in its first year (see Fig. 380, where the bud is denoted by the mark 1); the active bud in question springs from the lower face of the branch. The horizontal branches of the Horse Chestnut are therefore "false stems" made up of successive generations of branches strung end to end.

**Inflorescence.**

The tree flowers at ten or fifteen years of age, and regularly thereafter, in April or May. As the inflorescence is already prepared in the previous summer, it may precociously emerge in a mild autumn.

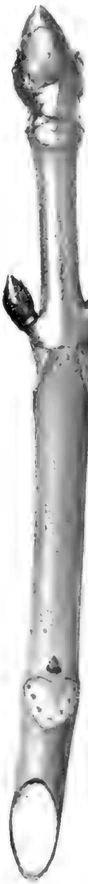

**Fig. 375.—Twig of Horse Chestnut in Winter.**

The erect conical inflorescence is compound. The main inflorescence - stem bears branches, the secondary inflorescences, which are distinctly curled at their ends when young. The flowers and lateral inflorescences being adequately protected in youth by the surrounding leaves and by their close packing, protective bracts become superfluous and are suppressed.

The flowers are not all alike. In a secondary inflorescence the lowest flowers, which also open first, are male; above

Fig. 376. Opening Buds (Stages 1, 2, and 3) of Horse Chestnut.

these may be flowers with fertile ovaries: and at the tip there are tiny flower-buds which never open, but become brown and drop off.

**Flowers.** Each flower, though irregular, can be divided into two equal similar halves, and stands horizontal. The five joined sepals ensheath the unopened flower in a bell-shaped envelope, which bursts irregularly when the flower opens. There are usually only four separate petals not differing greatly in shape, but the two back (upper) ones have larger yellow spots than the two side (lower) ones possess: the fifth petal, which should be present in front, is small or missing. The yellow spots are seen only in moderately young flowers, as they eventually become pink. Immediately within the petals lies the ring-like disk, which is larger at the back of the flower where

Fig. 377. Opening Bud (4th Stage) of Horse Chestnut.

nectar, which it excretes, accumulates. Inserted distinctly within the disk are from five to eight (usually seven) stamens, each of which has a long bent filament and a flesh-coloured anther, which easily moves as it is attached to the filament by a very thin joint. In the centre of the male flower is a white column-shaped body, which has no style, but possesses a feeble, discoloured stigma and a three-chambered ovary devoid of ovules: this, then, is a rudimentary pistil. But in bisexual flowers, which also have fertile stamens, and in female flowers, whose sterile stamens fall before

Fig. 378.—Opening Bud (5th Stage).

Fig. 379.—Opening Bud (6th Stage), also showing Young Inflorescence.

their anthers open, the pistil shows three carpels joined to form a swollen three-chambered ovary, a single long style, and a point-like stigma; and each chamber of the ovary contains two ovules. Thus, as in the Maples, flowers owe their unisexual nature to incomplete development of stamens or carpels.

**Pollination.**

Very conspicuous are the flowers massed together at the ends of the twigs in inflorescences, whose dominant creamy-white is flecked with yellow and pink. They are pollinated by the agency of humble-bees. Cross-pollination is favoured and self-pollination obstructed by the circumstances: (1) that the inflorescence is practically male at the commencement, as the male flowers open first; (2) that bisexual flowers are female in early life, because the stigma is receptive before the anthers are ready to open. In these latter flowers the style at first stands out horizontally, while the immature stamens are bent downwards; later on the stamens sweep upwards, and their open anthers occupy a position very near to the stigma; finally, the stamens with emptied anthers retreat downwards once more. Thus a humble-bee entering a bisexual flower in its second stage, and passing to one in its first stage, will strike the anthers and stigma respectively with the same part of the under-surface of its body, as it thrusts its tongue into the space at the base of the back (upper) petals.

The ovary develops into a rounded, spiny, green fruit (Fig. 381), which has a somewhat thick, fleshy wall that splits into three valves. The fruit may contain from one to three seeds, but usually only two. The large seed is covered by a coat which is brown and polished except where the relatively huge, dull scar is. Though somewhat similar in appearance to the edible chestnut, it differs in being a seed, which is produced


**Fig. 380.—Inflorescence of Horse Chestnut.**

**Fruit and Seed.**

**Fig. 381.—Fruits and Seeds of Horse Chestnut.**

inside a ripened ovary (the edible chestnut is itself a ripened ovary). The seed is wholly occupied by the embryo, the greater part of which is formed by the two large thick cotyledons, and the root of which lies in a peculiar little pocket formed by the infolding of the seed-coat. When the seed germinates the cotyledons remain below ground, and the rapidly-growing main stem at once produces ordinary foliage-leaves.

The Horse Chestnut is not a native of Great Britain, but was probably introduced into Europe from Asia Minor.

Double-varieties of the tree are in cultivation, and suggest that the additional petals are produced at the expense of the stamens, as intermediate stages between petals and stamens occur in such double-flowers.

Among the Horse Chestnuts in cultivation, some species belong to the sub-genus *Pavia*; these have no stiff spines on the ripe fruit, possess resting-buds that are dull in surface and not sticky, and have their leaflets attached to the common leaf-stalk by distinct stalks. One such species is the purple-flowered *Æsculus Pavia*. This must not be confused with the common red-flowered hybrid known as *A. carnea* (*A. rubicunda*), which is obtained by crossing *A. Hippocastanum* and *A. Pavia*, and has leaves like those of the former.

# AQUIFOLIACEÆ

## ILEX AQUIFOLIUM (*Linn.*).—Holly (*Aquifoliaceæ*)

The Holly-tree is the solitary British representative of its family, the Aquifoliaceæ, whose characters are sufficiently indicated by those of its flowers.

Fig. 382.—Bark of Holly.

Though often a shrub, the Holly may become a tree forty feet in height and possessing a single trunk which is coated with a smooth ashen bark (Fig. 382). Its branches may extend almost to the ground, and are themselves densely branched, so that the tree, with its evergreen foliage, casts deep shade. The plant freely emits branches from the base of the trunk and from younger shoots, and hence endures repeated clipping.

The spirally-arranged simple leaves are tough and evergreen, and live for some—

Fig. 383.—Shoots of Holly.

often four—years.* The leaf-blade is prickly on the lower parts of the tree, but frequently unarmed elsewhere (Fig. 383). It is suggested that the prickles protect the tree from large browsing mammals such as cattle, and are therefore superfluous excepting within reach of these. The leaf is stalked and has at its base two minute dark-pointed stipules.

**Leaves.**

The resting-buds, and especially the lateral ones, are very small. Examining a terminal bud, we see that it is "naked or open," as it lacks any true bud-scales. The outer leaves covering this resting-bud, though stalkless, possess stipules and have toothed margins; and when the bud sprouts they enlarge and remain green, in place of falling off, while the inner bud-leaves grow to a still greater extent and have larger pointed teeth at their margins. In other words, the leaves protecting the terminal bud are in character intermediate between foliage-leaves and scales.

**Buds.**

The Holly can flower at an age of twelve years or perhaps less. Its blossoming season is especially prolonged, as flowers may open at any time between May and August. Close clusters of creamy flowers arise in the axils of leaves of the preceding year, and include male, female, or bisexual flowers. The tree may bear only male or only female flowers, but at least clipped garden individuals may bear all three kinds.

**Flowers.**

The flower (Fig. 386) is regular and hypogynous, and all its parts are in fours. There is a small four-toothed calyx. The four creamy petals adhere at the base, and to this common base are attached the four stamens, which alternate with them. There is no disk. In the male flower the pistil is represented by a central lump which varies in structure, but often is a feeble two-lobed body containing no ovules. In the female flower the four stamens are smaller, and frequently possess white anthers that do not open. The pistil consists of a stigma with four small lobes, a very short style, and a four-chambered ovary containing one ovule in each chamber. The bisexual flowers include perfect anthers and a perfect ovule-containing ovary.

Nectar is secreted within the base of the petals, and is easily accessible to various short-tongued insects which effect cross-pollination.

The red fruit (Fig. 385) is not a berry, but a stone-fruit containing four stones, which are respectively formed by the four chambers of the ovary. The fruits ripen at any date after August, and may hang on the tree during winter. They attract and are dispersed by thrushes,

**Fruit.**

* The statement repeated in various books that the leaves live and remain attached for only about thirteen or fourteen months is probably copied from statistics provided by Continental botanists, who possibly originally were dealing with trees growing under a more rigid Continental climate or in towns.

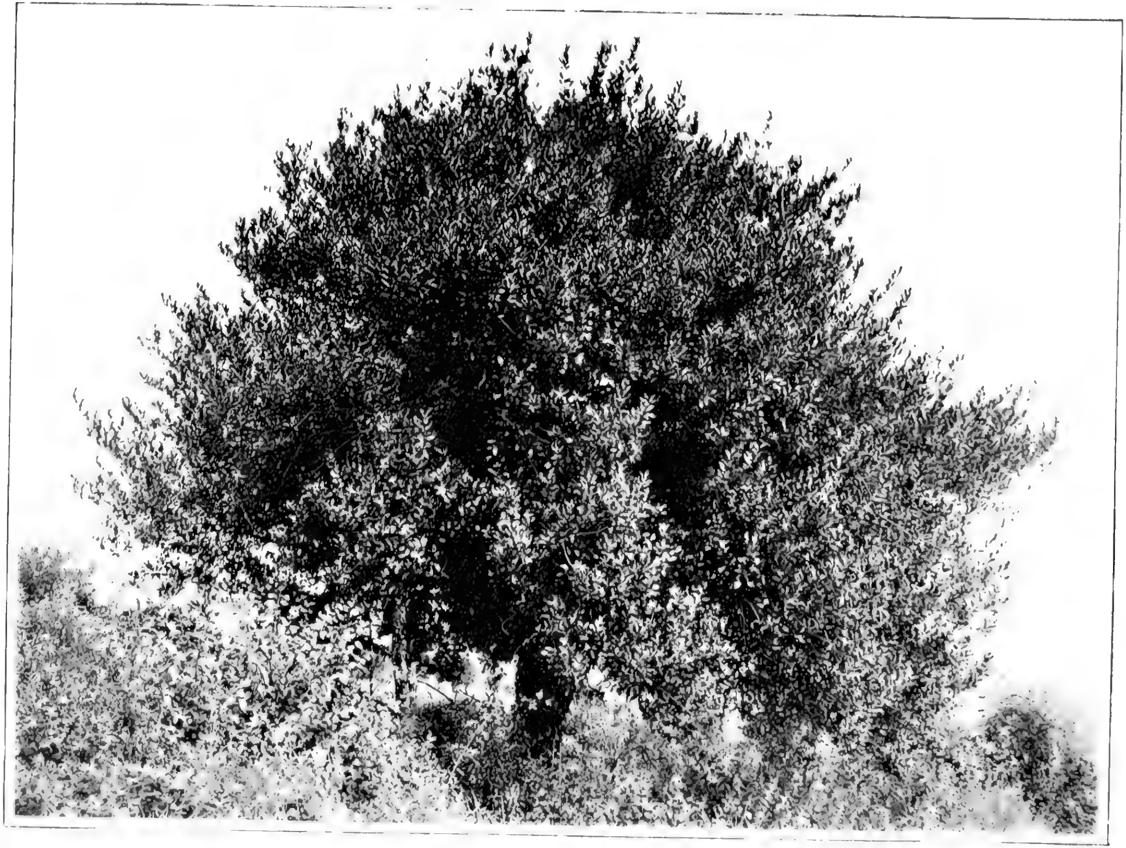

Fig. 384. HOLLY *ILEX AQUIFOLIUM.*

wild pigeons, and partridges, which swallow the fruit. The seed, protected by the "stone," passes uninjured through the bird's body, but during this passage the stone is softened and subsequent germination is thus facilitated.

The seed contains a minute embryo as well as a special store of food-material (endosperm). In germination the green, even-margined, cotyledons emerge from the soil, and are succeeded by small prickle-edged foliage-leaves. The young little plant grows but slowly.

**Seed.**

Fig. 386.—Flowers of Holly.

Fig. 385.—Fruits of Holly.

**Habits.**

The Holly-tree is a shade-enduring tree, capable of growing in forest, as is suggested by its smooth bark, its low-pitched and close branching, the duration of its leaves, the dense shade that it casts, and finally by its slow growth in height. The Holly again illustrates the fact that trees or shrubs which are evergreen in this country possess thick, stiff leaves able to resist excessive loss of water during winter when coldness of soil prevents the roots from absorbing rapidly. But the Holly-tree, though stiff-leaved, is not adapted to a life in dry places; on the contrary, it seems to flourish naturally where the air is moist, as in the island climate of England or near the coast on the Continent. In a continental climate it often dwindles to a mere shrub, as its twigs are regularly nipped by severe winter frosts; in England (*e.g.* in the Forest of Dean) it becomes a good-sized tree.

**Varieties.**

In cultivation there are many varieties of the Holly-tree, including those with yellow or white fruits, those with leaves that are variegated, devoid of prickles, or prickly on their faces as well as at their margins.

# CELASTRACEÆ

## EUONYMUS EUROPÆUS (*Linn.*).—Spindle-tree (*Celastraceæ*)

The Celastraceæ include only one British plant, the Spindle-tree, which is recognised by its inflorescences, the structure of its regular greenish-white flowers, and, above all, by its four-lobed red or purple fruits that open and expose the seeds, each of which has a fleshy orange-coloured coat.

The plant is a shrub or small tree, varying from five to twenty feet in height. Its trunk is eventually clothed by a grey, longitudinally furrowed bark (*see* Fig. 387). The opposite, simple leaves are ranged in four ranks. Each has two minute short-lived stipules, a stalk, and a hairless blade with finely-toothed margins (Fig. 391). The resting-buds, which are small, show several pairs of opposite scales disposed in four ranks (Fig. 390).

**Fig. 387.—Bark of Spindle-tree.**

The greenish-white flowers open in May or June, and are arranged in forked

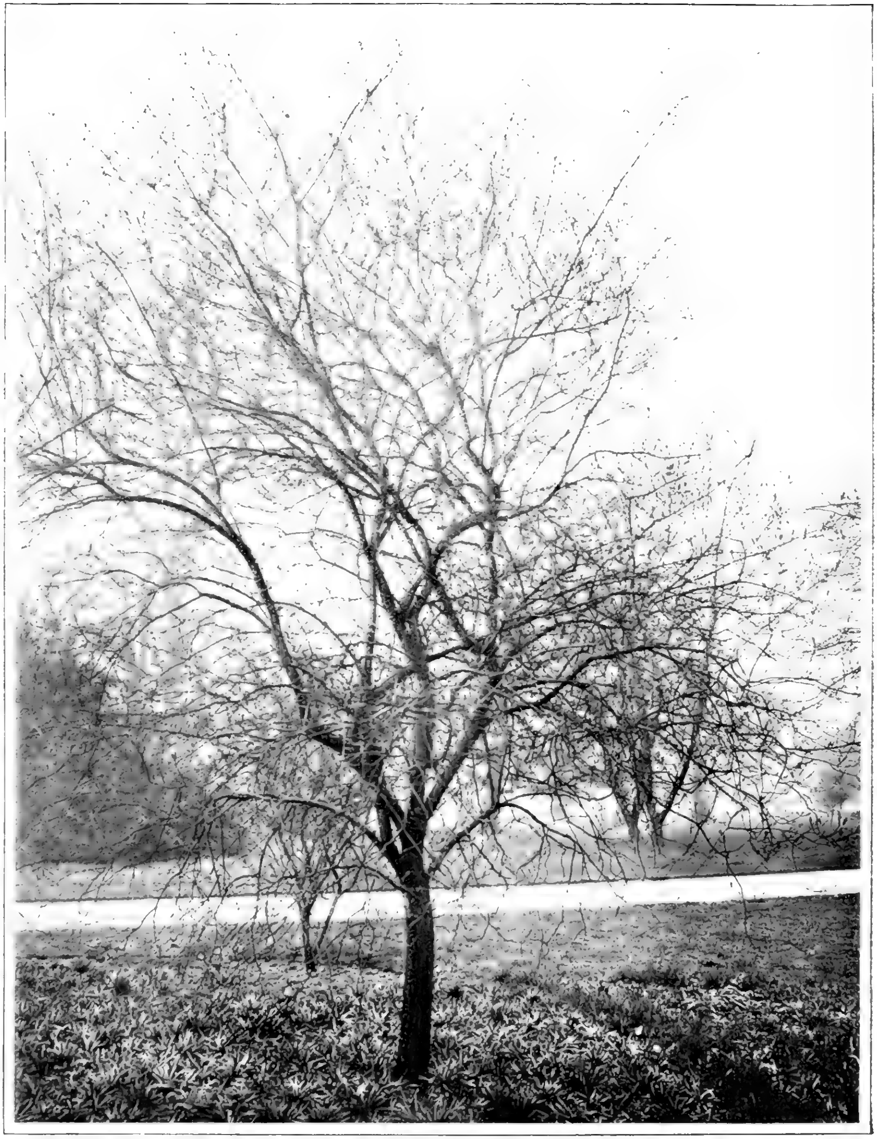

Fig. 388.—SPINDLE-TREE—*EUONYMUS EUROPÆUS*: WINTER.

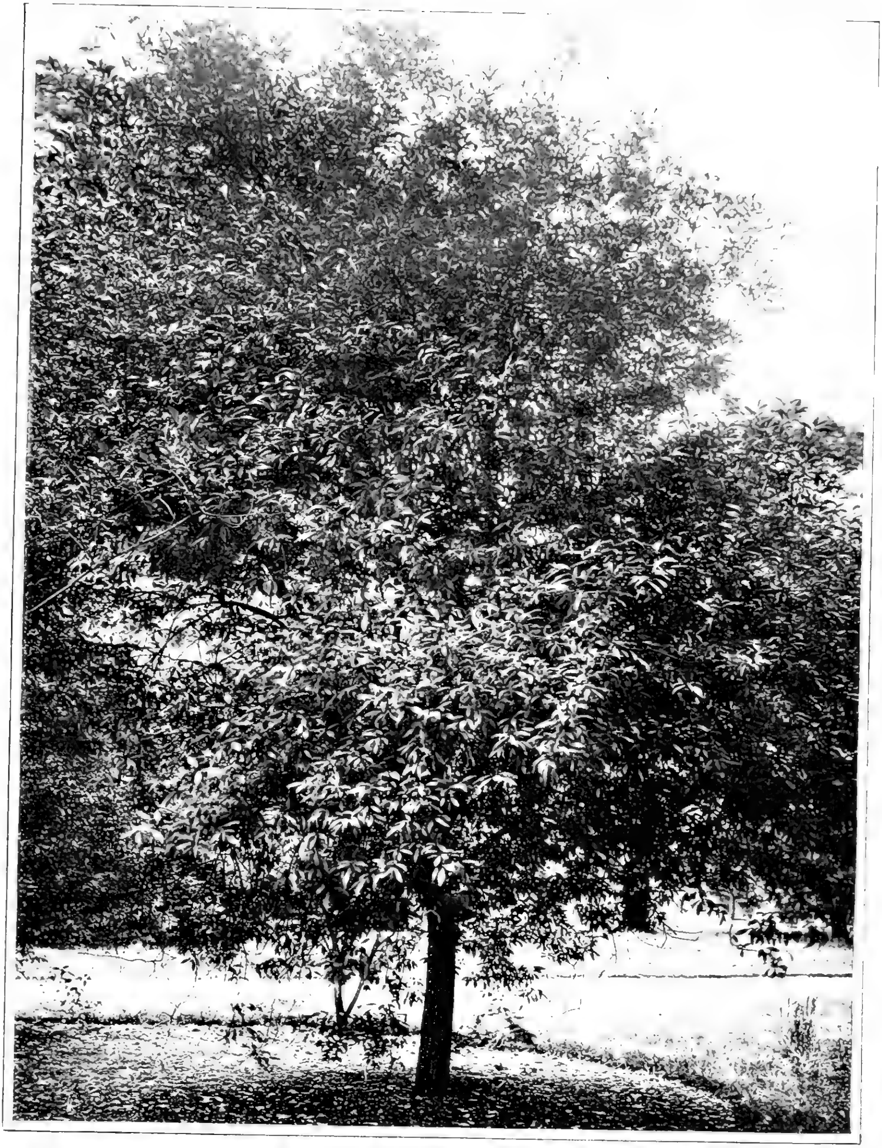

Fig. 389.—SPINDLE-TREE—*EUONYMUS EUROPÆUS*: SUMMER.

inflorescences that spring from the axils of leaves on the current year's-shoot (Fig. 392). Minute bracts are present.

**Flowers.** The bisexual, regular, hypogynous flower has four small green sepals, four greenish-white separate petals, four stamens alternating with the petals and inserted on a swollen green disk, and, rising from the middle of this, the single four-chambered ovary. The ovary terminates in a single style which is capped by a four-furrowed stigma; two ovules are present in each ovary-chamber. In addition to the bisexual flowers, there are, often on the same individual tree, male and female flowers in which the ovaries and stamens respectively are rudimentary.

Fig. 391.—Shoot of Spindle-tree.

**Pollination.** The flowers are relatively inconspicuous, moreover their nectar is easily seen and obtained because it is secreted by the swollen disk, so that cross-pollination is usually effected by flies of various kinds.

In the bisexual flowers the anthers open outwardly before the stigma is receptive,

Fig. 390.—Twig of Spindle-tree in Winter.

Fig. 392.—Flowers of Spindle-tree.

and by this means cross-pollination is favoured even in them; yet self-pollination is subsequently possible.

The ovary develops into a four-lobed rosy-red or reddish-purple fruit (Fig. 393), whose wall splits longitudinally into four valves and exposes the bright orange-coloured seeds.

**Fruit and Seed.**

Fig. 393.—Unopened Fruits of Spindle-tree.

One or two seeds are in each chamber, and owe their orange colour to an additional fleshy coat (false "aril") which covers the true seed-shell (testa).

The seeds are dispersed by birds, which are attracted by the red and orange colours and by the pulpy "aril."

# RHAMNACEÆ. BUCKTHORN FAMILY

The Rhamnaceæ are represented in this country by only two native species of *Rhamnus*, which are recognisable by their small, inconspicuous, green (and white), regular flowers. The flower has an equal number (four or five) of sepals, *separate petals*, and stamens, all of which are attached to the rim of a more or less bell-shaped receptacle; but the crucial character is that *the petals are very small, and each stands directly outside a stamen*, which is thus opposite to (not, as in *Euonymus*, alternate with) it. The superior ovary is from two- to five-chambered, with one ovule in each chamber. The flower is thus *perigynous*. The fruit is a small, globular, black, stone-fruit. Both species are shrubs or small trees.

## RHAMNUS FRANGULA (*Linn.*).—Alder Buckthorn (*Rhamnaceæ*)

This plant is usually a shrub from four to twelve feet high, and rarely becomes a tree twenty feet in height. As its whip-like shoots are feebly branched, the leaves are often largely grouped at the ends of long slender stems. The bark eventually becomes rough.

**Leaves.**

The simple leaves show an arrangement that is rare, as it is transitional between opposite and alternate. On the year's-shoot the leaves at the base are clearly in opposite or almost opposite pairs, the successive pairs standing at right angles; but as the shoot is ascended the leaves of a pair become gradually separated by increasing lengths of stem, thus becoming alternate; and still higher they may close together again. Each leaf has two narrow stipules, which soon shrivel after emerging from the bud. The stalked, nearly hairless, leaf-blade is oval and devoid of teeth, and has very regularly-arranged, straight, parallel, lateral nerves (Fig. 395).

**Buds and Shoots.**

The resting-buds (Fig. 394) are small, and show a few narrow hairy stipules which imperfectly conceal the folded foliage-leaves; the condition of the buds is therefore described as "naked."

**Growth of Shoots.**

If we observe the shoot that develops from a terminal resting-bud, several points of interest reveal themselves: (1) The shoot continues to grow and produce leaves throughout the summer; consequently, the year's-shoot (and therefore the whole stem) is long. (2) As the flowers are in the axils of leaves on the current year's-shoot, and as new leaves are constantly being produced during summer, the plant has an exceptionally long flowering season, which lasts from May to July. (3) The lowest two lateral buds on the year's-shoots frequently grow out into considerable branches in the year of their production, and even produce flowers. Hence the strongest branches on the year's-shoot are often at its base (as in many shrubs), not at its tip

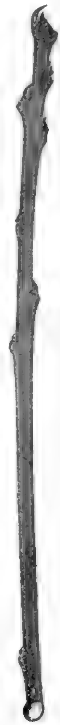

**Fig. 394.—Twig of Alder Buckthorn in Winter.**

Fig. 395.—Flowering Shoots of Alder Buckthorn.

(as in most trees). This habit, as well as the emission of stool-shoots and suckers, helps to explain the shrub-growth of the Alder Buckthorn. (4) Above the basal branches on the current year's-shoot inflorescences may appear in the axils of the leaves. (5) And still higher up on the same shoot there occur lateral resting-buds that do not sprout until some subsequent season.

The inflorescences take the form of tufts of stalked flowers in the axils of foliage-leaves.* In the axil of the leaf there first arises a central flower whose stalk bears two minute lateral scales; in the axils of these arise two lateral flowers. Hence the inflorescence consists of three flowers. But sometimes from the stalks of the lateral flowers in like manner other stalked flowers spring, so that the inflorescence may include from three to seven flowers. The flower-stalks are bent at certain stages in the career of the flower (Fig. 395).

**Flowers.**

The design of the regular, white and green, flower has already been described. It has five sepals; five small white petals which at first partly enfold the five tiny stamens. The two- or three-chambered ovary is surmounted by a short single style, which terminates in a stigma that exhibits feeble signs of being two- or three-lobed.

**Pollination.**

Despite of the nectar secreted by the lining of the goblet-shaped receptacle, few insects are attracted by these inconspicuous flowers, whose tiny white petals soon become discoloured. The stamens open before the stigma is receptive, but as they eventually shed pollen on the ripe stigma, self-pollination apparently also occurs.

* The inflorescences are of special interest in that they serve to throw light upon the inflorescences in the axils of catkin-scales of the Oak and Hazel families. *See* page 184 and Fig. 224.)

**Fruit.** After pollination the upper half of the receptacle-cup breaks off, but the lower half persists as a saucer at the base of the spherical stone-fruit, which contains two or three hard one-seeded stones. The fruit is green at first, subsequently red, but finally black, and about the size of a pea.

## RHAMNUS CATHARTICUS *(Linn.)*.—Common Buckthorn *(Rhamnaceæ)*

The Common Buckthorn is distinguished from the Alder Buckthorn by the following characters: the flower has four sepals, petals, and stamens, and is more or less

Fig. 396.—Twig with Spines of Common Buckthorn in Winter.


**Fig. 397.—Male (♂) and Female (♀) Flowers of Common Buckthorn.**

unisexual; the leaf is toothed, and has arched veins; the ends of stems are often converted into thorns. As a hedge-shrub, when not in flower, it may be mistaken for the Blackthorn (*see* page 344), but differs in that many of its leaves and branches are opposite.

Though usually a shrub, it may become a small tree, attaining a height of twenty feet. The stems become black in colour, and the trunk is eventually rough-barked.

**Leaves.** The stipulate leaves show the same transition between the opposite and alternate arrangement as in the Alder Buckthorn, but incline more towards the former disposition (Fig. 400).

**Buds.** The brownish-black resting-buds are clothed with scales, and the lateral ones are closely applied to the stem (Fig. 396). The buds develop into long-shoots, dwarf-shoots with tufted foliage, or into inflorescences. As the end of the stem often changes into a thorn and the highest two lateral buds grow out, the stems are repeatedly forked (Fig. 396).

**Flowers.** The axillary inflorescences are designed and arranged on the same plan as in the Alder Buckthorn, and are limited to the basal part of the current year's-shoot, whether this be a long-shoot or a dwarf-shoot (Fig. 397). The inflorescences are crowded together as they arise in the axils of the lowest foliage-leaves (and perhaps of the scales), which are smaller and usually shorter-lived than the higher leaves. Each inflorescence may have from seven to three flowers, but may be reduced to the solitary central flower. The greenish (and white) flowers open in May or June.

**Male Flower.** The male flower (*see* Fig. 397, ♂) has a bell-shaped receptacle, and the four petals mask only the filaments of the erect stamens, so that the light-coloured anthers project freely. Hidden at the bottom of the bell-like

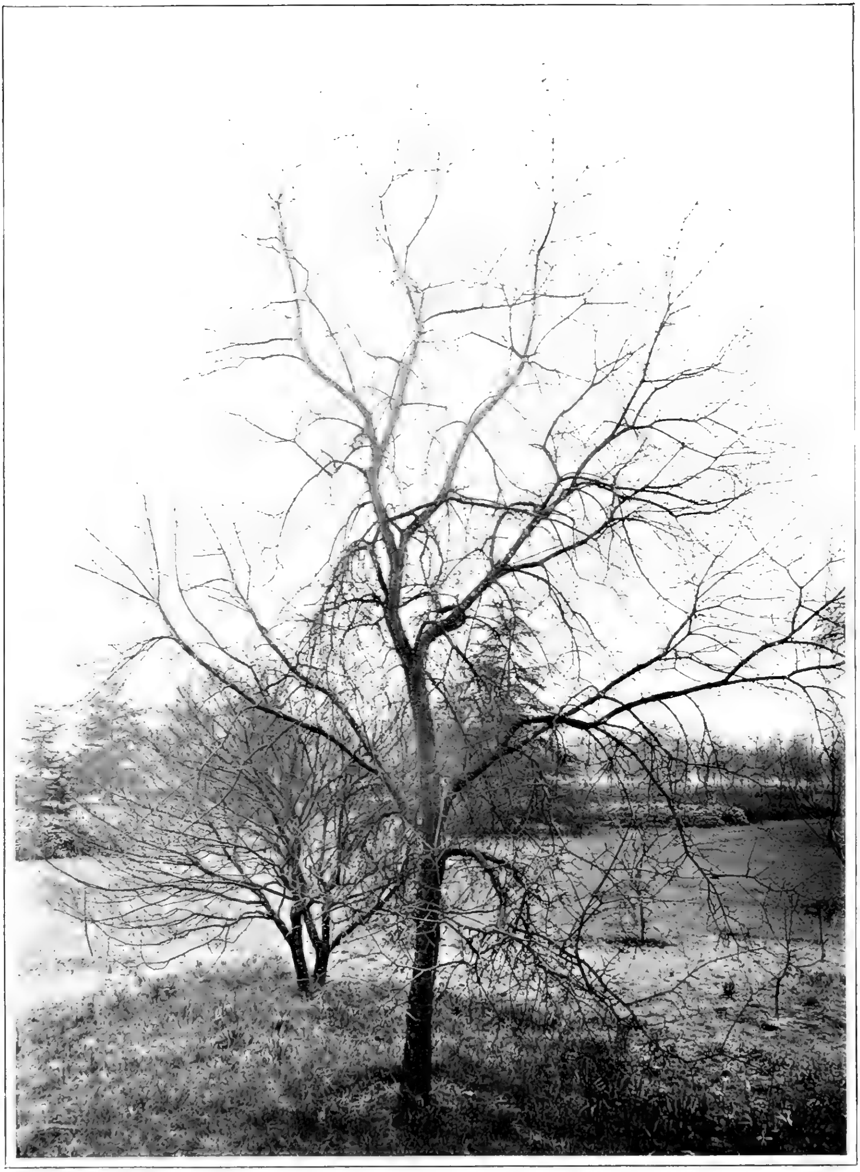

Fig. 398.—COMMON BUCKTHORN—*RHAMNUS CATHARTICUS*: WINTER.

Fig. 399.—COMMON BUCKTHORN—*RHAMNUS CATHARTICUS:* SUMMER.

cavity stands the reduced little pistil, which may show a distinct ovary, style, and even stigma.

**Female Flower.**

The female flower (Fig. 397, ♀) has a cup-shaped receptacle, and its four tiny petals conceal four minute stamens, each of which has a little filament and anther. The green, (usually) four-chambered ovary is surmounted by a style, and this divides about half-way up into four stigma-tipped branches, which freely project from the flower.

**Bisexual Flower.**

Between the perfectly male and female flowers intermediate kinds occur. This and other facts suggest that the ancestors of the Common Buckthorn had bisexual flowers, which have become more or less completely unisexual by reason of the degeneration of the stamens and pistil respectively.

Fig. 401.—Fruits of Common Buckthorn.

Fig. 400.—Shoot of Common Buckthorn.

As the greenish, scented flowers are very largely unisexual, and as the individual plant tends to bear only male or only female flowers, cross-pollination is favoured or even obligatory. Insect vistors seem to be few in numbers and in kinds.

The black, spherical, fleshy fruit (Fig. 401) is in size equal to a small pea, and contains four one-seeded stones.

# PAPILIONACEÆ. LABURNUM SUB-FAMILY

The Papilionaceæ form a subdivision of the large family Leguminosæ, and include such diverse plants as Clover, Peas, Vetches, Beans, Broom, Gorse, Laburnum, and False

Fig. 402.—Inflorescences of Robinia.

Acacia. They are easily recognisable by the *characteristic shape and construction of the flower.* Of the five petals there is, at the back, one (*standard*) which in the bud overlaps the two (*wings*) at the sides, and these in turn overlap the two front petals which form a kind of boat (*keel*) enclosing the stamens and ovary. The flower is irregular; its sepals and petals are slightly perigynous. The five sepals are joined; the five petals more or less completely separate; the ten stamens are all joined by their filaments to form a tube, or the tube is open at the back because one stamen occupying this position is separate from the nine others, which are joined. Within this tube is the single carpel, which forms a one-chambered ovary, a single style, and single stigma; inside the ovary are usually several ovules. The fruit is a pod which, as a rule, splits open longitudinally along two lines (and is therefore a *legume*). The seed is wholly occupied by the embryo or nearly so. The leaves are generally alternate, compound, and stipulate, the leaflets usually being devoid of teeth.

[The Leguminosæ include two other sub-families — *Cæsalpiniaceæ* and *Mimosaceæ* — which are not represented by any British plants. The irregular flowers of the Cæsalpiniaceæ are often very similar to those of the Papilionaceæ, but their petals, in the bud-condition, overlap in the reverse direction: that is to say, the two front petals overlap the two side ones, which in turn enfold the back petal. The Cæsalpiniaceæ include one tree cultivated in English gardens — the Judas-tree (*Cercis*) — whose irregular pink-crimson flowers spring from woody shoots that are a number of years old, and whose simple leaves provide an exception to the general prevalence of compound leaves in the sub-family. The Mimosaceæ, including *Acacia* and *Mimosa*, differ from both other sub-families in having regular flowers; often, too, the flower includes many stamens. Doubly-compound leaves possessing many small leaflets are also frequent.]

## LABURNUM VULGARE (*Linn.*).—Laburnum (*Papilionaceæ*)

The Laburnum is recognisable by its leaves, each composed of three leaflets, its smooth bark, and its luxuriant display of yellow blossoms arranged in hanging inflorescences (which cause Germans to give to the tree the name of "Golden Rain"), and finally by its pendent pods.

Fig. 403.—Bark of Laburnum.

The tree may be from fifteen to thirty feet in stature, but at considerably less height its cylindrical trunk usually gives way to a number of ascending boughs. These spread out in their upper parts, often arch over, and droop at their ends. On such a bough new long-shoots spring, not from the tip, but from somewhere near

**Height and Habit.**

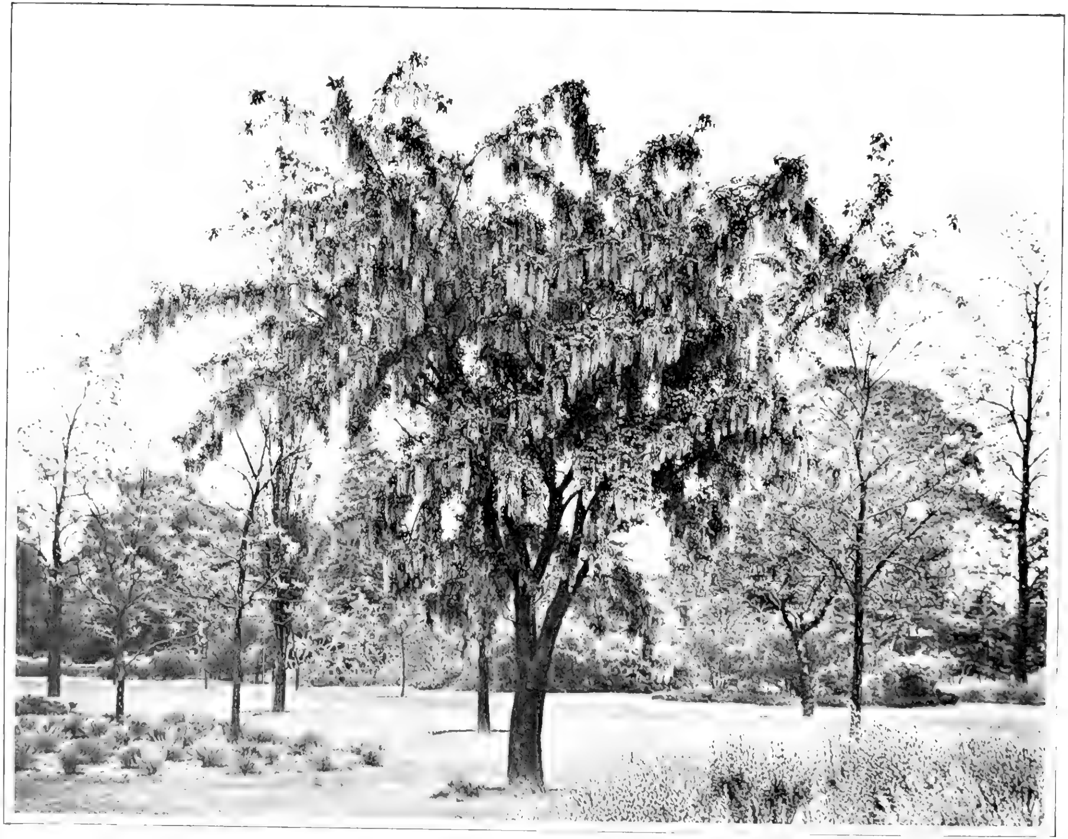

Fig. 404.—LABURNUM—*LABURNUM VULGARE*—IN FLOWER.

the highest point of the arch; they grow erect, but in turn droop over at their ends. The drooping Laburnum-tree thus exhibits a fountain-like method of growth.

The bark (Fig. 403) remains smooth and closed for many years, but eventually peels off in parchment-like flakes which separate by clefts running transversely round the trunk.

**Leaves.** The spirally arranged compound leaves (Fig. 405) have elongated narrow stipules that soon shrivel, a long leaf-stalk, and three leaflets. Each leaflet has a short stalk, and ends in a sudden sharp point, though it has no marginal teeth; its pale lower face is downy.

**Buds and Shoots.** The hairy resting-bud shows three scales, and the lateral buds are applied close to the side of the green twig (Fig. 406). Only few of the buds grow out into long-shoots, the vast majority developing into dwarf-shoots with closely tufted foliage, so that the tree bears many knotty, ringed dwarf-branches, but only a few long-branches.

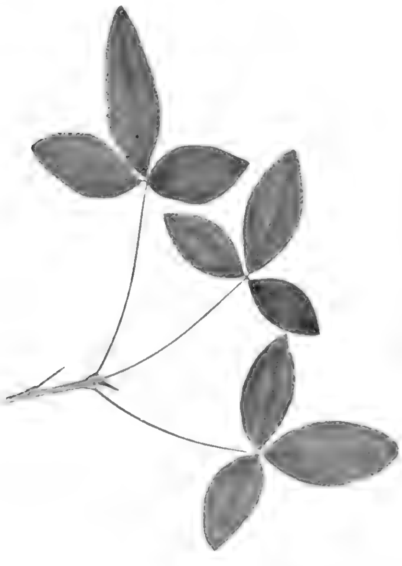

Fig. 405.—Leaves of Laburnum.

**Inflorescence.** The inflorescence (Fig. 408) is the terminal part of a dwarf flowering shoot which arises from a resting-bud produced during the preceding year at the tip of a long-shoot or dwarf-shoot. The inflorescence itself has a long, silver-haired, bractless stem from the sides of which spring many stalked flowers, with two or three minute bractlets on their stalks. The inflorescence-stem continues downwards into the stem of the dwarf-shoot, which bears two or three foliage-leaves, in whose axils are buds. These lateral buds subsequently sprout to produce foliaged shoots, and thus act as substitutes for the terminal bud, which has been utilised to produce the inflorescence. This mode of growth accounts for much of the apparent forking of the main branches.

Fig. 406.—Twig of Laburnum in Winter.

**Flowers.** The irregular flower has a bell-like calyx, which in its upper part divides into an upper (back) often two-toothed lip, and a lower (front) often three-toothed lip. The back petal (*standard*) is showy and partly erect, but the other petals as well as the flower itself are horizontal (Fig. 408). Of the ten stamens five alternate ones have larger anthers than their fellows. The filaments of all ten stamens are joined

Fig. 407.—Closed Fruits of Laburnum.

to form a tube surrounding the one-chambered ovary, which contains a double line of several ovules down the one side of its wall. The long style is bent and raises the stigma above and beyond the anthers. Stamens and pistil lie within the keel.

**Pollination.** The flowers are mainly pollinated by the agency of bees. The nectar is concealed at the base of the standard petal inside a cushion-like swelling on the outer face of the tube formed by the stamens. The position of the nectary is indicated by two dark-coloured lines on the standard, which thus act as sign-posts to show the bee where to thrust her tongue. The bee, in alighting on the flower, utilises the two wing-petals as a platform; these sink down and drag with them the two keel-petals, thus causing the stigma and anthers to come into contact with the lower surface of the bee's body. By this means pollination is carefully provided for. (The elaborate arrangement by which cross-pollination is favoured cannot be described here.) It will be instantly evident that this device would be useless if the flower were upside down and the keel consequently uppermost; yet this is the natural position when the inflorescence hangs down as it does. The flower-stalk therefore executes a twist that restores the flower to its suitable pose with the conspicuous standard uppermost.

**Fruit.** The ovary becomes a long, greyish-brown or greyish-yellow pod, which contains from three to seven

Fig. 408.—Inflorescences of Laburnum.

dark brown, or nearly black, poisonous seeds. The fruit hangs on for months, and eventually its wall splits down the two edges (Figs. 407 and 50).

In germination the food-storing cotyledons emerge from the soil, become green, but soon perish. Even the first foliage-leaves produced each show three leaflets.

There are several varieties of this beautiful tree, which is not a native of Great Britain, but the most interesting form of Laburnum is *Laburnum Adami*, on which

**Varieties.**

may be seen inflorescences of dirty pink or purple flowers, and often on the same individual tree yellow blossoms. *L. Adami* is regarded as a hybrid between *L. vulgare* and the purple or white flowered *L. purpureum*.

## ROBINIA PSEUD-ACACIA (*Linn.*).—False Acacia (*Papilionaceæ*)

The False Acacia or Locust-tree has a number of features rendering recognition

**Distinctive Features.**

easy. The trunk is deeply furrowed, and has a thick rough bark. The twigs are armed with paired thorns, and their lateral buds are completely hidden from view. The pinnately compound leaves have stipular thorns and a number of pairs of leaflets. The inflorescences of characteristic white flowers are pendulous, as are the flattened dark-reddish pods.

The tree attains a height of sixty or eighty feet, but the trunk gives way in the crown

**Trunk and Bark.**

into a number of main boughs. At its base the trunk is generally more deeply furrowed and clothed with a rougher, more uneven bark (Fig. 411) than any other dicotylous tree common in this country.

The False Acacia is endowed with considerable powers of throwing up shoots from its stump and suckers from its roots. By means of the latter behaviour the single tree can give rise to a thicket or little grove of small trees.

The spirally arranged compound leaves on the

**Leaves.**

non-flowering branches have stipules changed into flattened thorns that remain attached for years (Figs. 409 and 410). But on the flowering branches the stipules are soft, slender, and short-lived. The stalked leaf has from five to twelve pairs of opposite leaflets, and usually an odd terminal one. The leaflet is more or less oval in form.

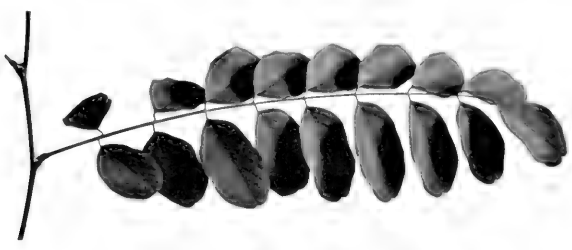

Fig. 409.—Leaf of False Acacia.

Fig. 410.—Twig of False Acacia in Winter.

untoothed at the margin, but generally shows a sudden, minute, sharp point at its tip; and although silver-haired when it unfolds, the leaflet is nearly hairless when mature. At the base of the stalk of each leaflet may be seen minute pointed stipule-like outgrowths, termed *stipels;* on vigorous shoots, and especially on suckers, these stipels are much larger and shaped like small leaflets.

The end of the twig dies at the conclusion of the growing season, and during this season the lateral resting-bud is concealed

**Buds.**

under the swollen base of the leaf-stalk, so as to be invisible. Even when the leaves are shed in autumn the minute hairy buds are concealed within depressions in the stem, two or more of them standing one above the other in the axil of each leaf-scar.

**Fig. 411.—Bark of False Acacia.**

The inflorescences (Fig. 402) open in June, and are in the axils of leaves. They are white, fragrant, and pendent. The white flower, though differing in detail, is like that

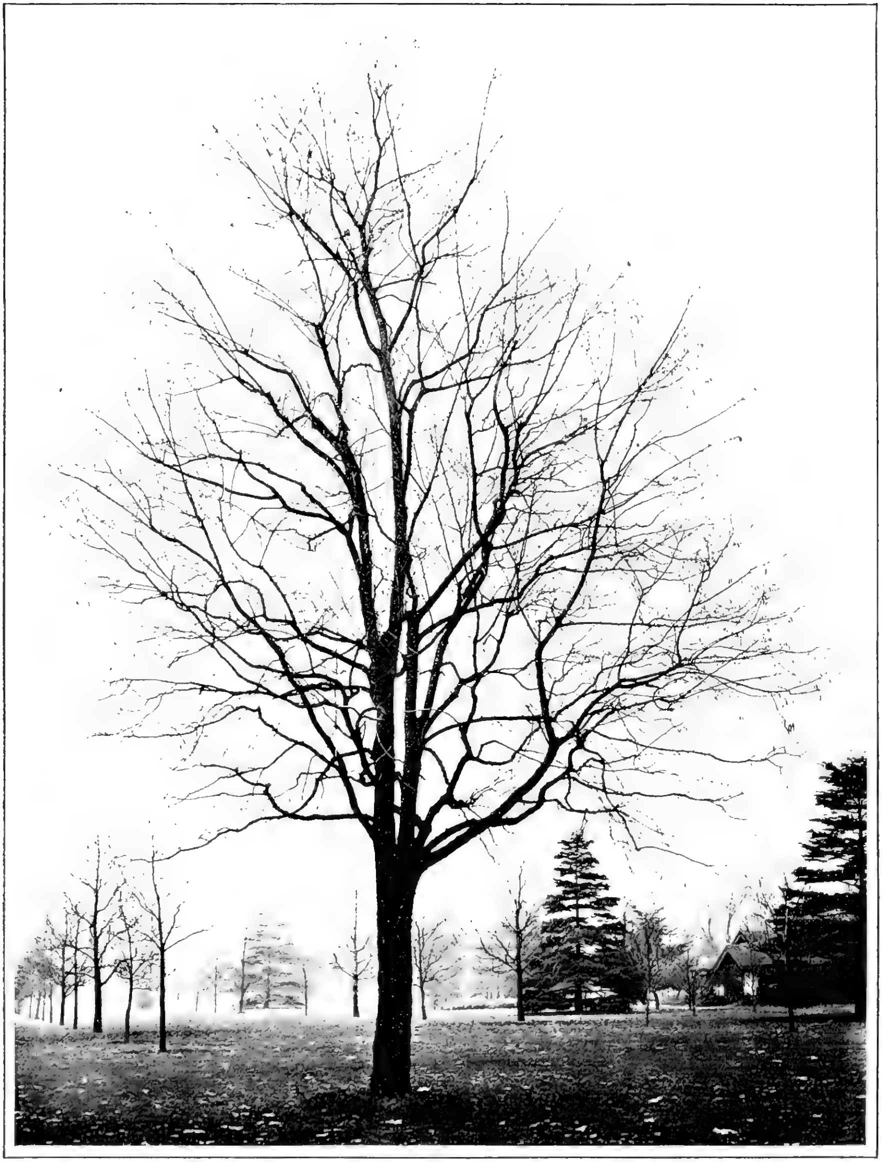

Fig. 412.—FALSE ACACIA—*ROBINIA PSEUD-ACACIA:* WINTER.

Fig. 413.—FALSE ACACIA—*ROBINIA PSEUD-ACACIA*: SUMMER.

**Flowers.**

of the Laburnum in general design and mechanism, except that the filaments of only nine stamens are united to form a tube, which is open along the back where the solitary separate stamen stands. This slit in the tube provides for the escape of the abundant nectar, which is secreted by the inner surface of the base of the tube. A yellow or green spot at the base of the back petal (standard) guides visiting bees to the outflowing nectar.

The dark-red, flattened pod (Fig. 414) contains up to twelve seeds, and often hangs attached by its stalk until the following spring.

**Fig. 414.—Fruits of False Acacia.**

The seedling pushes its food-storing cotyledons above the soil.

The timber of the tree is remarkable for the small size of the light-coloured sapwood encircling the brown heart-wood, and for the feature that all the pores (vessels) of the wood, except those lying very near the bark, are plugged with peculiar ingrowths (tyloses).

The home of the False Acacia is the United States, but the tree is widely grown in Europe, where a number of cultivated varieties are to be met with. Among these are forms with yellowish flowers, or variegated foliage, or devoid of thorns.

# ROSACEÆ. PLUM AND APPLE FAMILY

The Rosaceæ is a large family including the Meadowsweet, Strawberry, Blackberry, Raspberry, Rose, Cherry, Blackthorn, Plum, Almond, Peach, Apple, Pear, Mountain Ash, Hawthorn, and many others.

It is a family exceedingly difficult to define, and to all the usual characters mentioned below there are exceptions :—

*Flowers regular :* sepals, petals, and stamens attached to the edge of a saucer-like, cup-like, or urn-like *concave receptacle : petals separate,* usually five; *stamens more than twelve ; carpels several, separate from each other and superior ;* one or two ovules in each ovary; fruit not opening spontaneously. Leaves stipulate, often with toothed blades.

The types described in this work provide exceptions to these characters. *Prunus* (including the Cherry, Blackthorn, and Plum) has only one carpel, and therefore only a single one-chambered ovary, one style, and one stigma ; but in other respects it agrees with the characters given above. *Pyrus* (including the Apple, Pear, and Rowan) and *Cratægus* (Hawthorn) differ not only in having the several carpels more or less completely joined to form a single ovary, but also in that the ovary is *inferior*—that is to say, joined on its outer face with the lining of the cup-like receptacle. Thus *Prunus* is perigynous, whereas *Pyrus* and *Cratægus* are epigynous.

## PRUNUS AVIUM (*Linn.*).—Wild Cherry or Gean (*Rosaceæ*)

Fig. 415.—Shoot of Wild Cherry.

The two kinds of Cherry-trees growing wild are recognised by their tufts of stalked white flowers and fruits, and the characteristic bark, which is marked by transverse lines (lenticels) and flakes off in thin strips by splits running more or less round the stem.

*Prunus avium,* the Wild Cherry, has spreading and deep roots, which rarely send suckers above ground. (Whereas the Sour Cherry, *P. Cerasus,* shows an abundance of root-suckers rising out of the soil.)

**Height and Form.**

The tree may grow to a height of nearly seventy feet, and when isolated attains a great size. One characteristic feature is the marked manner in which the boughs ascend steeply.

**Bark.**

The bark at the base of large trees shows longitudinal furrows and is rough (Fig. 418); between the rough parts may usually be seen the bark that is characteristic of the boughs and upper parts of the trunk, and that is scored

Fig. 416.—WILD CHERRY—*PRUNUS AVIUM*—IN BLOOM.

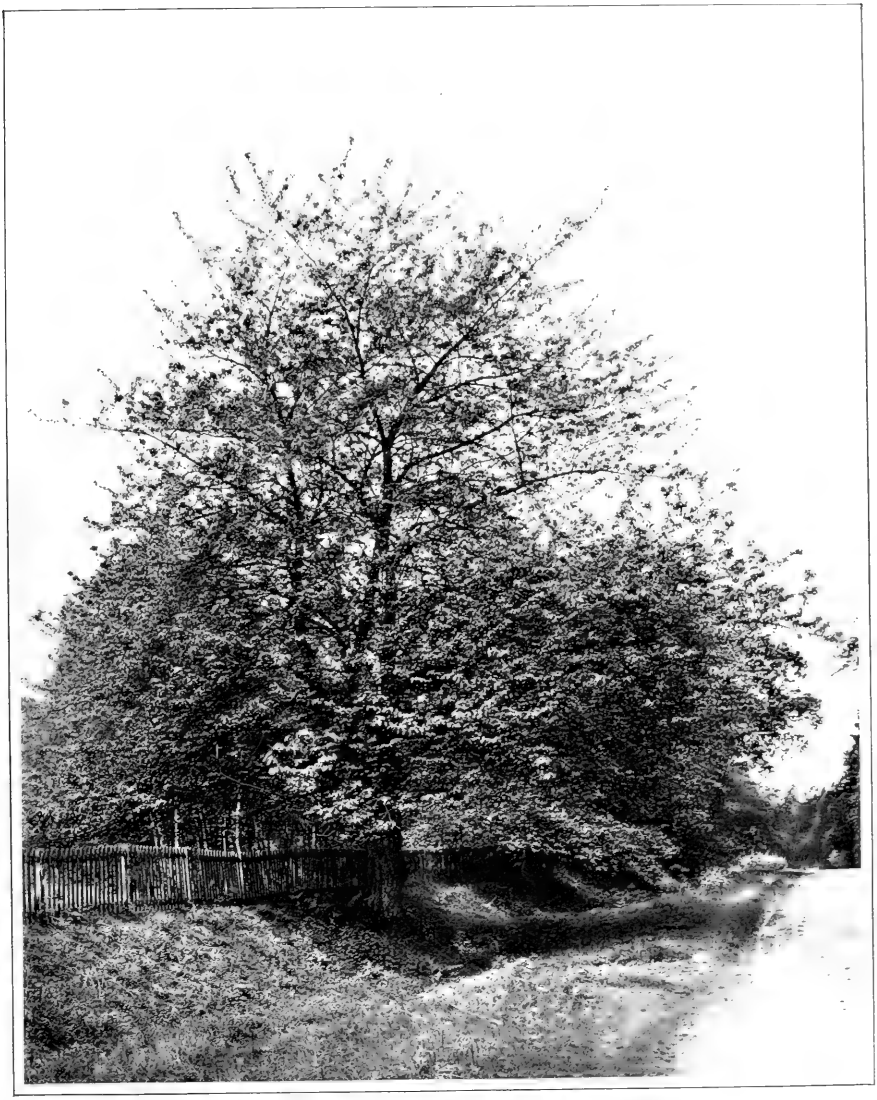

Fig. 417.—WILD CHERRY—*PRUNUS AVIUM*—IN LEAF.

with transverse lines (lenticels). This latter kind of bark peels in thin strips that partly embrace the stem.

The simple, spirally-arranged leaves droop from long stalks. Each has two slender stipules which soon become dry and brown. Near the top of the leaf-stalk stand two red glands (Fig. 415). The blade has a sharp tip and sharp double-teeth, and its lower face is slightly hairy.

**Leaves.**

The resting-buds are covered with thin chestnut-brown, or reddish-brown, scales, and are of two kinds: pointed buds (Fig. 419) that grow out into foliaged shoots, and blunt, more rounded, ones that develop into inflorescences. Those on the long-shoots are separated by distinct internodes (Fig. 419); but those on the dwarf-shoots are clustered near the tip of the short, closely-ringed stem. A vegetative bud, when it sprouts, shows above the scales interesting transitions between scales and foliage-leaves, in the form of green leaves

**Buds and Shoots.**

Fig. 418.—Bark of Wild Cherry.

Fig. 419. Twig of Wild Cherry in Winter.

possessing tiny, or small, blades and large stipules. Another point to notice is that the inner scales bend back as the bud opens (though they remain erect in the closely allied *Prunus Cerasus*). Each foliage-leaf in the bud has its right and left halves applied flat together by their upper faces. The teeth of the young blade and of the stipules are tipped with glands which pour out balsam, and thus coat the young blade with this glistening substance. Such vegetative buds give rise to long-shoots and to numerous dwarf-shoots.

The flowering buds are arranged on the sides of shoots produced during the preceding year. Frequently they are seen closely tufted on the sides of a dwarf-shoot which ends in a pointed vegetative bud; the tuft of lateral buds thus produces a cluster of inflorescences, while the terminal pointed bud continues the growth of the shoot. Each single inflorescence consists of from two to six long-stalked flowers (forming a so-called *umbel*). The resting-bud sends forth flowers at the same time as the foliage-leaves appear, but produces neither foliage nor foliage-like little leaves (and in this last respect provides a contrast with *P. Cerasus*).

**Flowers.**

The regular flower (Fig. 420) is perfectly *perigynous*—that is to say, its five sepals, five flaccid spreading white petals, and numerous stamens are all inserted at the edge of a cup-like receptacle, from the floor of which rises the single, one-chambered, two-ovuled ovary, which is surmounted by a single style and stigma.

Various insects, attracted by the showy blossom, its faint scent, and by the nectar secreted by a circumscribed glistening part of the lining of the cup-like receptacle, cross-pollinate the partly drooping flowers.

The ovary ripens to the familiar red glistening stone-fruit (Fig. 422) which has no

Fig. 420.—Flowers of Wild Cherry.

Fig. 421.—Double-Flowers of Cherry.

"bloom" on its surface, and is sweet. The cuplike receptacle is thrown off relatively soon after pollination. The cherry-stone is smooth in surface except for a sharp angle and two furrows. The seed is wholly occupied by the embryo.

**Fruit.**

Among the cultivated varieties of the tree is the double-flowered one (Fig. 421), in which the single whorl of five petals is replaced by many petals.

**Varieties.**

The Cherry-tree frequently bears "witch's-brooms" on its branches. These are nest-like, erect shoots composed of many short branches, which are especially conspicuous when the tree is a mass of blossom, for they alone are green-foliaged shoots undecked with flowers (Fig. 424). The "witch's-broom" is caused by a fungus (*Exoascus cerasi*), which lives year after year in the twigs. The fungus not only prevents the shoot affected from flowering, but also deforms the stems and leaves. The diseased stem is abnormally thick at the base, while the leaves concerned are twice their usual thickness, glossy, and pale green or reddish in tint. In late spring the infected leaf may show a white coating of spores which are produced solely in the foliage. The spores transmit the disease to other trees, on which they germinate, producing fine cotton-like threads that permeate the stem attacked.

**Witch's Brooms.**

Fig. 422.—Fruits of Wild Cherry.

Fig. 423. CULTIVATED CHERRY IN BLOOM.

W

*Prunus Cerasus* (Linn.), the Sour Cherry, which also grows wild, differs from *P. avium*, not only in having sour fruits and in emitting numerous root-suckers, but also in the following respects: It is smaller, often a shrub, and frequently has a reddish bark. Its more spreading branches often droop. Its leaves are more leathery, glossy, quite hairless, and stand out with shorter stalks, which often are glandless. The flowers come out before the leaves; and the inner scales, arising from the bud that produces the inflorescence, are foliage-like. The petals are firmer and more erect.

Fig. 424.—Witch's-broom on Wild Cherry.

The different kinds of Cherry-trees which are cultivated by growers (Fig. 423) for the sake of their fruits, are principally derived from the two species which have been mentioned above, namely, *Prunus avium* and *P. Cerasus*.

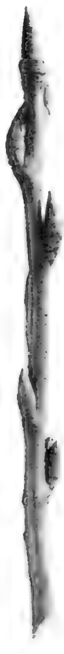

Fig. 425. Twig of Bird Cherry.

## PRUNUS PADUS (*Linn.*).—Bird Cherry (*Rosaceæ*)

The Bird Cherry (which is not *P. avium*, as might be anticipated) is distinguished from the Wild and Sour Cherry-trees by its graceful, stalked, hanging inflorescences of little white flowers (Fig. 43).

**Height and Habit.**

This shrub or little tree (rarely exceeding twenty feet in height) has spreading roots that give off suckers. Its branches also spread out, and some of them droop. The dull, dark bark remains smooth for several years, and shows transverse lines (lenticels) much shorter than those of the Wild Cherry (Fig. 427).

**Leaves.**

The spirally-arranged, simple, stipulate leaves each show two glands at the top of the leaf-stalk, and numerous very fine and pointed teeth at the margin of the blade, which has hairs in the angles of the nerves on the lower face (Fig. 428).

**Buds and Shoots.**

The distinctive and rather large resting-buds (Fig. 425) are long, conical, and often bent; their polished lower scales are tinted brown, and their upper ones yellow. From

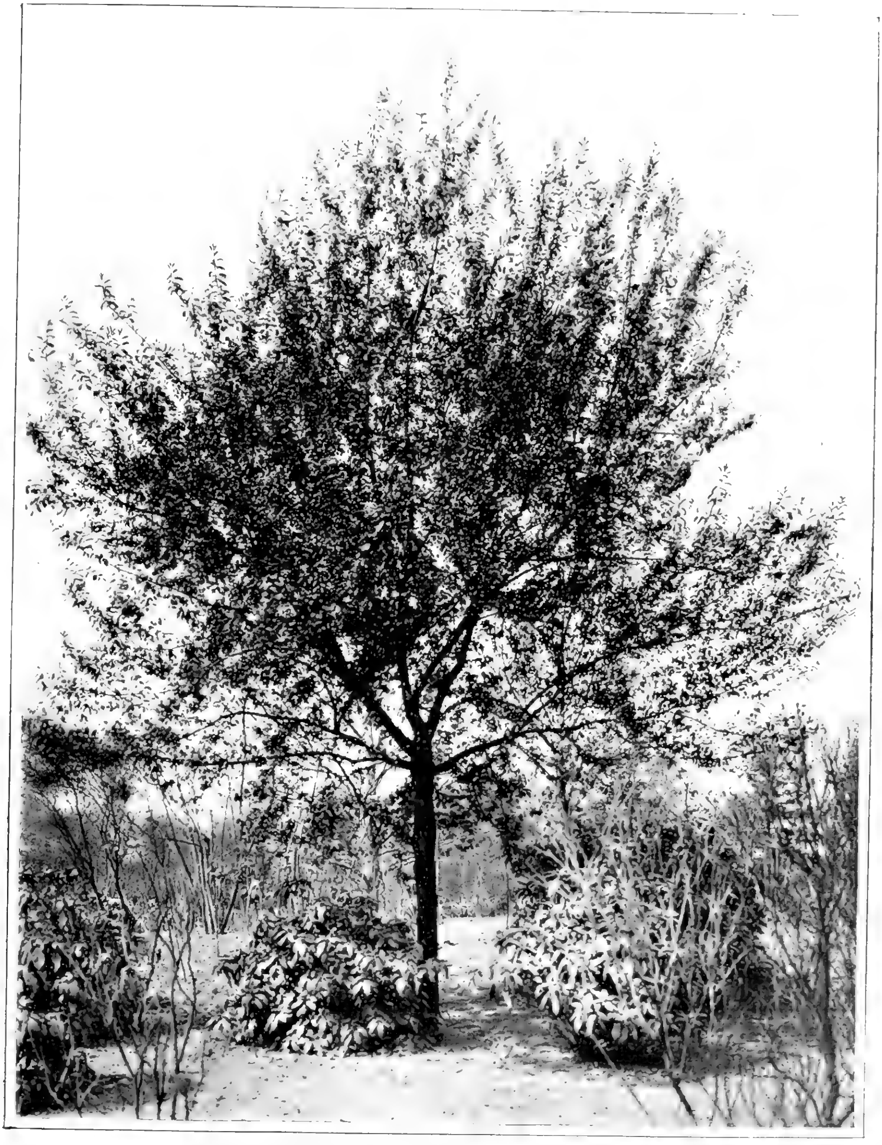

Fig. 426.—BIRD CHERRY—*PRUNUS PADUS*.

these buds proceed long-shoots, slender-stemmed foliaged dwarf-shoots (see Fig. 43), and lateral flowering dwarf-shoots which are foliaged.

The hanging or, less frequently, erect inflorescences bear numerous stalked, white flowers along the length of the inflorescence-axis (*see* Fig. 43); the little bracts in whose axils the flowers arise fall early. In design the little flower and the bitter, black, spherical fruit—about as large as a pea (Fig. 429)—agree with those of the Wild Cherry.

**Flowers and Fruit.**

In the strongly-scented flower the stigma is receptive before any of the stamens have opened their anthers, and during this female phase only cross-pollination is possible. Subsequently the anthers open while the stigma, if not pollinated, is still receptive, and, during the later stages of this bisexual phase, the inner stamens rise from their inwardly bent pose, rub pollen

**Fig. 427.—Bark of Bird Cherry.**

Fig. 428.—Shoot of Bird Cherry.

that is shed every autumn. (Compare the Larch and Cedars, also the British Oaks and the Holm Oak.)

The Cherry Laurel is an introduced shrub very common in English gardens. Its alternate, glossy, thick leaves are untoothed or are indented with widely separated little teeth ; very characteristic of the leaf are the glandular, shallow depressions on the under surface near the base of the blade, one or two occurring on each side of the mid-rib. The inflorescences of this shrub and of the Portugal Laurel arise in the axils of leaves produced during the immediately preceding year, and have no foliage-leaves at the base (contrast the Bird Cherry). The long, erect inflorescences open their white little flowers in early spring, and are disagreeably scented.

The Portugal Laurel, likewise introduced into this country, differs from the Cherry Laurel in the darker colour and smaller size of its leaves, also in the more close and regular occurrence of teeth at their margins, and, finally, in the absence of any glands from the lower face.

From these two shrubs, two others—" Laurustinus " (*see* page 397) and *Aucuba japonica*—which are likewise evergreens common in gardens, differ in having opposite leaves.

on to the stigma, and thus regularly effect self-pollination in the absence of insect visitors.

Erect inflorescences, flowers and fruits designed like those of *P. Padus* are possessed by two familiar evergreen garden shrubs, which are consequently species of *Prunus*. The shrubs in question are the Cherry Laurel (*P. Laurocerasus*) and the Portugal Laurel (*P. lusitanica*) ; both these illustrate the thicker texture of evergreen foliage when compared with the foliage of closely related species

Fig. 429.—Fruits of Bird Cherry.

Fig. 430. BLACKTHORN—*PRUNUS SPINOSA* IN BLOOM.

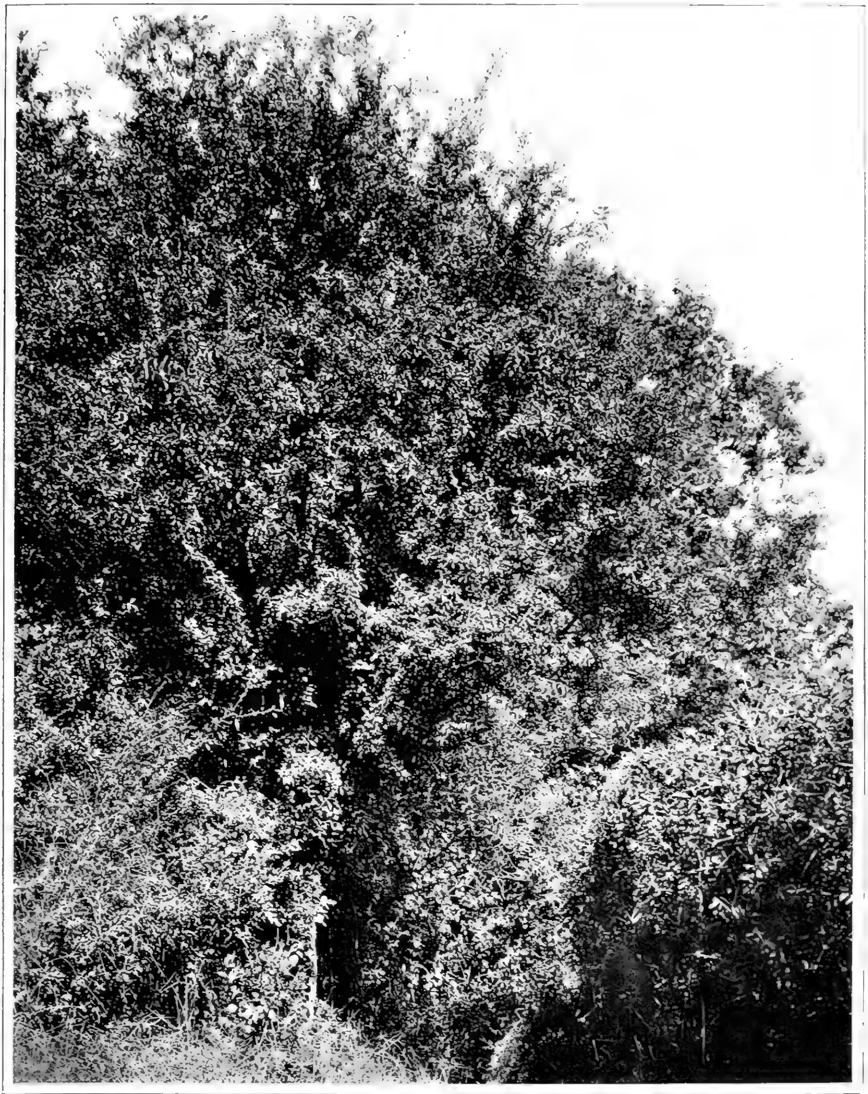

Fig. 431.—BLACKTHORN—*PRUNUS SPINOSA*—IN LEAF.

## PRUNUS COMMUNIS (*Huds.*).—Sloe and Plum (*Rosaceæ*)

Under the general (usually discarded) name of *Prunus communis* I include several more or less distinct forms, which are distinguished from Cherries by having their foliage-leaves rolled (not folded) in the bud, their stone-fruits coated with wax ("bloom"), and, finally, their white flowers short-stalked and solitary or in pairs.

Three species or sub-species are usually distinguished: *Prunus spinosa*, the Sloe or Blackthorn, *P. insititia*, the Bullace, and *P. domestica*, the Wild Plum. In general design of shoots, leaves, flowers, and fruit they agree with the Cherry.

**Forms.**

Fig. 432.—Bark of Blackthorn.

All are shrubs or small trees. The Blackthorn, often seen in hedges, is noticeable for its black rind, for the manner in which

Fig. 433.—Shoot of *Prunus communis*.

its woody branchlets stand out at right angles from erect or ascending shoots, and for the prevalence of thorns which are the terminations of shoots (Fig. 436). The twigs of the other two forms are brown, but the Wild Plum is distinguished from its fellows by the fact that its young shoots are hairless; the Bullace frequently, but not invariably, bears thorns, whereas the Wild Plum is nearly always thornless. All three can emit root-suckers.

The spirally-arranged, simple, stipulate, toothed leaves (Fig. 433) are broadest in the Wild Plum.

The blunt, rounded, resting-buds of the Sloe (Fig. 434) contrast with the pointed ones of the other two (Fig. 435). From these buds spring long-shoots with distinct internodes, dwarf-shoots with tufted foliage, and inflorescences consisting of one or two (rarely three) flowers.

The flowers open in March or April. The blossom is revealed before the leaves, usually in the Sloe, often in the Bullace, but never in the Wild Plum; in other

**Flowers.** cases, flowers and leaves open together. The lateral flowers are often solitary in the Sloe (Fig. 48), but in the others they are in pairs.

In general structure of flower (Fig. 48)

**Fruit.** and fruit (Fig. 55), the three plants agree with the Cherry; but the plum-like fruit possesses a rough stone, and in place of having a glossy surface it is covered with dull "bloom." The

Fig. 434.—Twig of Blackthorn in Winter.

Fig. 435.—Twig of Bullace or Wild Plum in Winter.

Fig. 436.—Spine of Blackthorn.

fruit of the Sloe is erect, also bitter and sour, and thus differs from those of the other two, which are directed downwards and are sweet in taste. The globular Sloe-fruit is blue in colour, and somewhat larger than a pea; the larger Bullace-fruit (about one inch in diameter) is globular or slightly oval, and bluish-black (rarely yellow) in colour; finally, the fruit of the Wild Plum is often still larger (one and a half inches in length), frequently oval rather than globular, and varies in colour from bluish-black to violet or red.

Between the Sloe and the Bullace there are intermediate forms which may be hybrids. The cultivated varieties of Plum-trees (*see* Fig. 437) are probably derived from the sweet-fruited Bullace and Wild Plum, rather than from the bitter-fruited Sloe, though possibly in some cases they have been crossed with other species.

Fig. 437.—Flower of Orchard Plum.

## PYRUS MALUS (*Linn.*).—Apple (*Rosaceæ*)

The Apple-tree is distinguished from the Pear not only by the fruit, but also by its whitish or yellow (in place of red) anthers, and by its five style-branches being united at the base into a single style.

Among the many varieties of Apple-trees the majority can be traced back to two different sub-species. These we may term the Crab Apple—*P. Malus sylvestris* (*acerba*)—and the Common Apple—*P. Malus pumila* (including the varieties *domestica* and *paradisiaca*). Here the Crab Apple will be first described, and subsequently the differences shown by the Common Apple will be denoted.

Fig. 438.—Bark of Apple.

The Crab-tree is a small tree, only from twenty to twenty-five feet in height, with

Fig. 439.—WILD APPLE—*PYRUS MALUS*: WINTER.

Fig. 440.—WILD APPLE—*PYRUS MALUS* IN BLOOM.

Fig. 441.—Shoot of Common Apple.

spreading branches that form a wide crown. The irregularly ridged trunk is covered by furrowed grey-brown bark, which flakes off in thin scales (Fig. 438).

The spirally-arranged, simple leaves (Fig. 444) have small, slender stipules that soon turn brown. The leaf-stalk is slender, nearly hairless, and long. The blade varies in form from a circle to an oval, and has a sharp tip as well as saw-like teeth; it is hairless and somewhat glossy on its dark upper and lighter lower face. In the bud the blade has its right and left halves rolled separately towards the mid-rib on the upper (inner) face.

**Leaves.**

The resting-bud shows a few scales and is more or less hairless, the lateral buds being applied to the stem. The buds grow out into three kinds of shoots: (1) Long-shoots with separated leaves (compare Fig. 441). (2) Non-flowering dwarf-shoots, which year after year grow very slowly, and show many closely-arranged ring-like markings (Fig. 444) as their foliage-leaves and bud-scales are closely crowded together. (3) Flowering dwarf-shoots or *spurs*, which shoot out from stouter resting-buds and are tipped with flowers (compare Fig. 443). But a fourth kind of shoot is often seen. The pointed end of a shoot may dry up, become hard and woody, and thus give rise to a thorn. The slender twigs, except in their first youth, are hairless (contrast Fig. 442).

**Buds.**

The Crab-tree opens its white, or pink and white, flowers in May. The inflorescence terminates a dwarf-shoot that is usually lateral, but may be at the tip of a long-shoot: the little flowering branch bears a number of small foliage-leaves and a few comparatively large flowers mounted on long unbranched stalks (compare Fig. 443).

**Flowers.**

The regular flower has five joined sepals whose free segments are hairy on their upper faces. The five petals have rounded "limbs," and are attached by narrow "claws." The numerous stamens form a circle round the nectar-secreting glistening disk: their anthers are creamy or light-yellow in tint. Beneath all these parts lies the inferior five-chambered ovary, which contains two ovules in each chamber. The single style divides low down into five branches.

Fig. 442.—Twig of Common Apple in Winter.

which are so long that they often raise the stigmas above the level of the anthers.

**Pollination.** The stigmas are receptive before the anthers open, and cross-pollination is favoured by this circumstance as well as often by the elevated position of the stigmas. The flowers are pollinated by various bees and flies; and probably by night-flying moths, as the white flowers are (always ?) more strongly scented in the evening. But it is to be observed that spontaneous self-pollination may also take place, because the anthers open before the stigmas have withered, and the style-branches eventually may bend back, bringing the still receptive stigmas into contact with the anthers.

The ovary develops into the familiar apple which is depressed at both top and bottom, and still carries the persistent calyx. The wall of the inferior ovary gives

**Fruit and Seeds.** rise to a thick, fleshy coat, in which three layers may be distinguished: (1) the peel; (2) the thick juicy layer; (3) a thin, tough, parchment-like layer which separately surrounds each chamber. These five parchment-like layers are comparable with stone-layers of a fruit with five stones. Inside each chamber may be two brown seeds, which have fairly thick seed-coats because the parchment-layer of the fruit is thin. The yellow fruit often hangs down, and is sour in taste.

Fig. 443.—Flowers of Apple.

The seed is wholly occupied by the embryo, whose food is stored in two fleshy cotyledons.

The *Common Apple-tree* differs from the

Fig. 444.—Fruits of Crab Apple.

Crab-tree in the following respects; it is much more hairy; soft, at first white, hairs clothe the ovary, the outer (lower) face of each sepal, the flower-stalk, resting-bud, twig (Fig. 442), and lower face of the leaf (Fig. 441); it has stouter leaf-stalks, twigs, and flower-stalks, the last of which often hold the fruits erect; the flowers, and often the fruits, are larger, and the latter are more or less sweet to taste.

**Diseases.**

The Apple-tree suffers from many diseases: gaping or cankerous wounds caused by frost, or by an insect (American Woolly Blight) which excretes cottony fluff, or by a fungus (*Nectria ditissima*) whose red little fructifications dot the margin of the wound. Various Green-flies and scale-insects suck its juices; while the larvæ of moths and beetles gnaw its foliage or burrow into its flowers and fruits, where they are familiar in the form of caterpillars or maggots.

## PYRUS COMMUNIS (*Linn.*).—Wild Pear (*Rosaceæ*)

The Pear-tree differs from the Apple-tree in having the five styles completely separate, in its purplish-red anthers, also in shape of fruit, which, even when not pear-shaped, has no depression at the base.

The Pear-tree recalls the Crab-tree in general form; in arrangement and even form of its variable leaves; in design of its branches, which include long-shoots, foliaged dwarf-shoots, flowering spurs, and often thorns; in form and position of its inflorescences and flowers. But the following special features may be noted:—

Fig. 445.—Leaf of Wild Pear.

The tree may be taller, and usually shows a narrower crown through which the trunk passes without obliteration. The deeply-furrowed bark (Fig. 446) only infrequently sheds small scales.

**Special Features.**

admixture of rose-colour, and in design is like that of the Apple-tree, except for the above-mentioned distinctness of the styles and darker colour of the anthers (compare Fig. 449).

The flower may remain fresh for seven or eight days, after which its withering petals fall. When the flower opens, the stigmas are already receptive and nearly erect. Crouching beneath them, and concealing the nectar secreted

**Pollination.**

Fig. 446.—Bark of Wild Pear.

The leaves (Fig. 445), when mature, and the resting-buds are hairless : this instantly distinguishes the tree from the Common Apple-tree.

The flower is usually white, without any

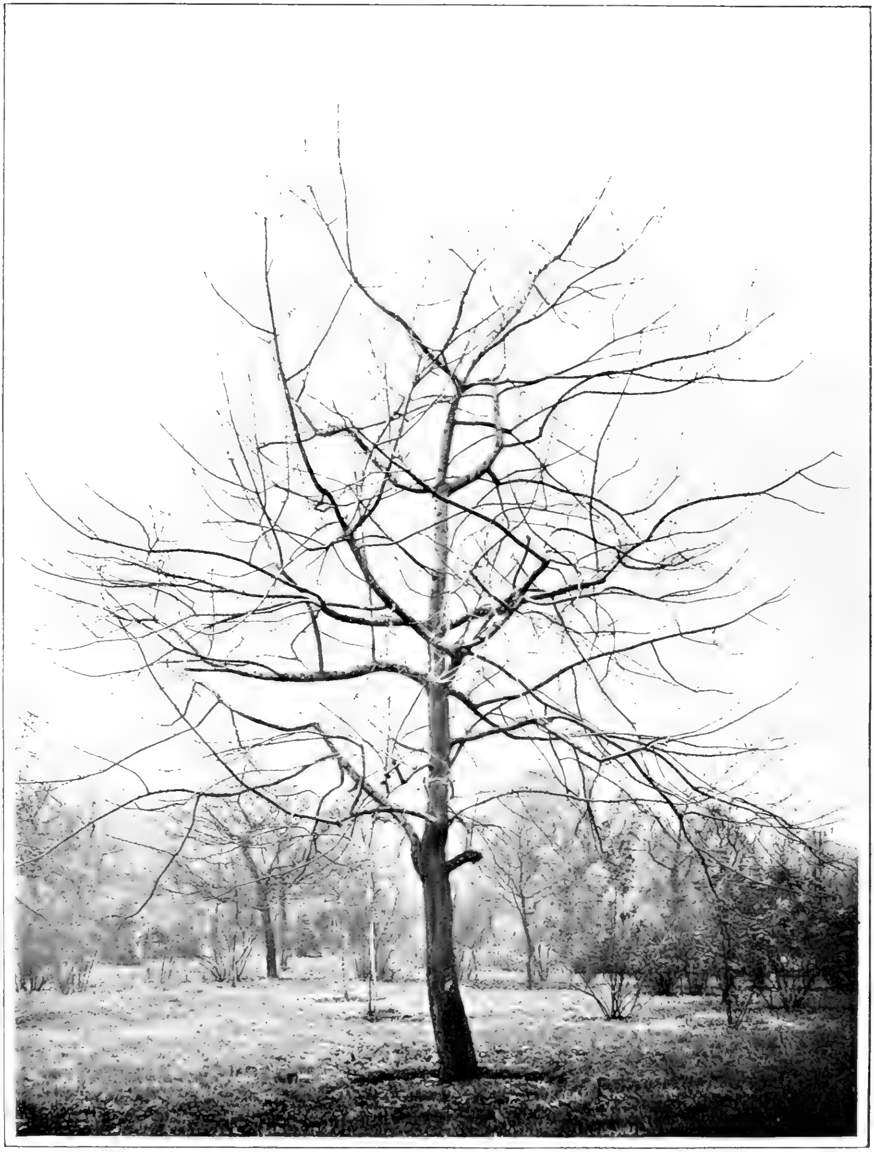

Fig. 447.—WILD PEAR—*PYRUS COMMUNIS:* WINTER.

Fig. 448.—WILD PEAR—*PYRUS COMMUNIS*—IN BLOOM.

Fig. 449.—Flowers of Pear.

by the receptacle, are the inwardly-bent stamens, whose anthers are still closed. From two to four days elapse before the outer stamens unbend, stretch outwards, and open their anthers, and are successively followed by the inner stamens, until the fifth, sixth, or seventh day finds even the innermost stamens extended with open anthers. Cross-pollination alone is possible at first, but subsequently self-pollination through the agency of insects would seem feasible; indeed, the final and spontaneous bending outwards of the styles can bring the stigmas against the pollen-laden anthers and render superfluous any intervention by insects. Yet it is doubtful whether or no self-pollination results in the production of good seed; for some cultivated sub-varieties of Pear-trees are more or less sterile to their own pollen.

The spotted, sour fruit may be pear-shaped (compare Fig. 450) or rounded, both forms occurring on the same individual tree. Apart from the absence of the concavity at its bottom, the fruit differs from an apple in that the five chambers, when cut across, are rounded at their outer margins (not narrowly acute as in the apple), also in that the fleshy layer is "gritty" when bitten, as minute stone-like bodies are lodged in it at intervals.

**Varieties.**

There are several varieties of Wild Pear which must not be confused with cultivated varieties that have escaped and are apparently wild. The relationships of the various cultivated varieties of Pear to *Pyrus communis* are not certainly known.

Fig. 450.—Fruits of Pear.

## PYRUS AUCUPARIA (*Ehr.*).—Rowan or Mountain Ash (*Rosaceæ*)

The Mountain Ash owes part of its name to its compound leaves, which resemble those of the Ash, but are alternate and possess stipules. From the Ash, as well as from the Apple and Pear trees, the Rowan is distinguished by its nearly flat-topped inflorescences of many small creamy flowers, and by its red berry-like fruits.

Fig. 451.—Bark of Rowan.

The tree is not a large one, its height being from ten to thirty feet. Its general form varies considerably, but the crown is never dense. The bark remains smooth for years, showing in its second stage a resemblance to that of the Cherry-tree, because it is marked with transverse lines (lenticels); but eventually

**Bark.**

Fig. 452.—ROWAN OR MOUNTAIN ASH—*PYRUS AUCUPARIA:* WINTER.

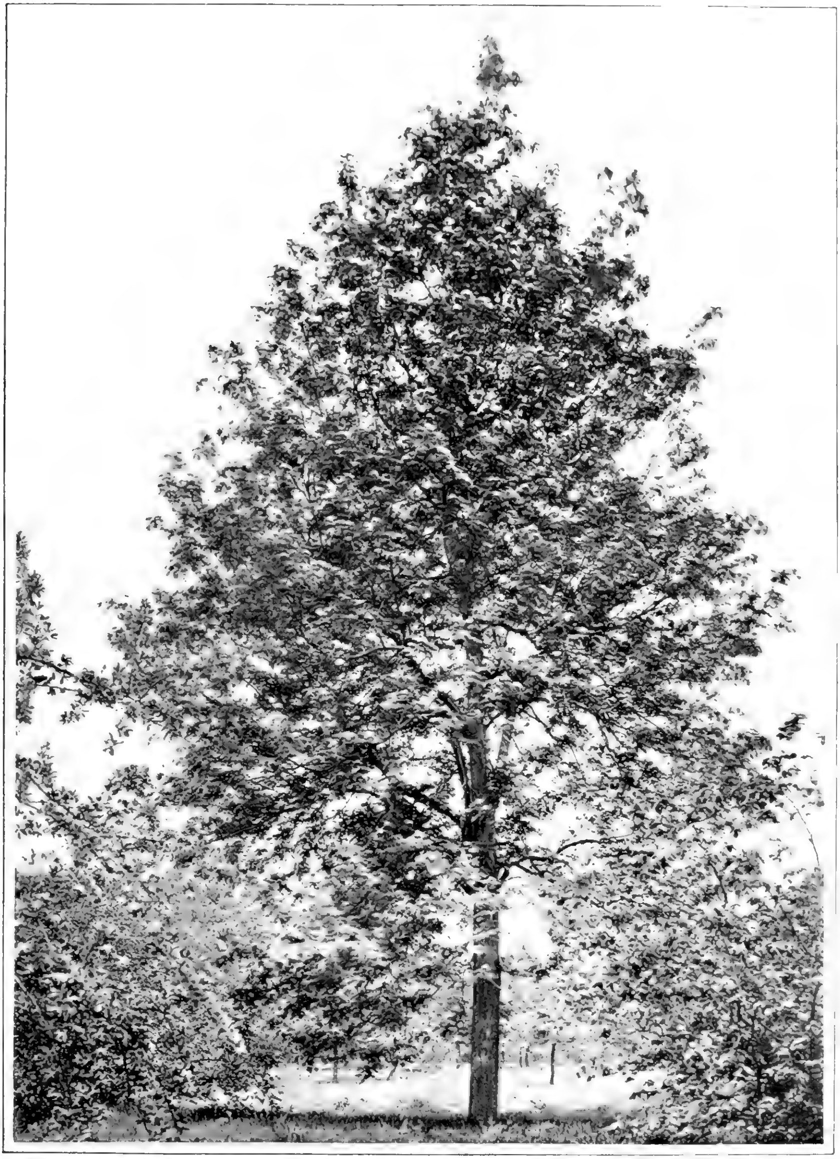

Fig. 453.—ROWAN OR MOUNTAIN ASH—*PYRUS AUCUPARIA*: SUMMER.

Fig. 454.—Leaf of Rowan.

it becomes thick, furrowed, and greyish-black (Fig. 451).

The spirally-arranged, stipulate leaves show pairs of opposed leaflets, and an odd terminal one (Fig. 454). The leaflet has saw-like teeth, and only its pale lower face preserves a thin film of scattered hairs, especially along the nerves.

**Leaves.**

The long, hair-coated resting-buds, like those of the Ash, have very dark-coloured scales, often nearly black; the lateral buds being pressed close against the side of the stem (Fig. 455). Some buds grow out into long-shoots, but many develop into slow-growing dwarf-shoots, whose few crowded leaves, year after year, cause the closely set ring-like markings on the stem.

**Buds.**

The showy inflorescences usually terminate foliaged dwarf-branches, which are inserted at the tips or on the sides of long-shoots. The inflorescences are repeatedly branched, but raise all the cream-tinted blossoms nearly to the same level (Fig. 456). They appear in May or June.

**Flowers.**

The regular flower agrees in design with that of the Apple-tree, except as regards the pistil. This consists of from two to four (often three) carpels, which at their bases are completely united to form a two- to four-chambered ovary, but higher up are separate at their inner edges; the two to four styles are likewise separate, and have white hairs on their lower parts.

The stigmas are receptive before the anthers open. The scent of the flowers is similar to that of the Hawthorn, and though attractive it is none the less due to a substance (trimethylamin) also exhaled by stinking dead fish. Lured by the conspicuous, scented inflorescences, and by the nectar, which is accessible though imperfectly concealed under the style-hairs, a mixed horde of short-tongued, unintelligent flies and beetles, as well as longer-tongued insects, including bees, visit the flowers and effect cross-pollination.

Each ovary develops into a small, red, rounded, apple-like fruit (the so-called "berry"), which has

**Fruit and Seeds.**

Fig. 455.—Twig of Rowan in Winter.

Fig. 456.—Inflorescence of Rowan.

from two to four thin-walled stones. The fruits are dispersed by birds. The seed is wholly occupied by the embryo.

The Rowan, a true British plant, has an extraordinarily wide range of distribution and habitat. Found in the far frigid North, with the Birch, it yet extends down to Greece. It can ascend to considerable altitudes (2,600 feet in Scotland)—hence the name Mountain Ash. It can live not only on ordinary fresh soil, but also on wet soil in company with the Alder; or, as a little tree, it can eke out an existence on rocks, where, in place of a long main root, it produces shallow, spreading, lateral ones that force their way into crevices; and I have seen it growing in the forks of large Oak-trees, on the broad trunk-heads of Pollard Willows, whither its seeds were conveyed by birds and where accumulations of leaves, dead wood, and mosses had provided a scanty soil. This hardiest of trees can also bear a fair amount of shade in forest.

**Habitat.**

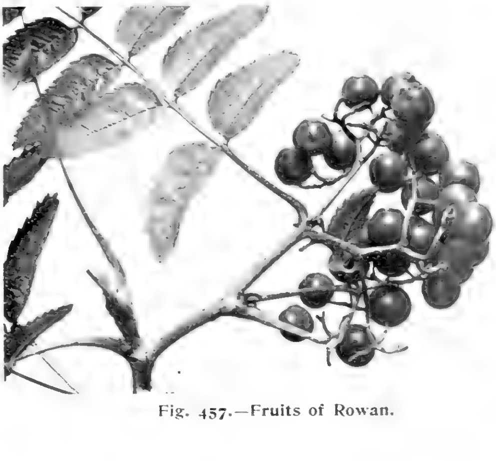

Fig. 457.—Fruits of Rowan.

Fig. 458.—SERVICE-TREE—*PYRUS SORBUS:* WINTER.

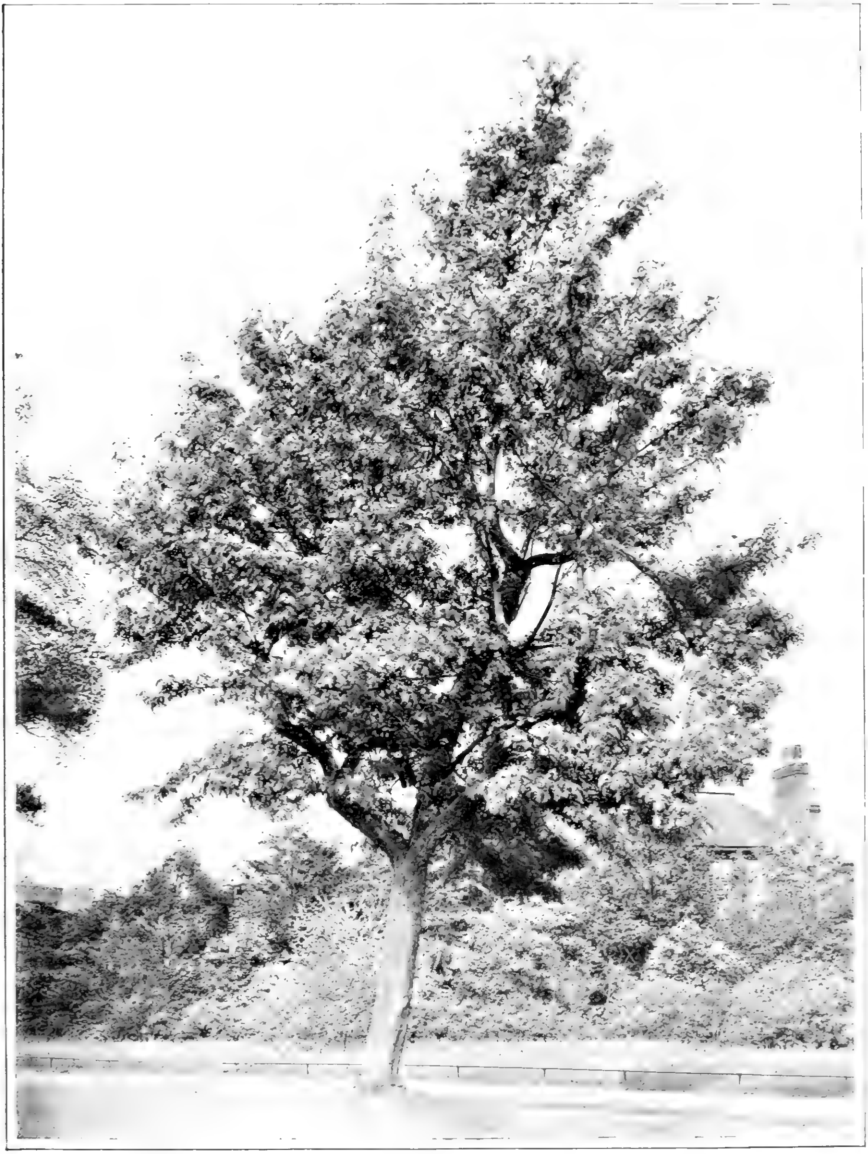

Fig. 459.—SERVICE-TREE—*PYRUS SORBUS*: SUMMER.

## PYRUS SORBUS (*Gaertn.*).—Service-tree (*Rosaceæ*)

The Service-tree is neither common in Great Britain nor is it a native. As it resembles the Mountain Ash in habit, foliage, and inflorescences, the points in which it differs from that tree are described below.

The bark becomes rough and scaly early in life (Fig. 460).

The compound leaves have leaflets that for the most part are toothed only near their tips (*i.e.* in the upper third) (Figs. 18, 56).

The resting-buds are greenish, or greenish-red, sticky, and nearly hairless; the lateral buds are not pressed close against the stem (Fig. 22).

Fig. 460.—Bark of Service-tree.

The larger white flower (Fig. 461) has five woolly styles and five ovary-chambers.

Fig. 461.—Inflorescence of Service-tree.

The larger, pear-shaped, or spherical fruits (Fig. 56) are green or yellow with red cheeks, but when rotting and edible may become brown.

## PYRUS ARIA (*Ehr.*).—White Beam (*Rosaceæ*)

Fig. 462.—Shoot of White Beam.

The White Beam is recognised by its repeatedly branched flat-topped inflorescences of white flowers, resembling those of the Mountain Ash, its similar collections of orange or scarlet berry-like fruits, and by the snowy under-surface of its simple leaves.

*Pyrus Aria* varies in form from a shrub to a tree that may be forty feet in height.

**Height and Form.**

As a tree its shape is so variable as to defy general description; sometimes the trunk remains distinct, and the branches ascend or spread horizontally, so that our illustration of the Mountain Ash would serve to denote this tree; at other times all the branches ascend steeply as in Figs. 463 and 464. The bark remains grey and smooth for many years, but eventually shows shallow longitudinal fissures (Fig. 465).

**Leaves.**

The spirally-arranged leaves have narrow little stipules that become brown and fall very early. The toothed blade shows considerable variety of form (Figs. 462 and 468), and may be feebly

Fig. 463.—WHITE BEAM—*PYRUS ARIA*: WINTER.

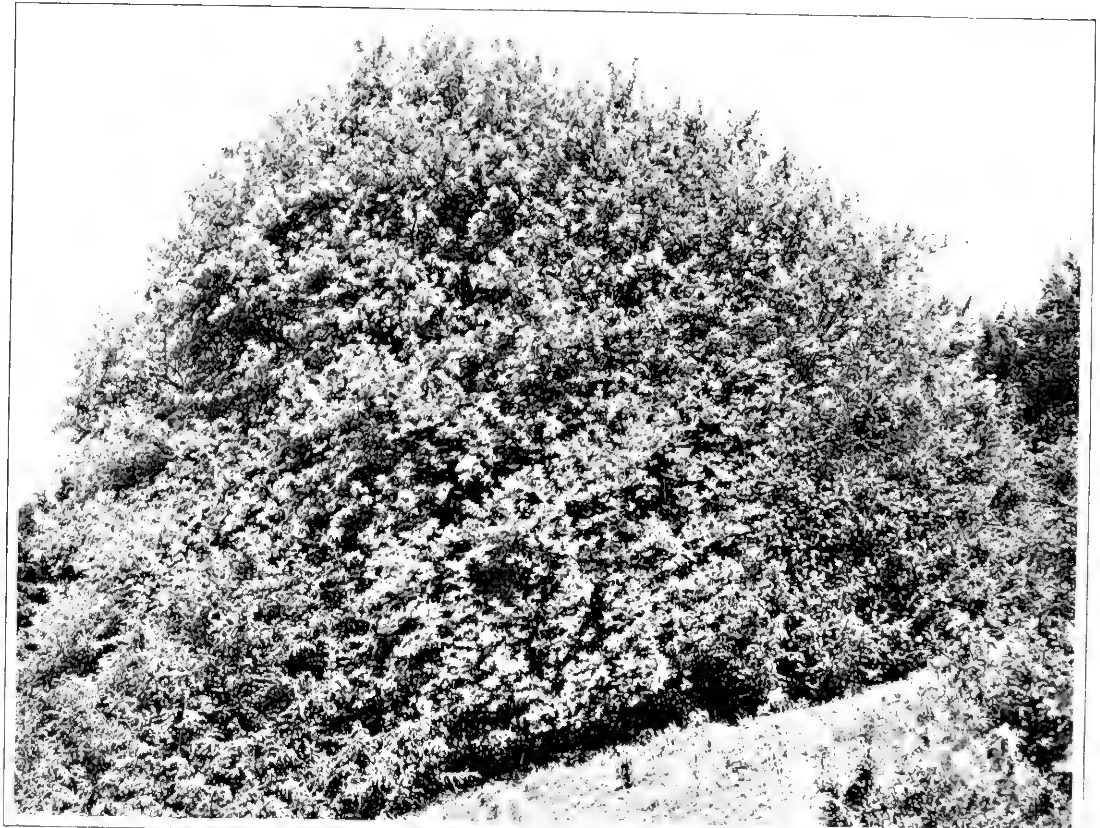

Fig. 464. WHITE BEAM *PYRUS ARIA*: SUMMER.

lobed towards its end; but the important feature is that its lower face (as well as the leaf-stalk) is coated with a permanent covering of snowy hairs which render the tree recognisable from a considerable distance.

shoots and dwarf-shoots as in the species of *Pyrus* already described.

**Flowers.** In May or June the masses of white blossom are revealed. The flat-topped, repeatedly branched, inflorescences terminate dwarf-shoots (Fig. 466) which are

Fig. 465.—Bark of White Beam.

at the tips or on the sides of long-shoots. The stems of the inflorescences are coated with white woolly hairs. The white flower is very like that of the Mountain Ash, but somewhat larger, and the structure of the pistil is different. The two or three carpels

**Buds.** The long, large, pointed resting-buds display a few brown and green scales fringed with hairs: the lateral buds are applied to the stem or stand out (Fig. 467).

There is the same distinction into long-

Fig. 466.—Inflorescences of White Beam.

are more closely united, being fused, not only as far up as the top of the two- or three-chambered ovary, but also for some distance up the style; yet even where the style is single the traces of the three original styles are shown in the form of ridges continued down from the separate style-branches. Each ovary-chamber contains two ovules.

**Fruit.** The fruits (Fig. 468) are ripe in September, when they somewhat resemble little cherries, but their scarlet or orange tints are often flecked with dots, and they are capped with the remnants of the calyx. The fruit is hardly juicy, for the layer of its wall outside the two or three thin-walled, seed-containing compartments is "flowery." Each compartment includes one or two seeds, whose structure agrees with that of an apple-seed.

**Requirements.** The precise needs of the White Beam have not been closely investigated by foresters, but a glance at the Beech-woods on chalk soils in Buckinghamshire gives the clue to two characters. Round these woods many White Beams may be seen standing like sentinels, with their snowy leaf-surfaces showing in the breeze. They are obviously trees that demand light, and are kept from the inside of the woods and even expelled by the shade-enduring Beech-trees. White Beams, then, are found in sunny places, often at the edge of a forest, and they thrive especially on soils containing lime (as does the Beech-tree).

There are in Great Britain several species (or sub-species) or hybrids which are closely allied to the White Beam, but differing especially in the form or lobing of the leaves. One of these, *Pyrus intermedia* (Ehr.), is so intermediate in character between the White Beam and the Wild

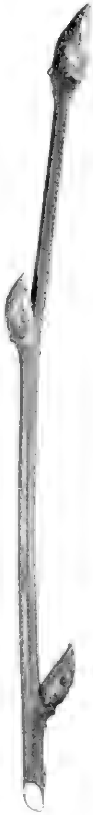

Fig. 467.
Twig of White Beam in Winter.

Fig. 468.—Fruits of White Beam.

Service-tree that some botanists regard it as a hybrid of these two species; while another, *P. pinnatifida* (Ehr.) [or *P. semi-pinnata* (Roth)], has leaves that show shapes intermediate between those of *P. Aria* and *P. Aucuparia*, as the blade is more or less divided into leaflets at its base, but is decreasingly lobed up towards its tip. This tree, then, is probably a hybrid of the two species in question.

## PYRUS TORMINALIS (*Ehr.*).—Wild Service-tree (*Rosaceæ*)

**Distinctive Features.**

This British tree is recognised by its flat-headed, repeatedly branched inflorescences of white flowers; its small brown pulpy fruits; its alternate simple leaves, which have pointed lobes with saw-like teeth, and are more or less hairless when mature.

As in the arrangement and design of its various parts the Wild Service-tree agrees closely with the Rowan and White Beam, we shall merely mention the points in which it differs from the last-named, which likewise has simple leaves.

The oval-crowned small tree, thirty or forty feet in height, shows at the base of its trunk a bark that regularly casts off thin little scales (Fig. 470).

The simple stipulate leaves vary in form, but their usual shapes are shown in the accompanying illustrations. It will be noticed that the lobes of the blade decrease in size from the base upwards, until they insensibly give way to mere teeth near the leaf-tip. The leaf contrasts with that of

Fig. 469.—Shoot of Wild Service-tree.

the White Beam, not only in shape, but in that the mature leaf-stalk and lower face of the blade, though sometimes still showing hairs, are at least devoid of any snowy covering.

The resting-buds are not long, but stumpy and rounded (Fig. 473).

The inflorescences (Fig. 45) and flowers are very like those of the White Beam. In the flower there are usually two carpels that combine to form an inferior two-chambered ovary, and a single style which divides above into two branches.

The pulpy fruit (Fig. 57) is rounded, oval, or pear-shaped, and as large as a small cherry; its final colour is brown, dotted with lighter spots (lenticels); the chambers are surrounded by a fairly hard stone.

Fig. 470.—Bark of Wild Service-tree.

In germination the two oval cotyledons emerge from the soil and become green.

The tree grows well on light, sandy or even calcareous, soils, avoiding wet or very

Fig. 471.—WILD SERVICE-TREE—*PYRUS TORMINALIS:* WINTER.

Fig. 472.—WILD SERVICE-TREE—*PYRUS TORMINALIS*: SUMMER.

dry places. By dint of spreading out its lateral roots the Wild Service-tree can live on shallow soil. Its form gives but little indication of the amount of light that the tree requires. Yet its slow growth during youth (and later life) and the feature that large boughs are attached relatively to the trunk, conform with the tree's capacity to ensure a fair amount of shade. The Wild Service-tree is therefore often found in woods as well as in hedgerows.

*Pyrus torminalis* and *P. Aria* show some analogy to *Viburnum Opulus* and *V. Lantana* respectively (pages 306–404), but the leaves of the first two are alternate, those of the last two opposite: in addition, in *Viburnum* the petals are united, and the stamens in each flower number only five and are attached, not to the receptacle, but to the corolla.

**Fig. 473.—Twig of Wild Service-tree in Winter.**

## CRATÆGUS OXYACANTHA (*Linn.*)

### HAWTHORN (*Rosaceæ*)

**Fig. 474. Twig of Hawthorn in Winter.**

As a shrub or tree the Hawthorn or White Thorn is recognised by its white or pink scented inflorescences ("May-blossom"), red stone-fruits ("haws"), spines, and characteristic lobed leaves, some of which have relatively large green persistent stipules.

**Height and Habit.**

Although usually seen as a closely branched hedge-shrub, the Hawthorn may attain to a height of thirty feet or more as a tree, with loosely or densely arranged slender branches, which frequently droop at their ends. The trunk often reaches a thickness of one foot. The bark eventually shows numerous, particularly longitudinal, furrows dividing it into many small scales (Fig. 475).

**Leaves.**

The simple leaves are spirally arranged. On the long-shoots the stipules are large, green, persistent, and indented (Fig. 479); but on the tufted dwarf-shoots the stipules are small, and short-lived. The stalked leaf-blade is divided into three or five lobes, which are more or less toothed; it is somewhat glossy, and nearly or completely hairless.

**Buds and Branches.**

The small resting-buds show a few spirally arranged scales (Fig. 474); but in winter it is the spines that specially aid the identification of the plant.

The buds may give rise to no less than five kinds of branches. (1) Some grow out into long-shoots having the leaves separated by distinct internodes (*see* Fig. 479). (2) Others develop into foliaged dwarf-shoots with imperceptible internodes, so that the leaves are tufted; and as the stem in this case grows slowly, year after year it shows numerous ring-like scars left by fallen bud-scales and leaves. (3) Still other buds grow into shoots like the last-mentioned save that they each terminate in an inflorescence (Fig. 480). (4) Sometimes a bud grows out into a shoot with moderately long internodes, as if it were about to produce a long-shoot, but towards its end the leaves gradually dwindle to tiny, narrow, red scales while the stem tapers to a point; the stem hardens and becomes woody to its extreme tip, and thus becomes a thorn; in later years this *long-thorn* may emit branches (Fig. 478). (5) Sometimes a bud in the axil of a leaf develops precociously, in the year of its birth, into a short red tapering stem which hardens and becomes a thorn, and has on its sides only two small basal scales, and a few minute ones separated by distinct internodes higher up: this is a *short-thorn* (*see* the upper shoot illustrated in Fig. 479). Such a short-thorn in later years may emit dwarf-branches from the axils in its basal scales. It will, therefore, be seen that the thorns are arrested branches, and that they represent stunted long-shoots rather than pointed dwarf-shoots.

**Fig. 475.—Bark of Hawthorn.**

Fig. 476.—HAWTHORN—*CRATÆGUS OXYACANTHA*: WINTER.

Fig. 477.—HAWTHORN *CRATÆGUS OXYACANTHA* IN BLOOM.

The white or rosy flowers open in May or June, and are arranged into an inflorescence which has a slightly curved or nearly flat top (Fig. 480). The general design of the flower is like that of an Apple-tree, except as regards the carpels.

**Flowers.**

Each regular flower has five joined sepals; five separate, rounded, white petals; about twenty stamens with anthers which are pink before they open; all these are attached at the edge of a little basin. From near the centre of this there rises a single style (less frequently two or three styles) capped by a broad stigma; below is the inferior one-chambered (less often two- or three-chambered) ovary. Each ovary-chamber contains two ovules, of which one is an incompletely developed rudiment incapable of producing a seed.

Fig. 479.—Shoots of Hawthorn.

**Pollination.**

The plant often covers itself so completely with blossom that the leaves, though present, are hardly seen. Moreover, the flowers have a characteristic odour that is pleasing to some human beings, and to flies that are fond of putrefying organic matter (the scent is at least partly due to trimethylamin, which is also exhaled from dead fish). Flies, as well as some beetles and bees, cross-pollinate the May-blossom. The stigma is receptive before the still pink anthers open; at this stage the outer stamens stand erect, and the inner stamens are bent inwards and downwards beyond reach of the stigma, so that only cross-pollination is possible. In fine weather all the stamens subsequently spread out radially, and reveal at the base of the style the silvery hairs that conceal the nectar. But

Fig. 478.—Spines of Hawthorn.

Fig. 480. Flowers of Hawthorn.

if the weather be cool and damp, the inner stamens never relinquish their bent pose, while the outer stamens project above the stigma upon which they shed their pollen, thus causing spontaneous self-pollination.

Not until October or November has the ovary given place to the ripe, red "haw" (Fig. 481), which is not a berry, but a stone-fruit containing a single, one-seeded, hard stone (less frequently two or three one-seeded stones). The roof of the fruit lying within the persistent ring of sepals has no fleshy layer, so that here the stone is near the surface. It is in the hardness of its stone that *Cratægus* differs from *Pyrus*. The fruits are eaten and dispersed by birds.

**Fruit.**

The seed is wholly occupied by the embryo. In germination the oval green cotyledons emerge from the soil, and are immediately succeeded by delicate little foliage-leaves very similar to the later ones.

**Seed.**

Of the Hawthorn there are two extreme kinds which are found growing wild, and are described as distinct species or sub-species. The common one has usually one style, one ovary-chamber, and therefore one stone—hence it is known as *C. monogyna*. The less common form, known as *C. oxyacanthoides*, has two or three styles, ovary-chambers, and stones, and differs in other respects. Between these two extremes there occur intermediate forms which may or may not be hybrids. In addition to the two species described above, there are garden varieties with red blossom, also with double white or red flowers. But many Hawthorns, trees and shrubs, cultivated in gardens belong to entirely different species.

**Forms.**

Fig. 481.—Fruits of Hawthorn.

# CORNACEÆ

## CORNUS SANGUINEA (*Linn.*).—Dogwood (*Cornaceæ*)

The Dogwood-shrub is recognised by its creamy-white, terminal, nearly flat-topped inflorescences, its characteristically veined, simple, opposite leaves, its red branchlets and autumn leaves, and above all by the

**Fig. 482.—Shoot of Dogwood.**

structure of its regular flowers. The flower has separate petals, and an inferior two-chambered ovary; it includes four sepals, four petals, and four stamens, one style, and a knob-like stigma.

**Habit.** The shrub often approaches a tree in form, and varies in height from six to fifteen feet. The main branches are erect, or ascend steeply, and tend to be straight; they are covered with brown bark which shows many fine cracks running lengthwise and crosswise. The straight slender branchlets, on the other hand, are blood-red in colour, especially at spring-time.

**Leaves.** The simple, stalked leaves (Fig. 482) are opposite and ranged in four ranks. They possess no stipules. The leaf-blade is often oval in shape, has an untoothed margin, but terminates in a sharp point. The most characteristic feature of the leaf, however, is the form of the veining; the lateral veins are few (three or four pairs) in number, are prominent and arched, so as to converge finally towards the tip. The leaves become red in autumn.

**Buds.** The downy resting-buds (Fig. 483) are compressed and lance-shaped, the lateral ones being more or less applied to the stem. Each shows from two to four scales. Beneath the obvious lateral bud in the axil of a leaf there stands a smaller "accessory" bud.

**Flowers.** The creamy-white flowers, which are ranged in terminal, stalked, more or less flat-topped, repeatedly forked inflorescences (Fig. 484), open in June or July; but occasionally a second crop of them bursts into blossom in September or October.

The flower is regular and bisexual. Four tiny teeth represent the sepals. The four white petals are succeeded by four stamens which alternate

**Fig. 483. Twig of Dogwood in Winter.**

Fig. 484.—Inflorescences of Dogwood.

pea, and containing a two-chambered stone within its feeble fleshy layer. At its summit there still remain the four teeth representing the sepals.

*Cornus Mas* (Linn.) is a shrub or little tree often see in English gardens, although it is not a British plant. Its opposite, simple leaves are marked by the same characteristic arched veining as those of *C. sanguinea*. But the flowers of *C. Mas* are yellow and open in February or March before the leaves appear. At this season the shrub, with its little groups of stalked yellow flowers decking the tips and sides of the leafless twigs, is therefore almost unmistakable. The fleshy fruits are red.

with them. In the centre of the flower is a knob-like stigma, which terminates a single style. And below all these parts is the inferior two-chambered ovary containing one ovule in each chamber.

**Pollination.** The nectar is freely accessible to all kinds of insects, as it is manufactured by the disk surmounting the ovary. For this reason, also because the small flowers are massed together to form showy blossom, and exhale the scent of trimethylamin (which is also exhaled from dead fish), the insect visitors include a considerable number of short-tongued, unintelligent, flies and beetles. These easily lick the surface of the exposed disk, as do the few bees and the hover-flies that also come to the flowers. As the anthers open towards the centre of the flower at the same time as the stigma is receptive, cross-pollination and self-pollination by the agency of insects are both possible.

**Fruit.** The fruit (Fig. 485) ripens in September, when it is seen to be a black or bluish-purple, somewhat dry, spherical stone-fruit, about as large as a

Fig. 485.—Fruits of Dogwood.

Fig. 486.—DOGWOOD—*CORNUS SANGUINEA*: WINTER.

Fig. 487.—DOGWOOD *CORNUS SANGUINEA*: SUMMER.

# OLEACEÆ. OLIVE FAMILY

Among the familiar members of the Oleaceæ are the Lilac, Privet, and Ash-tree. In this family the *leaves* are *opposite*, and devoid of stipules. The flower is *regular* and *hypogynous*, and commonly shows the following parts: *four sepals*, *four united petals*, only *two stamens*, and a superior *two-chambered ovary* containing only a few (often four) ovules. The peculiar feature is the presence of only two stamens.

But, as will be seen hereafter, the Common Ash-tree differs in being a degenerate representative which has lost both sepals and petals.

## FRAXINUS EXCELSIOR (*Linn.*)

COMMON ASH-TREE (*Oleaceæ*)

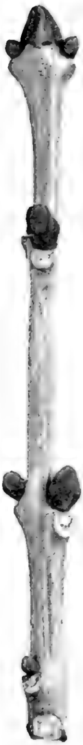

Fig. 488. Long-shoot of Ash in Winter.

This tree is recognised by its opposite pinnately compound leaves, which are mounted on prominent leaf-cushions; its black resting-buds and coarse lumpy twigs; its dingy tufts of little flowers which emerge before the leaves; its clusters of hanging strap-like fruits; as well as by the peculiar structure of the flowers.

The deep and large root-system limits well-grown Ash-trees to deep soil.

**Dimensions and Form.** The tree may be 100 feet in height, but the trunk is not proportionately thick, as it rarely exceeds a yard in diameter. In the forest the trunk is straight, cylindrical, and branchless up to a height of perhaps forty or fifty feet, but in the open the boughs may be within ten feet of the ground. The crown is rather loosely branched and the foliage relatively light, so that the tree does not cast deep shade.

The bark remains smooth for thirty or forty years, but finally becomes rough and furrowed (Fig. 490).

**Leaves.** The opposite, four-ranked leaves (Fig. 494) are stalked, but lack stipules. Each has four or six pairs of stalkless opposite leaflets as well as a terminal one; the leaflets are toothed and sharp-pointed. The leaves unfold late in the season, not before May, and fall in autumn, often while still green.

**Buds.** The black resting-buds (Figs. 488, 489) are very characteristic of the tree. The terminal bud is considerably larger than the lateral ones. The black colour is mainly due to a velvety coating of black hairs clothing the outermost pair of scales, which, with

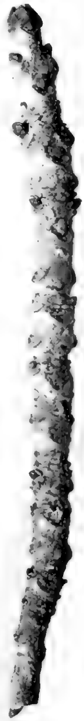

Fig. 489. Dwarf-shoot of Ash in Winter.

or without the co-operation of two others, invest the bud. The twigs are coarse, and are remarkable for the thick nodes, which owe their prominence to the large opposite leaf-cushions upon which the and that these together with the following leaves display an interesting series of transitional stages between scales and full-sized elaborate foliage-leaves. The terminal buds develop exclusively into leafy shoots.

Fig. 490.—Bark of Ash.

leaf-scars are mounted (Fig. 488); particularly striking for these reasons are the rough leafless dwarf-shoots (Fig. 489), which have the projecting leaf-cushions separated only by very short internodes. When a foliage-bud opens it is seen that there are often three pairs of scales enveloping each bud,



**Flowers.**

In April or May, before the leaves unfold, the branched and tufted inflorescences shoot forth from lateral buds on the twig produced during the preceding year (Fig. 493). The tree commences to flower regularly at an age of from thirty to forty years.

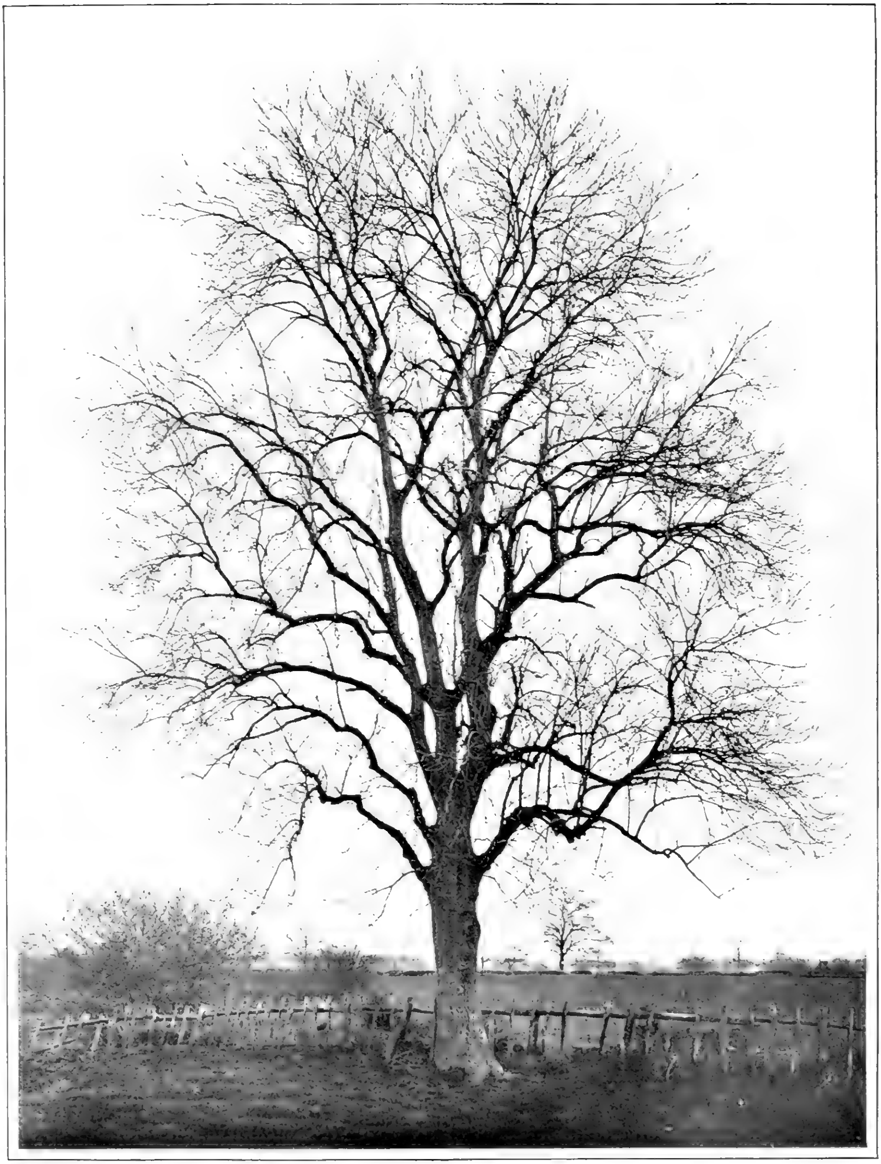

Fig. 491.—ASH—*FRAXINUS EXCELSIOR:* WINTER.

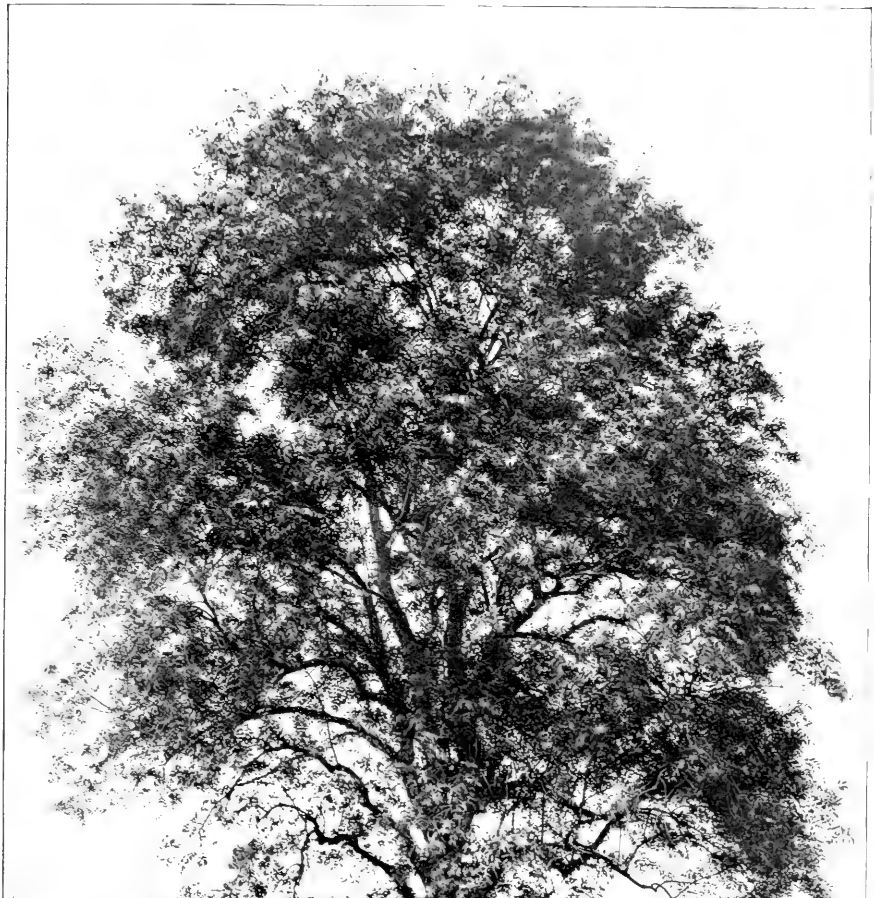

Fig. 492.—ASH—*FRAXINUS EXCELSIOR:* SUMMER.

The flowers are extremely interesting as affording examples of degeneration that has culminated in the production of unisexual flowers devoid of sepals and petals. There are three distinct kinds of flowers—bisexual, male, and female—each standing alone in the axil of a narrow, pointed, little bract. None of the flowers have sepals or petals. The bisexual flower consists solely of two stamens with purple anthers, and a superior pistil; this latter shows two large fleshy stigmas combining below into a very short style, which caps the two-chambered, laterally flattened, ovary; in each ovary-chamber there are (ultimately) two ovules. The female flower is similar, except that the two stamens soon fall off, never open their anthers, nor produce perfect pollen. But the male flower consists entirely of two stamens. There are, however, flowers intermediate between these three types. Some apparently bisexual flowers are really male, as the pistil falls off early; and seemingly other falsely bisexual flowers do not produce seed, despite of pollination, and are therefore male flowers. The three distinct kinds of flowers are grouped on the same individual tree or on different trees in various ways; and it is of great interest that the same individual tree is not necessarily of the same sex in successive years.

**Fig. 494.—Shoots of Ash.**

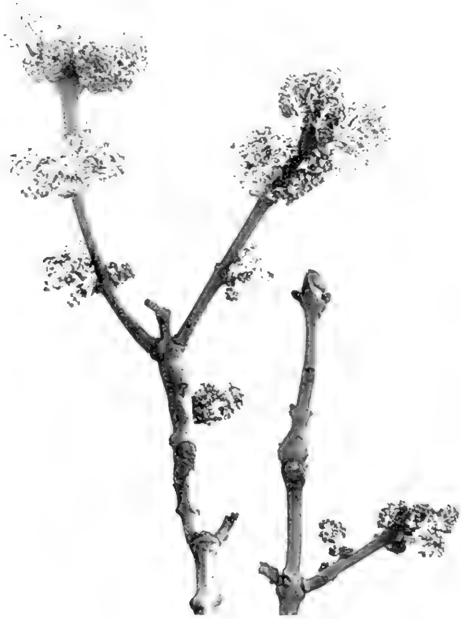

**Fig. 493. Inflorescences of Ash.**

Comparison with the Manna Ash (*Fraxinus Ornus*), which has sepals, and four narrow long petals to each flower, suggests that the Common Ash has lost these structures as it has become wind-pollinated. Even the Manna Ash sometimes produces

Fig. 495.—Fruits of Ash.

flowers without petals; and the Common Ash, on the contrary, is known to produce four sepals sometimes. It is also evident that the Common Ash has produced male and female flowers through the degeneration of the pistil and stamens respectively of an originally bisexual flower.

The flowers are wind-pollinated, and pollination is facilitated by the circumstance that blossoming takes place before the foliage comes out to obstruct the free transference of pollen blown to the stigmas.

**Fruit.** The ovary develops into a strap-like winged fruit, and, as the fruits remain green for many weeks, and hang in large clusters (Fig. 495), they are apt to be mistaken for foliage. The wing is terminal, aud often is tipped by the remains of the style. At the base is the seed-chamber containing one seed. The fruit does not open spontaneously, so that it is described as a one-winged nut. But in addition to these fruits are other smaller strap-like fruits which contain merely the four minute shrivelled ovules; fertilisation has not been effective, and these fruits, of course, will not give rise to new plants. The dry, brownish, fertile fruits usually hang from the tree all through the winter, after which they are dispersed by wind.

**Seed.** The seed contains an embryo as well as food-material (endosperm) outside this. At germination the seedling lifts the fruit bodily above the soil, and the cotyledons remain for a time inside the seed, sucking up the food-material. The cotyledons subsequently expand as green, nearly oval leaves, and are succeeded, not by ordinary foliage-leaves, but by three-lobed leaves. For about five years the growth of the little stem is tolerably slow, but thereafter the young tree grows relatively rapidly.

The Ash-tree demands a considerable amount of light, as might be surmised from the length of its bole in forest, the rapid growth of the young tree, the loose crown and thin foliage and the comparatively slight shade cast by it, and from the rough bark of later years.

Among the cultivated varieties of the

Fig. 496.—Weeping Ash.

**Varieties.**

Common Ash two deserve special mention: (1) The Weeping Ash (Fig. 496), which, as regards its branching, shows the mode of growth of an Elder, Weeping Beech, or Laburnum (*see* pages 392, 209, 322–4). (2) The variety which is known as *monophylla* because all the leaflets except the terminal one of the leaf are suppressed, so that the leaf at first sight seems to be simple.

# CAPRIFOLIACEÆ. ELDER FAMILY

The Caprifoliaceæ include the Elder, Guelder Rose, Snowberry, and Honeysuckle. The *petals* of the flower are *united*, and the *ovary* is *inferior* and often three-chambered. Each flower includes usually five sepals (represented), five petals, and five stamens, which are attached to the corolla but alternate with the petals. The *leaves* of the members of this family are *opposite*, and usually devoid of stipules.

## SAMBUCUS NIGRA (*Linn.*).—Common Elder (*Caprifoliaceæ*)

The Elder is recognised by the flat-topped inflorescences of small cream-coloured flowers, the opposite pinnately compound leaves, the large white pith of the vigorous shoots, as well as by the rough bark, the general habit, and the structure of the flowers.

Fig. 497.—Twig of Elder in Winter.

The Elder-tree varies in stature from twelve to thirty feet, and in habit from a shrub to a tree with drooping branches. The bark soon becomes rough and deeply furrowed; eventually it is thick, yellowish-brown, and scaly (Fig. 499).

**Leaves.** The opposite compound leaves (Fig. 500) are arranged in four ranks. Some of the leaves are devoid of stipules, but others have at the base one or two short thread-like stipules, which seem to be attached to the stem between the leaf-stalks, rather than to the leaves. The tip of the young stipule is glandular, and is said to excrete sugar. The utility of these nectaries, if they be such, is entirely unknown, as they are also found on stipules far away from the flowers. The stalked, almost hairless, leaflets are arranged in from two to five opposite pairs, but there is also a terminal leaflet which is usually more equal-sided at the base of its blade than are the others; each leaflet has marginal saw-like teeth, and often is prolonged into a slender tip.

Fig. 498.—Stem of Elder, showing Pith.

The resting-bud is peculiar in that though it has two, four, or six scales at the base, the upper leaves projecting at its tip are green foliage-leaves. The bud is therefore partly "naked" (Fig. 497). Another characteristic feature is that in

**Buds.**

the axil of each leaf, directly beneath the main bud, there is a smaller one, or there may be two or three smaller ones. The twigs are noticeable for . (1) the large size of the white pith (Fig. 498); and (2) the distinctness of the lenticels (Figs. 497-8), which are yellow-brown, cork-like little lumps standing out especially clearly from the green twigs of the current year.

The Elder admirably illustrates the mode of growth of a weeping-tree, and of a shrub.

**Mode of Growth.**

It tends to lose the tree-like form owing to two peculiarities in its behaviour. First, each stem grows only for a limited time, after which the end droops over. The buds that develop most strongly from such a drooping shoot are not at the tip, but are situated near the top of the arch or towards the base of the shoot. Such buds produce stout, long, erect shoots which in turn droop over. Conse-

Fig. 499.—Bark of Elder.

Fig. 500.—*Shoot of Elder.*

quently the apparent trunk of a tree is not a true one, but is composed of the bases of many branches, and it shows a more or less distinct zig-zag form. Not only the arrested growth of the main stem (and branches) causes the shrub-like form, but the repeated shooting out of tall, erect, pithy stems from the base of the trunk (*see* Fig. 499) and from the bases of the main boughs also contributes to produce this result. In addition to these vigorous ascending branches there are other shorter branchlets that spread horizontally and are to some extent dwarf-shoots.

**Flowers.**

The small, cream-tinted flowers open in June, and are arranged in repeatedly branched and flat-topped inflorescences, which terminate foliaged shoots of the current year (Fig. 501). The regular bisexual flower is attached to its stalk by a distinct joint. The five little green sepals do not touch one another in the bud. The five cream-coloured petals are united at the base to form a very short tube, to which the five stamens are attached. The inferior, green ovary contains one ovule in each of its three chambers, and is surmounted by a short thick style with a three-lobed stigma.

Although the inflorescences are showy and scented, the flowers are visited by but few insects, and these are mainly flies and beetles, which take pollen from the yellow anthers—for there is no nectar. The anthers open outwardly, yet self-pollination is easily accomplished, because the anthers and stigmas are ripe at the same time.

Fig. 501.—Flowers of Elder.

Fig. 502.—ELDER—*SAMBUCUS NIGRA:* WINTER.

Fig. 503.—ELDER—*SAMBUCUS NIGRA*—IN BLOOM.

**Fruit and Seeds.** The ovary develops into a stone-fruit containing three one-seeded stones, and having a pulpy outer wall which is usually black, though occasionally green. The fruits are dispersed by birds. The seed contains food-material stored outside the tiny embryo.

**Fig. 504.—Fruits of Elder.**

## VIBURNUM LANTANA (*Linn.*).—Wayfaring-tree (*Caprifoliaceæ*)

**Fig. 505.—Shoot of Wayfaring-tree.**

Characteristic of the Wayfaring-tree are the terminal parasol-like white inflorescences, the opposite simple leaves, the scurfy hairs clothing the shoots, the black fleshy fruit containing only one stone, and, finally, the structure of the little flowers.

Despite its name the Wayfaring-tree is usually a shrub rarely exceeding fifteen feet in height, and often not half this. From its base spring many long, ascending, branched shoots, whose growth is so rapid that they frequently attain a length of six feet in their first year. Branched scurfy hairs clothe the shoot, and remain attached for five years; but the stems eventually become encased in longitudinally fissured bark.

**Height and Habit.**

The opposite, four-ranked leaves (Fig. 505) are simple, and stalked, but lack stipules. The leaf-blade is toothed at the margin; on its somewhat wrinkled upper face scattered hairs occur, while on the lower face, and especially along the very prominent

**Leaves.**

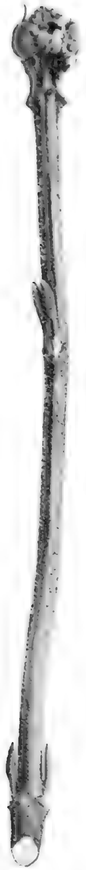

**Fig. 506. – Buds of Wayfaring-tree in Winter.**

veins, are borne numerous branched, scurfy hairs, which are continued along the leaf-stalk.

**Buds.** The resting-buds are of two kinds. A vegetative bud destined to develop into a foliaged branch is narrow and stalked; at first it has two external scales, which soon fall off, but it finally shows only a pair of erect, folded foliage-leaves clothed with hairs —the bud is thus "naked." But a terminal bud that in due time will produce an inflorescence is spherical in shape, and swells observably during the winter (Fig. 506), even though the blossom does not open before May or June.

**Flowers.** The inflorescence (Fig. 507) terminates a shoot, and resembles that of the Elder, though tending to be more umbrella-like in place of being flat-topped. The white flower, which has two bractlets at its base, is designed like that of the Elder except that the disk above the ovary excretes sugar, and that the three stigmas are directly inserted upon the ovary, and, finally, that the ovary has one complete chamber containing one ovule, and two rudimentary chambers devoid of ovules.

Cross-pollination and self-pollination through the agency of insects can take place in the Wayfaring-tree and Guelder Rose, as the projecting stamens open their anthers at the same time as the stigma is receptive. Bees visit the flowers in order to collect pollen, while short-tongued flies and beetles sip the freely accessible nectar. As the stamens eventually spread out, spontaneous self-pollination seems to be infrequent, but pollen may fall on to the stigmas of adjacent flowers and thus effect pollination of a kind. [The long-tubed Honeysuckle flowers are pollinated by long-tongued insects (moths and humble-bees).]

**Fruit.** The oval stone-fruit (Fig. 510) is somewhat flattened laterally; green at first, it becomes red, and finally black. It differs from the fruit of the Elder in containing a single one-seeded

**Fig. 507.—Inflorescence of Wayfaring-tree.**

Fig. 508.—WAYFARING-TREE—*VIBURNUM LANTANA*: WINTER.

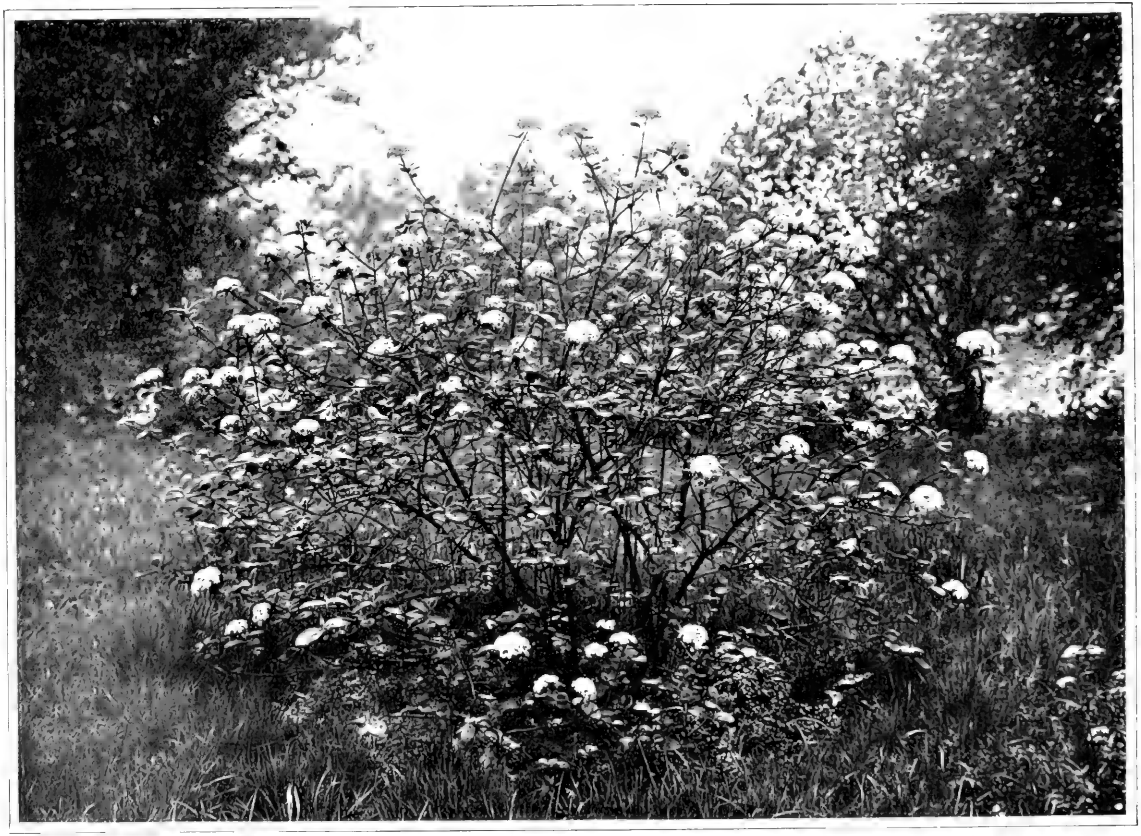

Fig. 509.—WAYFARING-TREE—*VIBURNUM LANTANA*—IN BLOOM.

stone, as is the natural result of the presence of only one ovule in the ovary.

The Wayfaring-tree is of interest in displaying a strong preference for a soil containing much lime, or, at least, it is usually found on calcareous soil.

*Viburnum Tinus*, a common garden shrub known as "laurustinus," differs from *V. Lantana*, in that its simple leaves are evergreen, and consequently thick and leathery.

**Fig. 510.—Fruits of Wayfaring-tree.**

## VIBURNUM OPULUS (*Linn.*).—Guelder Rose (*Caprifoliaceæ*)

The Guelder Rose is easily recognised by its characteristic inflorescences, consisting of showy, white, irregular, marginal flowers, and small, regular, central flowers; by its opposite lobed leaves, each of which has two pairs of stipules as well as some basin-like glands on the leaf-stalk. (The only plant in common cultivation likely to be confused with this plant is *Hydrangea*, which has similar inflorescences; but the central flowers of the Guelder Rose are designed on the same plan as those of the Elder, and have five stamens each, whereas those of *Hydrangea* have from eight to ten stamens each.)

*Viburnum Opulus* is a shrub, from nine to fifteen feet in height, which emits from its base many ascending shoots that give off slender hairless branches.

**Leaves.**

The opposite, four-ranked leaves are simple (Fig. 511). At the base of the leaf on each side are two thread-like stipules. At the tip of the stipule is a gland which is often basin-like;

**Fig. 511.—Shoot of Guelder Rose.**

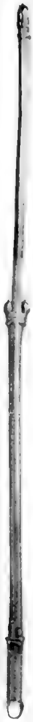

Fig. 512. Twig of Guelder Rose in Winter.

higher up the leaf-stalk there stand larger basin-like glands supported on very short stalks. These glands are stated to secrete sugar, but their utility to the plant is entirely unknown. The leaf-blade has three or five pointed lobes, and the veining tends to be palmate at the base: only on the lower face does the blade possess hairs, which are scantily arranged along the veins.

The egg-shaped resting-bud (Fig. 512) is closely enveloped by a single scale, which is often divided into two near the tip, and probably represents two united scales.

The showy inflorescences (Fig. 513) terminate foliaged shoots of the current year, and are repeatedly branched, more or less flat-topped, collections of flowers, which open in June.

The flowers assume two forms.

The central flowers are small, white, and regular; moreover, each is designed like the flower of *Viburnum Lantana*.

**Flowers.** The marginal flowers are conspicuous, white, and somewhat irregular; each has five green sepals; five somewhat irregular, spreading petals, united at the base to form a short tube; five very small sterile stamens showing swellings that denote the anthers; and, although these flowers are universally described as sterile, sometimes at least there is an ovule in the inferior ovary, which is capped by two or three stigmas.

**Pollination.** The marginal flowers are (mainly or exclusively) designed to attract the notice of insects, but the central ones produce seed. Bees visit the flowers in order to steal pollen, while flies and beetles come to sip at the nectar excreted by the disk that lies above the ovary. Cross- and self-pollination are both possible, as stamens and stigma ripen simultaneously.

The ovary becomes a vivid red fruit (Fig. 517) containing a single one-seeded stone.

The Guelder Rose has a cultivated double-variety known as the "Snowball-tree"

Fig. 513.—Inflorescences of Guelder Rose.

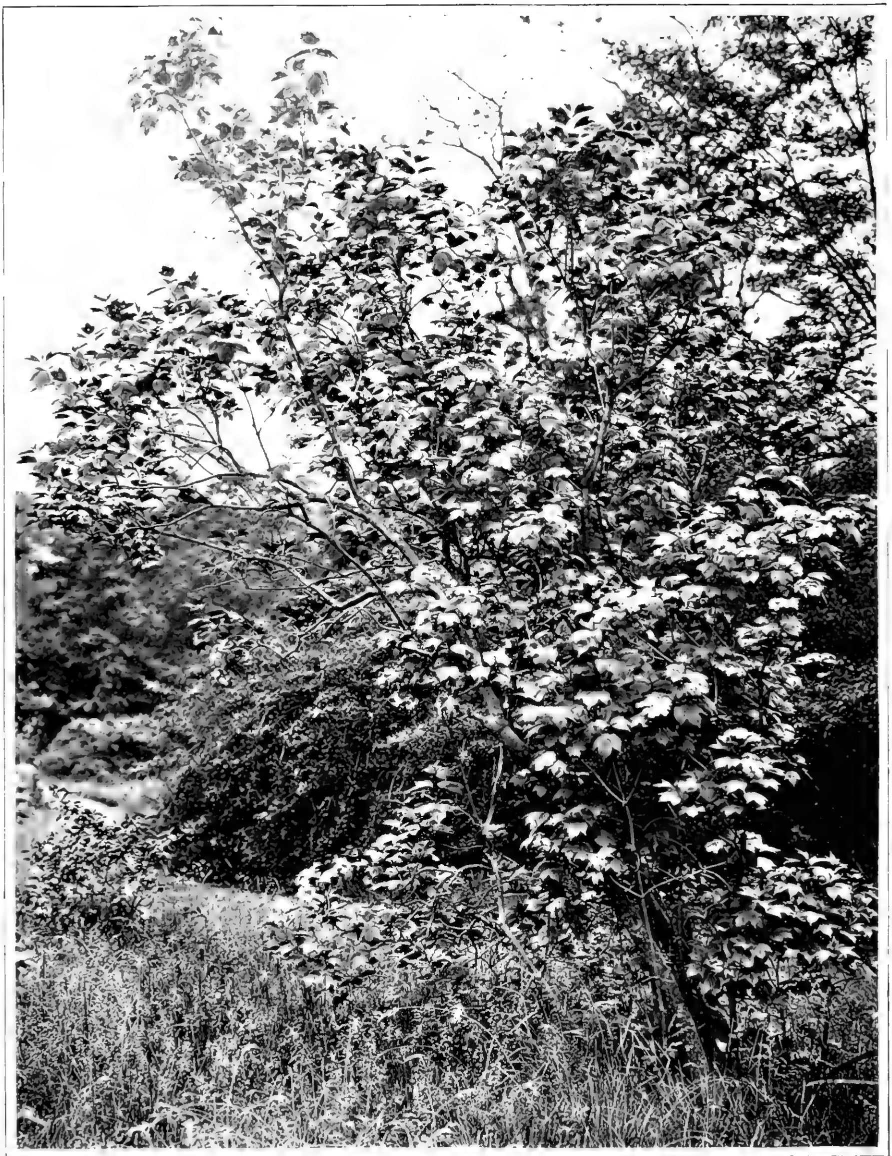

Fig. 514. GUELDER ROSE *VIBURNUM OPULUS.*

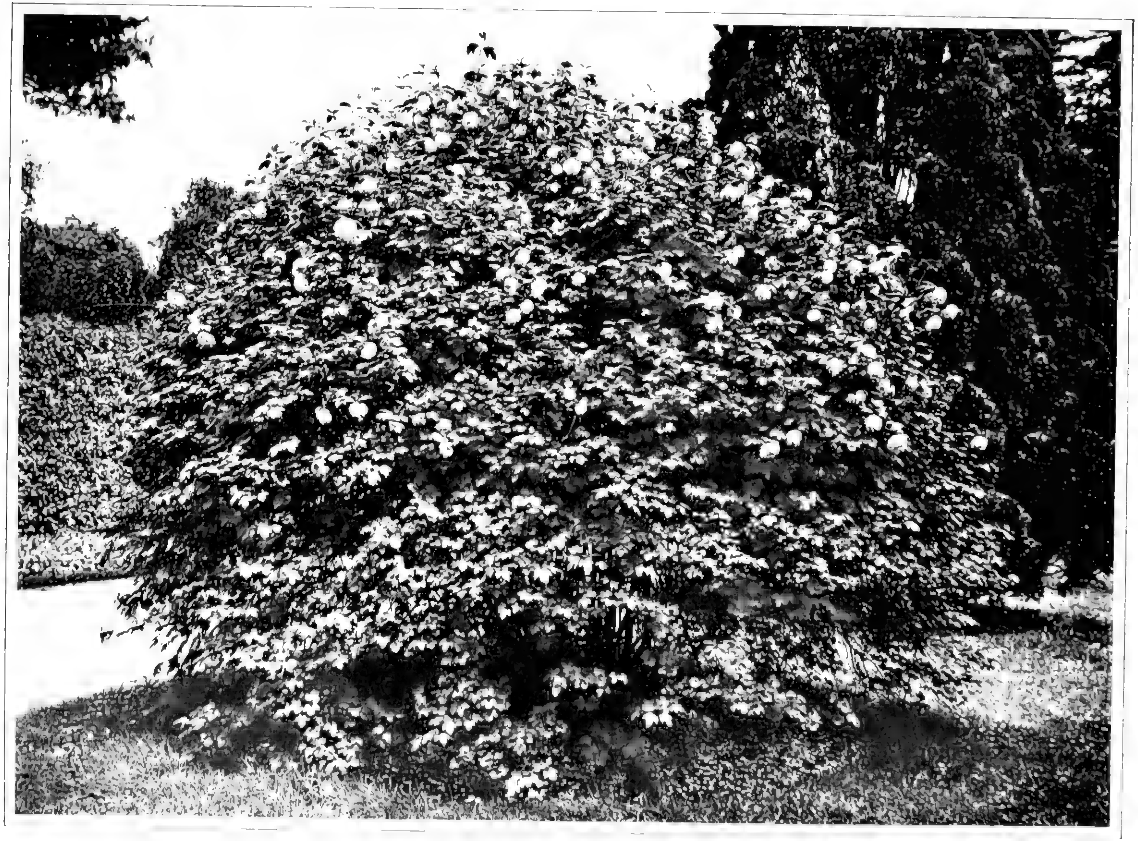

Fig. 515.—SNOWBALL-TREE *VIBURNUM OPULUS.*

(Figs. 515 and 516). It should be noted that this "doubling" is quite different from that in the Cherry. The double blossom of the Cherry is one flower that possesses an abnormal number of petals; the double-blossom of the Snowball-tree is an inflorescence in which all the flowers are changed into marginal (sterile) flowers. A tree of this latter kind can be propagated only by cuttings.

Fig. 516.—Inflorescences of Snowball-tree.

Fig. 517.—Fruits of Guelder Rose.

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