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ENGLISH ESTATE FORESTRY

OAK IN AN ENGLISH PARK.

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ENGLISH ESTATE FORESTRY

BY

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LATE FORESTER ON THE MARQUIS OF BATH'S
LONGLEAT ESTATE, ETC. ETC.

LONDON

EDWARD ARNOLD

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1904

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PREFACE

THIS book contains the opinions and impressions of a practical forester on a few of the more important subjects connected with English Estate Forestry. In its pages an attempt has been made to place the position of Estate Forestry clearly before the reader, and to indicate a few directions in which improvements are possible. The Author feels, probably in common with many practical foresters, that English Forestry is sufficiently distinct from Continental, or even Scotch Forestry to entitle it to be regarded as a separate subject, and that the non-recognition of this fact has led to a great deal of misconception in the minds of many, who are more or less anxious to see English Forestry raised to a higher level.

This book is intended to be suggestive rather than instructive to the practical forester. There is little in its pages but what he already knows, and possibly a great deal with which he will not agree. But as a more or less faithful record of individual experience it is offered as a small contribution to forestry literature, which, if it does not enrich, it will not, it is hoped, disgrace.

To the woodland proprietor it may also prove more suggestive than instructive. He will, at any rate, find its few recommendations in accord with his own interests, and that both Sport and Landscape Effect have been dealt with sympathetically. That both these matters can be considered in practical forestry without prejudicially affecting economic

sylviculture to some extent is scarcely to be expected ; but with a little sacrifice on the side of each, and a fair amount of common-sense practice, they can succeed side by side without great difficulty.

In conclusion, it may be pointed out that this book is not, nor does it make a pretence of being, a text-book. The intelligent reader, therefore, who discovers that it does not contain a Planter's Guide, nor a reference to more than *one* work on German Forestry, is requested not to despise it on that account, nor to conclude prematurely that the Author has written on a subject he knows nothing about.

A. C. FORBES.

September 1904.

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ENGLISH ESTATE FORESTRY

CHAPTER I

ENGLISH FORESTRY IN THE PAST

THE exact period of time which has elapsed since the last Glacial Period has been variously estimated by different geologists, but is generally assumed to be something between fifty thousand and a hundred thousand years. During that period there is no evidence that the indigenous forest flora of England has altered to any material extent, although the distribution of certain species may have been affected by physical changes and human agencies. The plant remains found in peat bogs and buried forests afford conclusive evidence of the species of trees and shrubs which flourished when the boundaries of Great Britain extended farther than they do at present. Submerged forests exist at intervals along the entire coast-line from the Shetland Islands to Land's End, and the trees and shrubs they contain are in a perfect state of preservation. The Cromer Forest Bed, one of the best preserved of our submerged forests, contains the remains of forest trees and shrubs which are still indigenous, and none that are not, unless it be the spruce. In the Fens the Arctic birch is the only tree, in Post-Glacial deposits, not indigenous, and in Sussex and Hampshire a few of these deposits contain a species of maple not now found nearer than France; but these may simply be considered as exceptions which prove the rule, and it may safely be asserted that the indigenous forest flora is older than the earliest trace of Neolithic man. What species existed when

the British Isles were united to the Continent, or when the lion, tiger, elephant, and hyæna lived in its jungles, it is hardly worth while speculating upon; but everything points to the fact that we still possess all those types of forest trees which have existed within these islands during the last hundred thousand years. What changes have taken place in comparatively recent times have been in the direction of augmenting the number of species which can thrive in the British climate by artificial assistance or protection; and if our woodlands were once again left to their own resources, there is every probability that a large number of introductions would hold their own with the original occupant.

Trees and shrubs generally considered to be indigenous to England are the following:—Oak, ash, beech, wych elm, Scots pine, yew, alder, willow, poplar, maple, hornbeam, whitebeam, mountain ash, birch, bird cherry, gean, dogwood, privet, holly, hazel, black and white thorn, service tree, elder, juniper, gorse, broom, buckthorn, spindle tree, etc. These species may be found in most of the remains of our natural forests to-day, and are more or less widely distributed in hedges and copses.

The distribution of these species in the shape of forest was practically universal, so far as the soil and situation would allow. If it were possible to go far enough back, we should probably find that Cæsar's assertion two thousand years ago that Britain was "*one horrid forest*" was practically true at one time, although it is doubtful if that was the case in his day. In *The Making of England* Mr. J. R. Green gives us the following picture of the natural woodlands previous to or in the time of the Romans. He states that "neither moor nor fen covered so vast a tract of Britain as its woods. The wedge of forest and scrub which filled the hollow between the North and South Downs, stretched in an unbroken mass for 120 miles from Hampshire to the Valley of the Medway; but huge as it was, this Andreds Weald was hardly greater than other of the woodlands which covered Great Britain. A line of thickets along the shore of the Southampton Water linked it with as large a forest tract to the west, a fragment of which survives in our New Forest, but which then bent away through the present Dorsetshire, and spread northward

through the western edge of the Wiltshire Downs to the Valley of the Frome. The line of the Severn was blocked above Worcester by the Forest of Wyre, which extended northward to Cheshire, while the Avon skirted the border of a mighty woodland, of which Shakespeare's Arden became the dwindled representative, and which all but covered the area of the present Warwickshire. Away to the east the rises of Highgate and Hampstead formed the southern edge of a forest tract that stretched without a break to the Wash, and thus almost touched the belt of woodland which ran athwart Mid Britain in the forests of Rockingham and Charnwood, and in the Brunewald of the Lincoln Heights. The northern part of the province was yet wilder and more inaccessible than part of the south, while Sherwood and Needwood filled the space between the Peak and the Trent. The Vale of York was pressed between the moorlands of Pickering and the waste or desert which stretched from the Peak of Derbyshire to the Roman Wall, and beyond the Wall to the Forth the country was little more than a vast wilderness of moorland and woodland, which later times knew as the Forest of Selkirk."

In fact, the whole of England in prehistoric times might have been divided into three classes—*1st*, open down or heath; *2nd*, woodland or forest; and *3rd*, marsh or swamp. The downs were represented then, as they are to-day, by the chalk ranges of Kent, Hants, Wilts, and Herts, and the oolitic hills of the Cotswolds. The heaths were found on the sand-covered chalk of the Lincolnshire Wolds, the drift of Cambridge, Norfolk and Suffolk, and the poorer soils of the Tertiary and recent formations. But it must not be taken too much for granted that either of these comparatively open tracts of country were originally treeless. While the nature of the soil prohibited the growth of large timber, and facilitated early attempts at clearing, it probably maintained a great deal of scrub which deserved the title of "forest" as much as the more fertile land. We have patches of natural woodland on our chalk downs to-day which have every appearance of being the remains of primeval forest, and it is impossible to say what denuding effect the grazing of countless generations of sheep upon them has had. The heath-covered

ground, again, may have had its growth of birch, and possibly Scots fir, although the latter tree appears to have become extinct in the southern counties until reintroduced within recent times.

The marsh or swamp land was mostly represented in the eastern counties, Somersetshire, etc., and the mouths of rivers generally. Here, too, alders, willows, etc., invested it with a certain degree of forest character, and a great deal has only been reclaimed within recent times. The remaining class of land, woodland, occupied, as we have seen, fully half or more of the country, the remains of which exist down to the present day.

The condition of these primeval forests was probably much the same in Britain in prehistoric times, as may be found in thinly inhabited forest districts in other parts of the world. Composed of the indigenous species already enumerated, their existence depended entirely upon natural regeneration, such as may be seen to-day whenever a piece of waste land exists within a short distance of surrounding trees or woods. Their natural enemies, in addition to man himself, would principally be deer, wild cattle, hares, etc., and constant warfare between the animal and vegetable world would be carried on. The character of the soil would decide whether the forest growth would consist of tall or large oak or ash, with holly or yew beneath, stunted and crooked scrub of the same species, or birch, alder, willow, and other moisture-loving trees. In sheltered valleys with good deep soil and natural drainage, numerous oaks and other timber trees would attain large dimensions, and, where favourably situated, a great height, but there would be little of that regularity characteristic of planted or artificially managed woods. Wherever a favourable seed-bed existed, or a gap occurred in the leaf canopy by the fall of an old tree, a dense crop of seedlings would make its appearance from time to time. If not interfered with by deer or ground game, or shaded by overhanging branches, these patches would develop into clumps, in which the struggle for existence or self-thinning would constantly be going on. The final result would be a few tall clean trees in the centre, and the edges of the clump composed of stunted and leaning trees—pushed outward in

the struggle for light, heavily branched on one side, and destitute of leading shoots. With the presence of game or other animals, various contingencies would arise to interfere with the normal development of the group. Browsing, beheading, and barking may convert the promising sapling into a gnarled and stunted bush, a many-forked stem, or a bush-headed tree. Seedlings springing up amidst a patch of thorns, hollies, or brambles, would have a better chance of escaping injury than those on bare or grassy ground, and the single tree or small group, with the protecting bush at its base, would be the result. Every form and size of tree, every conceivable combination of stem and bush, would be represented in one place or another, separated by grassy glades or patches of weeds, bracken, or other growth characteristic of forest soil.

It is impossible to estimate the influence of prehistoric man on the forests of Britain. The Druids are usually associated with our earliest ideas of the ancient Briton and his religion, and it is recorded that Malmud, supposed to be the founder of Malmesbury, about 400 B.C. formed a code of laws in which forest preservation was referred to. This reference states that it was within the right of every man to cut firewood from a dead tree, thus implying that living trees were protected even at that time.

There can be little doubt but that the earliest tribes did something towards the subjection or destruction of the native forests. The gigantic temples of Stonehenge and Avebury in Wiltshire, with the barrows and tumuli scattered about over the open downs which exist in other parts of the country, suggest that the earliest settlements were on the more open and thinly wooded tracts of country. These remains point to a population of considerable size, and, although it chiefly confined itself to the open country already referred to, it depended a great deal for its food and clothing upon the surrounding forest. Fuel and timber would be necessary at all times, and although it is improbable that prehistoric man was the means of reducing the natural forest area of the country to any appreciable extent, it is not unreasonable to infer that he was the means of thinning out and keeping in check forest growth at a very early period. Gradually,

and in proportion to the increase of the population, the drier and most suitable forest districts would be occupied, and their crop of indigenous timber thinned from various causes; but that wholesale destruction of forest by fire, such as went on in America even before the advent of the white man, would be out of the question, for deciduous forest growth in this country does not readily burn or easily ignite. It would be upon the forest, again, that the early Briton depended for his wealth in the shape of cattle and hogs, and his sport in the shape of deer and other animals; and it is reasonably safe to conclude, that while the downs upon which his remains are so abundant were comparatively treeless, yet forest land surrounded and was scattered amongst them wherever the soil was of a suitable nature.

The first important attack made on the dense forest of the country was probably during the Roman occupation. Numerous evidences exist to point to the fact that one branch of engineering with which the invaders employed themselves, was the destruction of a portion of these forests. The draining of Hatfield Chase in the reign of Charles I. brought to light large numbers of buried trees, which had in many cases been burned or felled, and amongst them were found many Roman remains. They are said to have set fire to an extensive pine forest near Doncaster, into which the Britons retreated after their defeat at Osterfield, and the fallen and charred trees have been discovered beneath the surface. This work was probably carried out, partly for agricultural, and partly for strategic and political reasons. The forests were the natural strongholds of the savage tribes with whom the invaders had to contend, and they naturally endeavoured to reduce the area of the former as far as lay in their power.

The earliest occupation of the forest on a large scale appears to have taken place during the Saxon Period. Kemble, in his well-known work, *The Saxons in England*, fully describes the conditions under which these people existed. He supposes that every settlement or community was surrounded by a tract of forest or waste, and which separated the possessions of one tribe from those of another. This waste belonged to the community, and no individual had

a right to appropriate or alter its character without the consent of the former. The boundaries of each tract of waste, or "mark" as it was called in those days, were clearly defined, and the usual boundary marks appear to have been trees which were specifically mentioned in the Anglo-Saxon charters, such as the oak, ash, beech, thorn, elder, lime, and birch. It was expressly forbidden to cut or destroy these trees, many of which are said to have been of peculiar size or beauty, and carved with the figures of birds and beasts. As time went on, these village communities were increased in number and the originals in size, until they assumed the proportion of towns, and gradually led to the appropriation of larger tracts of waste or forest for purposes of cultivation or building. Still the Saxons appear to have paid great attention to the preservation of the main characters of the forests, and even in their time no great process of clearing went on, so far as we know. They paid special attention to the preservation of the oak on account of its value for providing food for swine and deer, and they probably laid the foundations of those forest laws which assumed such importance in later times.

Although Canute is generally credited with having drawn up the first comprehensive code of forest laws, it was not until the arrival of the Normans that these laws assumed that objectionable character which we know to have been the case during that period. The highest existing authority on these laws is Manwood, who gives us a very clear idea of their far-reaching and comprehensive nature. According to him, the king could seize upon any tract of country by issuing a Commission under the Great Seal, instructing certain persons to make a forest in such a place as he might choose and lay out the boundaries. This forest had to be stocked with deer in order to bring it within the provisions of the forest laws, and it was in the maintenance and preservation of these animals that the greatest injustice and tyranny appears to have been exercised upon the inhabitants in and around the royal forests. Freeholders were entitled to occupy and retain their lands after, as before, the formation of the forest, but they were prohibited from erecting fences high enough to keep out the deer from feeding upon their

crops. They could not cut down woods upon their freeholds without the consent of the king's forester, and the latter had the right of cutting the boughs of ash and other trees upon freehold lands within the forest, to serve as food for deer when required. The penalty for killing deer in a royal forest was death, while the cutting down of an oak carried with it a fine of 20s. In return for the conditions imposed upon them, the freeholders had rights of pasturage and fuel in the forest, although certain animals, such as sheep, swine, goats, etc., were not allowed, and certain seasons of the year were regarded as closed periods with respect to all animals. Those having parks within the forest had to prevent the deer from entering them, or they were considered as belonging to the forest when this occurred.

The severity of these laws is said to have been one of the causes which brought about the passing of the Magna Charta, with which was associated the *Charta Foresta*. This latter did away with a great many restrictions which had so far been imposed upon the freeholders of the forest, and threw out a great deal of land which had hitherto been regarded as within the boundaries of the forests. In the year 1300 a survey was made of all royal forests, and the land which had been appropriated and added to existing forests at an earlier period again restored to its owners. These surveys were known as *Perambulations*, and copies of them are still preserved in the *Forest Roll*.

About this period the greatest clearance of woodland generally appears to have taken place. In the reign of Edward III. great strides in the social and industrial condition of the country took place. Houses which had hitherto been constructed of mud or "wattle or daub," as it was termed, began to be built of timber, and agriculture was making greater demands upon the land of the country, and the increase of population required the increased utilisation of land for various purposes. In the reign of Henry III. the Statute of Merton was passed, by which lords of the manors were enabled to enclose portions of their waste, provided sufficient was left for the needs of the commoners. No doubt, the provisions of this Act were taken full advantage

of by lords of the manor, and was the commencement of that process of enclosure which practically terminated in the eighteenth century. Its effect upon the natural forest of the country, combined with the gradual reduction of the area devoted entirely to the sport of the Sovereign, combined to bring the extent of land occupied by wastes and forest down to about half the total area of the country by the time of Henry VIII. It is evident that the stock of timber by this time had been greatly reduced. The increasing flocks and herds and the general absence of enclosed woodland interfered greatly with that natural regeneration which went on at an earlier period without any serious interruption. In this reign, too, the dissolution of the monasteries converted a great deal of woodland, which had hitherto been held in trust for the good of these bodies, into the lands of private estates, upon which no restrictions existed regarding its sale or destruction. At any rate, it was during this reign that one of the first Acts connected with the preservation and growing of timber trees was passed.

This Act provided that, in copse or underwood felled at twenty-four years' growth, twelve standards or store oaks should be left on each acre, or, in default of oak, so many elm, ash, or beech. The penalty for neglecting to obey this law was a fine of 3s. 4d. for every standard, one-half of which should go to the Crown, and the other to the informer. When cut under fourteen years of age, the ground had to be enclosed or protected for four years, and no calves were to be turned in under two years, or cattle under four years. Cutting trees on waste or common lands was to be punished by forfeiting 6s. 8d. for every tree so cut, but in the county of Cornwall, within two miles of the sea, trees might be felled when dead on the top.

During the sixteenth and seventeenth centuries we find considerable references in manuscripts and records to the growing scarcity of timber. In the *Breviary of Suffolk*, written by Robert Reyce in 1618, he complains that "timber is nothing so plentiful as of late days; what with multiplicity of curious buildings, variety of costly shipping, and various other causes, hath almost totally consumed our timber, a decay long since espied, but hereafter will be more bewailed,

unless there be some universal care someways to repair so important a ruin."

In the *Paston Letters* a reference is also made to the scarcity of timber in Suffolk, or rather to the great clearing which preceded it. Both Pepys and Evelyn also have much to tell us about the decreasing supply and great neglect of woodlands in their time, and it was to the latter that we owe that ancient text-book on forestry known as *Sylva*. During the reign of Charles I. and the period occupied by the Commonwealth, both timber and woodlands suffered a great decrease. Royal forests were sold to private individuals in return for cash, the timber they contained was felled, and the troubled times of the Civil War did much to increase the prevailing neglect. Many of our parks and woodlands were wasted and destroyed during the Civil War, for the mere sake of spoiling the property of their owners. Trees were cut down and sold for a few pence apiece, park palings were pulled up and burnt, and everything possible that could be done to disfigure the estates owned by the opposing parties carried out.

About this time the woodlands of the country chiefly consisted of coppice with standards on the drier soils, while swampy and boggy spots were occupied by alder coppice, known at that time as "alder moors." During this period surveys were made of all lands previously in the possession of the Crown, and valuations made of the coppice and timber. In fact, every care seems to have been taken that the stock of timber in the country at this time should be carefully preserved, and there is no reason to suppose that the waste referred to above continued after order was restored.

But, while many attempts were made to preserve existing supplies, there is little evidence that any serious attempt at the improvement or extension of woods was made until the end of the seventeenth century. When Evelyn read his famous discourse before the Royal Society in 1662, the end was reached of a long period of neglect and indifference to the claims of economic forestry. It was at last being recognised that the efforts hitherto made to maintain the stock of timber in the country were inadequate. The importance of the navy to national progress, and its de-

ALDER MOOR.

AVENUE IN 17TH CENTURY GROVE.

pendence upon a supply of oak timber, roused the attention of statesmen and politicians to the condition of the Crown forests, which up to that time were the chief sources of naval timber. Down to this time the stock of natural timber seems to have been amply sufficient to meet the domestic and industrial needs of the country; but the smelting of iron in Kent, Surrey, and Sussex, the increased use of timber in architecture, and the general increase in the population, all combined to render a supply of this commodity extremely uncertain, and it was beginning to be realised that energetic measures would have to be taken if a serious timber famine was to be averted. It was about this time that the first signs of economic forestry began to show themselves on the Crown lands. Enclosures were made in the royal forests and sown with acorns, beech-masts, etc., greater attention was paid to the exclusion of cattle and the protection of seedlings, and a more accurate classification of the timber-growing capabilities of the Crown lands made.

The woods of private estates before this time must have been on a very small scale. Hitherto the waste of the manor had provided a sufficient stock of timber for home use and building purposes, agriculture, and fuel—all of which had to be provided in the immediate vicinity, owing to the difficulties of transport and the absence of good roads; but as these manorial wastes were reduced by progressive enclosure, the lord of the manor was compelled to turn his attention to the cultivation of timber and underwood on his own demesne land. No doubt, small enclosures existed as far back as Saxon times, for frequent reference is made to them in *Domesday*, but beyond the fact that they were divided from the waste over which common rights existed, there is no evidence to show that silviculture in any shape or form was practised. The earliest plantation in Windsor Park is said to have been made or sown in 1580, and is claimed as the true progenitor, both of the modern royal woods of England, and also of the system of rearing oaks where they never previously existed. Whether this claim can be substantiated or not we do not pretend to say, but there is little doubt that ordinary plantations were not made on anything like a large scale until after the Restoration.

The more peaceful condition of the country which followed this epoch in our history doubtless encouraged landowners in improving their estates, and the introduction of the French style of landscape gardening stimulated tree planting, and gave planters new ideas regarding their functions on a residential estate. Many of the most famous country seats were laid out about this time, and although Evelyn has been termed the father of English planters, we doubt very much if he did more than record the prevailing practice of arboriculture in his day. A great many of his recommendations savour more of the ideal than the real, and it is difficult to gather from his work the extent or the advancement of forest planting in the seventeenth century. Enclosed woods at that period consisted almost entirely of coppice with standards, cultivated for the sake of firewood, rods, poles, etc., which then had to serve for many purposes for which iron, bricks, and converted timber are now used. Fences, drains, agricultural implements, sheds, and various other articles and erections were largely constructed of fagots, rods, and poles produced by this system of woodcraft, while the oak and ash standards furnished materials for more substantial buildings, carts, domestic furniture, etc. These woods were probably small and chiefly clustered round the manor house or village, and the villagers and lower classes still obtained most of their firewood from the remaining commons and waste of the manor, or from hedgerow timber which was pollarded from time to time.

With the continued enclosure of these commons and the introduction of modern systems of agriculture, estate forestry was gradually developed. So long as waste land formed so large a proportion of the estate, there was little opportunity, supposing the inducement existed, to plant or maintain woods on a large scale. The greater part of the country had a well-wooded appearance, the æsthetic tastes of the landowners were not of a high order, and the extent of waste land provided plenty of sport for the sportsman of that day, without resorting to artificial plantations. The extension of enclosures, however, doubtless paved the way for that process of land improvement which has gone on more or less uninterruptedly for the last two centuries. With larger

farms improved systems of cultivation and stock-raising were introduced, drainage was better attended to, and the productive power of the soil increased. Between 1750 and 1800 a great number of Enclosure Acts were passed throughout the whole of England, and hand in hand with these enclosures went on the development of modern forestry into its present form.

Between 1760 and 1820 the bulk of the larger plantations on English estates were formed. Many reasons for this extension of woodlands may be found, and it is difficult to say which of them was most powerful. The change of taste with regard to landscape gardening, the growing scarcity of timber on the one hand and its increasing consumption on the other, and the increasing wealth and population of the country, which enhanced the value of land and stimulated all forms of estate improvement to a greater or less extent; the development of landed properties, the throwing together of small manors into larger estates, and the ambition of the large landowner to surround his mansion with an extensive park,—all conduced to the planting of large woods, which served to beautify the landscape, provide sport for the owner, and replenish the stock of native timber, which at that time was considered of the first importance.

But the introduction of the natural style of landscape gardening by Kent, Brown, and other exponents of the art, did much to turn the attention of landowners towards the improvement of the more outlying portion of their estates by planting. With the formal or geometric style introduced in the reign of Charles II., ornamental planting ran chiefly in the direction of avenues or straight rows of trees running out from a common centre—usually the mansion or residence of the proprietor. The general aspect of the country outside the limit of these avenues received little consideration, and when so large a proportion of it was unenclosed, planting was practically out of the question. No doubt, the existence of large areas in a partly wooded condition, as much of the unenclosed land was, rendered its imitation by artificial methods a doubtful form of improvement. The landowner of that day would naturally desire to give his private property some distinctive features which would be recognised

as a mark of importance and indicate the extent of his possessions. In a country already thickly wooded by nature, the planting of single trees and clumps would be superfluous, and, when the geometric style was first introduced, England generally was probably well wooded, and presented few opportunities for what we now term "landscape gardening." The style once introduced, however, it naturally outlived the period which saw its birth, and it was not until a truer conception of what constituted natural beauty was attained that a change of opinion more in accordance with refined taste arose.

The natural style of landscape gardening, under the direction of the immortal "Capability Brown," reached its highest stage of development about 1780. The "change in taste," as it was termed, was probably nothing more than a desire to be in the fashion, and the majority of estate owners who called in and followed the advice of this professor had as little idea of the merits or demerits of the one style as they had of the other. When Brown laid down the law that certain ground should be planted, planted it was forthwith, and in this way large areas of ground were covered with wood which had previously been bare ground or common. Many of the woods thus formed were doubtless small, and consisted of belts and clumps which had, and have, little economic importance. But when once a wood has been planted there is often a tendency on the part of the owner to enlarge it, and this in many cases has been done where the surrounding ground favoured such a step. In Brown's time the only trees available for planting on poor ground were beech and Scots fir, for the larch and other conifers had not then become available for extensive planting. Nearly all Brown's clumps and park timber on poor ground were composed of these species, but more especially the former, and they stand to-day as monuments of his work, whether good, bad, or indifferent. Spruce, silver fir, oak, and Spanish chestnut were also used to a less degree, but from natural causes and other reasons they are not so conspicuous to-day as beech and Scots fir.

Another reason for the increase of plantations about this time may be traced to the growing need for timber and

underwood in agricultural districts. Farm houses and buildings were being erected and improved in all directions, while agricultural implements, tools, hurdles, etc., consumed large quantities of forest produce, which were not affected by foreign timber imports for many years afterwards. Land-owners, therefore, had every inducement to plant land which did not fit in for agricultural purposes, or which was difficult or inconvenient to work. In this way much of the coppice with standards which exist to-day was formed on rough or uneven ground, or heavy low-lying land which could not be cultivated with advantage. It is evident that great expense was incurred in forming these woods, especially on wet and heavy land in the way of draining. In most cases the ground was thrown up in low ridges about a perch wide, and oak, ash, or hazel sown or planted on them. Marshall, in his work on *Planting and Rural Ornament*, published in 1796, describes the various methods employed when planting these woods. The ground was previously ploughed or cultivated, and the seeds were sown in drills about three to four feet apart, and the intervals used for growing corn, beans, or other agricultural crops. After the first season these drills were carefully gone over and thinned out or filled up as required, and the wood afterwards treated as an ordinary coppice. Ordinary plantations in those days were little known, while the facilities for hill planting did not exist, and the majority of hardwoods required fairly heavy ground.

During the early part of the nineteenth century planting in England does not seem to have made great strides. This may be partly explained by the natural reaction which would follow the extensive planting operations of the previous fifty years, for nearly all proprietors, with a taste for improvement, had improved their estates while the craze was in full swing, and planting for economic purposes was then, as now, not a popular form of amusement. Those who had recently called in and acted upon the advice of the landscape gardener would have little inducement to do much for a few years, but would content themselves by watching the growth and effect produced by their young plantation and clumps. But the chief cause of the decline in planting work about this time must be attributed partly to political

affairs, which were not favourable for rural pursuits. The Peninsular War, and the demand made by it upon the country for men and money, kept the attention of landowners from being directed to such work as planting, although it went on to some extent in spite of all distractions in the political world. At a later period the flourishing condition of agriculture, and the large profits derived from the cultivation of wheat, drew the attention of landowners away from the less profitable undertaking of timber-growing. Poor pastures were broken up and rough ground cleared to make room for this cereal, and landlords who had land fit for anything at all were not inclined to sacrifice their high rents for planting operations.

That great stride in afforestation which went on in Scotland in the early part of the century saw no corresponding movement in England, for the conditions in the rural economies of the two countries were very different. In Scotland vast areas existed which were practically unutilised, and incapable of being utilised except as most inferior pasture, and the improving landlord saw a fine opportunity for turning it to good account, and at the same time beautifying his estate, by planting. In England, as we have already seen, such work had already been done, although on a better class of land than the Scotch planter dealt with, and on possibly a smaller scale. In connection with English forestry, however, the planting operations in Scotland about this time were interesting, as they were the means, or to a great extent the means, of introducing a system of forestry and a class of foresters which have been largely instrumental in altering the appearance of English plantations. Hitherto English woods were chiefly planted and grown on the system of coppice with standards, or more or less pure plantations, such as beech or Scots fir. But the reputation which Scotland gained as a nation of planters about this time also gained Scotch foresters a reputation as well, and forty or fifty years ago it was as much the correct thing for an estate to have a Scotch forester as it was for a nobleman's establishment to possess a French *chef*.

Whether the influence of Scotch foresters has been beneficial to English forests or the reverse, we do not pretend

to decide, but it is, we believe, an undoubted fact that the practice of early and heavy thinning, which prevailed in England for fifty or more years, was introduced by Scotch foresters to a greater or less extent. About 1850, Brown, a forester at Arniston, published *The Forester*, a work which accurately reflected the ideas of his contemporaries on forestry. Considering that *The Forester* was almost entirely original matter, and that it was written with an almost entire disregard for the opinions of anyone else, it is surprising to find what a large amount of accurate information it contains. It was the first book of any importance which had appeared on forestry for some time, and its appearance was hailed with delight and soon regarded as a text-book on the subject. To disagree with Brown was considered rank heresy, and it is not surprising that Brown's views on planting, thinning, etc., were regarded as absolutely correct, and that the majority of Scotch foresters followed his lead. It is to Brown and his school that we owe the introduction of the mixed plantation—a system of planting which has led to some of the worst results that could possibly be obtained. This system, although based on economic ideas, ignored the silvicultural requirements of different species, and the majority of mixed plantations formed within the last fifty years have produced timber of low economic value for that reason. He and his followers erred again in their practice, through an imperfect comprehension of the principles of silviculture as regards thinning, and they grew timber by arboricultural methods which increased the cost of production without a corresponding increase in the value of the crop produced.

Until within the last twenty years or so, no fresh ideas were instilled into English forestry. The mixed plantation was still the order of the day, free thinning was the rule, and the main features of the "Brown" system of forestry were strictly observed. Pure plantations, when such were planted, invariably consisted of larch, owing to the high value of that tree in the shape of thinnings and poles. The object in many cases was not so much the ultimate production of first-class timber, as the speedy growth of game cover or screens and belts for landscape effect. There was rarely any definite idea as to the object in view, and any system of

planting which looked farther ahead than the next twenty or thirty years was rather the exception than otherwise.

During the last ten years or so, however, views on English forestry have undergone a considerable change. Although it may not yet be regarded as a tempting commercial enterprise, or the results in eighty or a hundred years' time be considered too closely, yet it is evident that a large number of landowners hold more economic views on the management of their woods than was the case before. This has been partly brought about by the dissemination of knowledge more or less derived from Continental sources, where economic forestry has been developed on scientific lines. But however valuable such knowledge may be in the abstract,—and no sensible man would dispute it,—it is apparent to those who have closely studied the question, that English forestry must possess certain characteristics of its own, and any attempt to revolutionise English woodlands and adopt the Continental style in its entirety will end more or less in failure. An attempt will be made in the following chapters to show how far beneficial changes can be produced, and, while improving upon the old system of managing woodlands, retaining at the same time those features which the majority of English estate owners value and appreciate, and without which they would probably regard any change as a doubtful advantage.

CHAPTER II

PRESENT CONDITION OF ENGLISH FORESTRY

THE extent and distribution of woodland in England varies a great deal in different counties. The best wooded counties are those lying in the south of England,—Hants, Kent, Surrey, and Sussex,—and a great deal of their woodland either consists of coppice with standards, or forms the remains of natural forests which have existed from time immemorial. Looking at the question from an economic point of view, and comparing the distribution of English woodlands with the different classes of soils on which they stand, it will be seen that no very definite relation exists between the value of the soil for agriculture and its utilisation for forestry purposes. The waste land of England, classified in the Agricultural Returns as “Mountain and Heath Land,” practically resembles the soils of those extensive forest areas on the Continent which render the majority of Continental countries so much better wooded than England. Yet, when one glances at the returns above referred to, it is apparent that very large areas of waste land exist in those counties, which have a very small proportion of woodland. The three northernmost counties of Northumberland, Cumberland, and Westmorland have nearly one million acres of mountain and heath land between them, and Yorkshire alone contains over half a million. Norfolk and Suffolk have 75,000 acres between them, and Dorset 26,000, and in all of the above counties the area under woods is comparatively small.

So far as soils are concerned it is probable that no great difference exists between the surface soil of one county and another, apart from the geological formation from which these soils are formed. Those which give rise to the gravels,

sands, and peat deposits are probably the most favourable for economic forestry, and such are the Tertiary, Greensand, etc., which cover a considerable area in the south of England; but in the north, where the mountain ranges are more extensive, more elevated, and probably more uniform in their character, considerable areas are covered by gravels which are equally as favourable to tree growth as the deeper gravel beds in the south of England. To show the distribution of woods more clearly, the table on page 21, extracted from the Returns of the Board of Agriculture, may be given.

A brief examination of the table reveals the fact that the best wooded counties of England are Berks, Hants, Kent, Surrey, and Sussex. These counties are not conspicuous by the existence of mountain land, and it is a significant indication of the uneconomic lines upon which English forestry is conducted, that the class of land which ought to be most heavily wooded is least so.

In describing the condition of these million and a half acres of woodland in England, it is necessary to discriminate between the plantations of conifers or mixed conifers and hardwoods which prevail in the north of England and on the poorer soils generally, and the older sylvicultural system known as coppice with standards which is more or less universal in the Midlands and southern counties. Taking the ordinary plantations first, it may be stated in a general way that their condition is anything but good. Why this should be so is due to many causes, and an endeavour will be made to enumerate a few of them. In the first place, there is little doubt that the English planter of the last hundred years or so has suffered from the disadvantage of having too big a list of species to choose from. That development in the introduction of coniferous trees, which may be said to have begun with the larch about the middle of the eighteenth century, and which is still going on at the present day, is responsible for an unsettling of planters' minds, which is anything but conducive to economic forestry. At short intervals of a few years or so, the introduction of a species of conifer is invariably announced with a great flourish of trumpets, and we are assured by the highest authorities that

PRESENT CONDITION OF ENGLISH FORESTRY 21

TOTAL AREA OF LAND AND WOODS IN EACH COUNTY OF ENGLAND,
FROM THE RETURNS OF THE BOARD OF AGRICULTURE.

Counties.	Land (Acres).	Woods and Plantations.	Percentage of Woodland.
		(1895)	
Bedford	301,810	12,542	3 $\frac{3}{4}$
Berks	459,403	35,791	7
Buckingham	477,307	32,125	6
Cambridge	551,469	6,146	1 $\frac{1}{4}$
Chester	647,816	24,836	3
Cornwall	866,250	31,043	3 $\frac{1}{2}$
Cumberland	961,544	35,054	3 $\frac{1}{4}$
Derby	646,412	25,760	4
Devon	1,666,839	86,050	5
Dorset	623,948	37,615	5
Durham	945,926	29,469	4
Essex	976,125	30,860	3
Gloucester	802,840	58,407	7
Hants	1,048,808	125,674	12
Hereford	535,990	41,957	7
Hertford	402,856	24,545	6
Huntingdon	233,211	4,714	1
Kent	973,846	98,302	10
Lancaster	1,183,048	41,906	3
Leicester	530,798	14,282	2
Lincoln	1,691,793	43,127	2
London	73,982	367	...
Middlesex	147,007	3,656	2
Monmouth	347,696	32,733	9
Norfolk	1,307,188	53,870	4
Northampton	636,123	28,017	4
Northumberland	1,284,189	49,626	3
Notts	536,697	28,517	5
Oxford	478,112	26,611	5
Rutland	97,086	3,838	3
Salop	856,316	50,493	6
Somerset	1,035,038	45,650	4
Stafford	737,956	39,191	5
Suffolk	946,011	34,771	3
Surrey	458,886	54,437	12
Sussex	929,319	124,632	13
Warwick	576,200	21,261	3
Westmorland	497,100	17,334	3
Wilts.	861,358	51,755	6
Worcester	476,710	19,188	4
York, E. Riding	751,890	17,181	2
„ N. Riding	1,357,525	52,816	4
„ W. Riding	1,760,623	69,592	4
	32,381,051	1,665,741	5 (nearly)

this particular introduction is going to revolutionise English forestry. The general result of these announcements has been, that planters of ordinary plantations, during the last fifty years or so, have been unable to decide definitely what is or is not the best tree to plant on their particular soils and situations. A species from North America, another from Japan, and probably a third from Siberia, or some other remote part of Europe, has equal claims upon their attention, and the general outcome of their indecision is a mixture of trees which resembles an arboretum or pinetum more than a plantation which is intended to supply the English timber trade with useful timber.

Another cause of the unsatisfactory condition of English plantations may be traced to the prevalence of rabbits, which do so much to hamper and obstruct English forestry. These pests are responsible for that premature thinning out of the trees which is more or less general before the twentieth year of a plantation's life. In spite of protection by wire netting, it invariably happens that these animals gain access to a plantation before it is proof against their attacks. To certain species, such as Scots fir or larch, they probably do little harm, but with hardwoods generally, such as oak, beech, and ash, their presence is responsible for the thinning out of the trees to an extent which renders the growth of clean timber impossible.

A frequent cause of the defective condition of plantations is the method of thinning applied to many of them by the older school of forestry. An idea prevailed for many years that a plantation was more easily ruined by a crowded condition during its youth than by any other means. This idea was probably fostered to some extent by the importance and prevalence of the larch as a timber tree. The Duke of Atholl, who introduced this tree to Scottish forestry, was a strong believer in wide planting, and, so far as that tree was concerned, his views on the matter may have been correct. But there is little doubt that the system applied to larch plantations generally was also applied to any other species which happened to be present in plantations throughout the country. Up to within comparatively recent times the ordinary plantation was a novelty in many parts of

England, and forestry was represented almost entirely by the coppice with standards, which will be dealt with presently. The chief ideas on the subject of treating plantations were derived from Scotch foresters and authors, and a perusal of their works and observation of their methods of thinning in the past will leave little doubt in the mind of the impartial critic that their object was rather to grow trees than timber. The system of thinning applied to English plantations in the past has therefore led to the production of woods full of coarse, knotty, and more or less unsaleable timber, and has led chiefly, if not entirely, to a prejudice being entertained by the timber merchant against a large number of species which might, had they been properly grown, have proved of great value.

But the influence of early thinning on English woods has probably been less fatal to successful silviculture than the process of late thinning carried out to meet the demand for poles or timber, or to improve the woods for game cover. The fact cannot be denied, that thick woods with little or no herbage or undergrowth cannot support or shelter the same head of game and rabbits per acre as ground covered with rough grass, brambles, and general rubbish, with just enough trees for roosting and sheltering purposes. The (perhaps unconscious) recognition of this fact is greatly responsible for the open order which the majority of English woods exhibit after middle age. Occasionally, where the provision of game cover is almost reduced to a science, it is the practice to sacrifice from over half to three-fourths of the growing crop at one sweep, and then underplant the remainder with laurels, privet, rhododendrons, or anything that may be fancied for game cover. But the general practice is to combine a process of gradual thinning until none but a few trees per acre remain, and allow those to stand for an indefinite period. In the meantime grass and other growth gradually cover the surface, and thus arises the gamekeeper's ideal of a wood or plantation.

Another cause of thin woods may be traced to the mixed plantation system. This system is based on the idea that a certain number of hardwoods will constitute the main crop, and that these should be planted at such a distance apart

as will enable them to form a full crop at, say, fifty years of age. This distance is usually 12 feet, and the intervening spaces are filled up with larch or other conifers. Theoretically this is simple enough, and sometimes works out as it should do; but in most cases where ground game is plentiful it is found that, by the twentieth year or so, a great many of these hardwoods originally planted are no longer there. The larch and other conifers are usually safe from rabbit attack by the tenth or twelfth year, but oak, ash, and beech are easily injured by rabbits long after this age. The consequence is that after the wire netting is removed or becomes gappy, and the mixed plantation it has protected is exposed to rabbit attack, the hardwoods are invariably attacked, and partly, if not entirely, destroyed. On ground which is not adapted for bringing larch to maturity, the result is obvious. After the so-called nurses are removed or die out, an imperfect and gappy crop of hardwoods remain, and this not only means a reduced crop of timber, but also timber of rough and poor quality, owing to the want of cleaning and drawing up of the stems.

Another evil often attending such mixtures is due to the different rates of growth of the species used, and which allows one to be practically crushed out, while another develops a head out of proportion to its size. This also leads to the production of rough timber, and in many cases to the plantation eventually becoming composed of a different species to the one originally intended for it, owing to the latter having been crushed out.

But although the above causes are responsible for thin or unprofitable woods in the early and middle-aged stages of their existence, they are comparatively trivial to the method of felling adopted in the great majority of cases when English woods approach maturity. It is difficult to fix any definite period at which this process can be said to begin, as it is often a continuation of the thinning which commences in the early stages, and never ceases until the last tree is cut. But in any case the evil consists in breaking up or reducing the leaf canopy of the wood, so that weeds and rubbish cover the surface of the soil, and light favours the production of adventitious shoots, etc.

When this occurs, the growth of the timber decreases more or less rapidly—according to soil and situation ; while ground which might be carrying a healthy tree, steadily increasing in value, is lying waste or breeding weeds and rubbish. On good deep soils the growth of the trees is less seriously affected than on poor thin ground, while sheltered and moist places can bear it better than high-lying ground exposed to wind and drought. But a broken leaf canopy in early life invariably means reduced height-growth and premature crown development, both of which seriously diminish the total production of timber per acre and price per foot obtained.

Another bad feature of the prevailing practice is that connected with the lengthened period over which the clearing of the ground is extended after the crop may be said to have reached maturity. Various reasons may be found for this delay. In one case it may be a sentimental reluctance to clear off an old crop of trees which has been before the owner's eyes from his earliest recollections. There is little doubt that old woods or trees are associated in the mind of their owner with many family incidents and recollections. He has probably gone bird-nesting in them as a boy, he has shot over them as a youth, and as time goes on they become familiar objects in his eyes which he is often loth to part with. They represent, not so many feet of timber, but individual objects associated with the estate he has inherited, and he considers that to destroy them for the mere sake of pecuniary advantage to himself is an act approaching vandalism or brutality. Another cause of this hesitation to clear off a plantation long past maturity is the obligation it carries with it, of going to the expense of replanting the ground. An estate owner, whether legally obliged to do so or not, invariably feels himself bound to replant ground he has cleared, although this operation may be a direct loss to himself personally. By leaving the old crop on the ground he at least retains the appearance and sporting value of his estate, and he probably feels that any advantage which would follow the clearing and replanting of the ground would neither benefit himself nor his direct heirs to any known extent.

The above, if not the only ones, are at least the principal causes responsible for the condition of English plantations which have passed middle age in many parts of the country. They may not apply to every individual plantation, but, taking one with another, we may safely state that a thin stock on the ground and a coarse and inferior class of timber are their prominent characteristics, and that they vary to a greater or less extent from the ideal which advanced sylviculturists have before their eyes.

The condition of the coppice with standards, which covers so large a portion of the woodland area in the south of England, is little better, if not actually worse, than plantations. These coppice woods in many cases were formed two or three centuries ago, but a considerable area of them was planted from one hundred to one hundred and fifty years back from the present time. The object in planting them was doubtless twofold: first, that of supplying oak timber for the navy; second, supplying the requirements of rural districts in firewood, hurdles, charcoal, and many other forms of produce which have little significance at the present time. The condition of these woods may be said to have been unfavourably affected by the great difficulty of raising up young standards amongst the underwood or coppice. When first planted or sown, the oak, ash, or other standards had an equal opportunity of maintaining their existence with the hazel or other growth intended as underwood. They probably stood quite thick enough upon the ground for the first fifty or sixty years, and little was done but to weed out a few of the weaker or damaged trees each time that the underwood was cut. As time went on, and the trees increased in size and value, the temptation to cut and dispose of them became greater, and for the last fifty years at any rate, if not longer, the mature standards in almost every coppice wood in England have been severely thinned out. No doubt many of these standards were fully ripe; and had a proper succession been maintained by replanting at every fall of the underwood, little harm would have been done. But owing to the difficulties already referred to, and the greater importance attached to ground game by modern sportsmen, young standards were either

prevented from springing up, or were eaten off when planted by rabbits. The gradual result has been, therefore, that our coppice woods to-day contain little but stunted or badly shaped oaks, young or immature ash, etc., scattered at irregular distances amongst the stools of coppice. The latter, which at one time was of considerable value, and made from £10 to £12 per acre when cut at intervals of ten years or so, is now almost worthless, and this fact still further aggravates the economic condition of this class of woodland.

The fact must not be overlooked that practically the whole of these coppice woods stand on much more fertile ground than the majority of ordinary plantations. It is no uncommon thing to find coppice woods surrounded by ground which has an agricultural value of from £1 to £2 per acre. Their condition therefore becomes all the more unsatisfactory when viewed as a branch of estate economy, and it is at least a source of gratification to note that this fact is being gradually recognised.

Another but more limited class of woodland represented in England is that found in the beech woods on the Chiltern Hills. How these woods originated it is difficult to say, but they are generally regarded as being indigenous to the soil. At one time it appears they were cut over for firewood, and their value in any other direction was small. But during the last fifty years or so they have acquired considerable importance by the development of the chair-making industry, which has its centre at High Wycombe. The chalky loam which covers these hills forms an almost ideal soil for this tree, and occasional patches of beech may be seen which, as regards growth, density of the crop, and condition generally, leave nothing to be desired. But the fact cannot be denied that these woods, like those of every other description in England, have greatly deteriorated by over-cutting. The system of management adopted for many years has been that of going through them at comparatively short intervals and taking out the best and largest timber. After each cutting, the first good seed year which follows sees a plentiful crop of seedlings spring up to take the place of those removed. Theoretically, therefore, the system is more or less satisfactory,

and, where practice has kept in touch with the system, the condition of these woods is fairly good. But in too many cases the trees selected at each felling have been far too small and too numerous for maintaining the stock of timber which ought to be present on the ground. Trees, again, have been taken out which ought to have remained for at least twenty or thirty years longer, while crooked and partly suppressed trees, which ought to have been removed to make room for the young crop to grow, have been allowed to remain. The result has been that a large number of these woods are now of little value, and time and proper care will be required to again restore them to a satisfactory condition.

A form of coppice is also represented on a small scale by the pure Spanish chestnut underwoods of Sussex. A few years ago these coppice woods probably paid a higher rental for the land they occupied than any other form of sylviculture in England. Coppice of eight or ten years' growth is said to have made from £30 to £40 per acre, and although its value has gone down considerably, it still fetches a far higher price than the ordinary coppice found in most parts of the country. This form of coppice is grown without standards, and the management and preservation of its economic condition is greatly simplified. Most of this wood stands on the Greensand formation, and might possibly be grown with advantage in other parts of the south of England. The great value of this wood in Sussex, however, depends upon the demand for rods and barrel hoops, the latter being used principally in the north of England and Scotland for fish barrels. This industry, however, like many other rural industries, suffers from depression, and it is questionable whether it can long survive the advances made in all forms of manufactures which have wood for their raw material.

The above may be considered the principal systems of sylviculture practised in England. No attempt has been made to describe them in great detail, as they are more or less familiar to all acquainted with country life. It only remains to say a few words upon the financial aspect of English forestry as it is now practised. It has long been asserted by many proprietors, who ought to be in a position

to know, that English forestry does not pay. As a matter of fact, probably it does not, if by "paying" is meant a return of 5 or 6 per cent. on the capital outlay. Certain crops, such as larch or ash, may possibly pay 5 per cent., and larch certainly pays in many cases a great deal more. But taking woods of all classes throughout England, the nett return per acre probably does not exceed 5s. This return is of course too small to entitle forestry to be regarded as a commercial success, but it must be remembered that the money returns are not the only ones derived from the cultivation of trees. Their value in the direction of sport and landscape effect are probably greater than their value as timber producers, although it is by no means inevitable that this should be the case. The low returns so often complained of are due to the causes already referred to, and it remains for landowners to inaugurate and carry out a better system of planting and managing their woods which will bring them more into line with other branches of estate economy.

PRESENT ASPECTS OF ENGLISH FORESTRY.

The definition of English forestry as it is practised at the present day is not an easy matter. Sylviculture pure and simple may be practically defined as the art of growing trees into marketable timber; arboriculture as the cultivation of trees for ornament; landscape gardening as the improvement of the landscape, by planting and felling trees, and their picturesque arrangement over a tract of country. English estate forestry is all and none of these. It produces marketable timber, and yet cannot be termed sylviculture except in isolated patches. It produces ornamental trees without any cultural effort on the part of the forester, and it also improves the landscape without strictly conforming to the rules of landscape gardening. The English climate has been said to be made up of "samples," and in much the same way English estate forestry is made up of samples of sylviculture, arboriculture, and landscape gardening.

The absence of any definite object being kept in view with regard to English forestry is due to various causes. No

doubt the majority of English landowners regard their woods in much the same light as the Norman baron or earl regarded his chase, or the king his forest, namely, as so much ground set apart for sport. If this ground yielded something more in the shape of timber or firewood, so much the better for the lord of the manor, and in the same way the English landowner of to-day looks upon any return in timber from his plantations as a perquisite which he has done nothing to secure, and which is therefore more or less nett profit. To plant timber trees with any definite idea of obtaining a higher rent from the ground, or of increasing the capital value of the estate, is a step which the average landed proprietor very seldom takes, owing to the long length of time which must elapse before any scheme of this kind can reach maturity. The consequence is, therefore, that English forestry has developed into a more or less haphazard combination of planting, thinning, and felling; or, in other words, into a mixture of silviculture, arboriculture, and landscape gardening, as already said.

Silviculture in English forestry is usually confined to young plantations under fifty years of age, or to groups of greater or less extent in older woods. It is very rare to find it practised over a large area or throughout the life of the wood, and in many cases where an exhibition of it may be found, it is as often as not due to neglect or accidental causes unconnected with any system of organised management. Generally speaking, English plantations are not formed on strictly silvicultural lines to begin with. The general idea which permeates planting operations is that of covering the ground with trees which will ultimately develop into a wood. The size or quality of the timber this wood will produce, and the period at which it will probably arrive at maturity, are regarded as remote contingencies, and are seldom taken into account when deciding on the species to be planted and the subsequent operations of thinning.

For the first ten or twenty years after planting, English plantations are usually left pretty much to themselves. In the first place, the thinnings are of little value, the plantations themselves are usually available for game cover, and their ornamental features have not yet had time to develop

to any considerable extent. But after that stage is reached the subsequent treatment of the crop depends a great deal upon the individual point of view of the proprietor. In some cases he wants timber or poles for estate purposes, in others he wants plantations which will provide shelter for the greatest possible head of game, while another will probably look upon his woods in much the same way as his pleasure grounds, park timber, or any other ornamental feature which may exist upon the estate. In the one case, therefore, sylviculture is practised more or less throughout the life of the plantation; in another it practically terminates by the time the trees are 20 to 30 feet high; and in the third case it may never be allowed to begin, or may develop unaided by artificial agency until the crop is fully mature and commencing to decay.

The arboricultural aspect of English woods is one which is often pushed to the front as an excuse for bad forestry. We are told that landowners do not maintain their woods for profit so much as for their ornamental features, and as an amenity to a country estate. If this be so, the wonder is that the results in this direction are so miserably bad, and that English woods in many cases, instead of exhibiting the most attractive features which woodlands are capable of, are more often as insipid and monotonous as they can be. Possibly this may sometimes arise from the mistaken idea that the only type of tree worth looking at is that which possesses a full, well-developed crown, such as the typical park or hedgerow tree. Such trees are often pointed to with pride as examples of the result of giving them plenty of room, and in the old days it is possible that the forester or his equivalent in the dialect of the locality had a lurking idea that such trees were the ideal composition of a plantation. But, as most people know, any attempt to grow such trees under ordinary plantation conditions ends in failure, unless the plantation is converted into a park-like degree of openness. The general result of attempting it is the production of coarse timber and unsightly trees, for anything more unsightly could hardly be imagined than trees with a coarse branchy stem, short bole, and crown which has been arrested in its development after a number

of years of more or less uninterrupted growth. Of course such results are not always due to an attempt to render the wood ornamental, but are quite as often due to mistaken silvicultural notions. But, as a general rule, the old-fashioned idea regarding an ornamental tree is responsible for a great deal of coarse timber, and a good many of the unsightly woods which exist at the present day, and which render a woodland landscape about as picturesque as a field of cabbages.

The final result of this mixture of silviculture and arboriculture is sometimes good, sometimes bad, and in most cases indifferent. It is usually good, outside the forester's point of view, where a definite aim has been kept in view for a number of years, and work has been carried out on principles generally recognised as correct when applied to a particular object or branch of work. It is invariably bad where no definite aim is kept in view, but the management based more or less on lines which fluctuate from year to year, and the work carried out on wrongly applied principles. The prevailing indifferent result is the outcome of a mixture of both of these systems, and usually exists where the management of the work is split up between two or three individuals.

Good results, as already said, are the outcome of a definite aim being kept in view, and will usually be found on estates where a succession of competent foresters have been employed, and the woods left practically in their charge. In such cases, which are unfortunately few and far between, woods are intelligently planted with the right species for the soil and situation, they are regularly and properly thinned, and when ripe are felled and placed on the market by a man who knows something about the state of the timber trade, and the total cubic contents of the timber he is selling. While the production of timber is the main object in view, the forester in charge of such woods studies their ornamental features to some extent, as well as their value as game preserves. Ornamental trees and shrubs are planted in suitable situations, and attended to when necessary. The wants of the gamekeeper are met at least expense to the proprietor, and without that utter disregard of the suitability

of shrubs and trees for the purpose in question. Park and hedgerow trees are pruned in a neat and tasty manner, and not mutilated or disfigured by ignorant workmen, while neatness and tidiness are conspicuous in all departments. A typical forester on such estates is a man who has been brought up as a forester, and has made a thorough practical study of the subject. Such men do not profess to know everything, neither do they hold extravagant ideas on any particular branch of their profession, to the neglect or detriment of most others. They naturally object to being interfered with when discharging their legitimate duties, but on the other hand are quite willing to leave the business of others alone.

The general result of leaving the management of estate woods to such a man is, as already said, good. From a strictly forestry point of view, it is of course not perfect, because forestry pure and simple is rarely practicable on English estates. But considered as a mixture of the various elements which combine to make up estate forestry, and which meet the requirements of most proprietors nowadays, it comes nearer to perfection than any other in the bounds of practice.

The worst results obtained in English forestry are usually on small estates, where the commercial details and higher branches of the work are left in the hands of agents, and the practical woodcraft in the hands of a foreman woodman or labourer. The former are generally ignorant of the general principles of silviculture, and are too often guided by motives of an indefinite nature. The woodman, on the other hand, is little more than a skilled workman at the best, with a rule-of-thumb acquaintance with the elements of planting, thinning, draining, and so forth. The timber is usually cut at irregular intervals, and quite independent of its ripeness or technical value. Thinning depends more upon the requirements of the estate for the thinnings than the need of the plantation thinned, while replanting is usually neglected altogether, or placed in the hands of nurserymen at so much per acre. The result is inevitably bad, and it is difficult to see how it could be otherwise. With a small area of woods, it does not pay the proprietor to employ a

competent forester, while agents who are thoroughly conversant with all branches of estate work are few and far between. The difference between the nett returns from a small area under good and bad management is probably not great, while it takes many years to improve the returns from neglected woodlands. Under such circumstances the proprietor rarely takes the trouble to alter existing matters, and the woods are mismanaged until they are converted into practically a wooded waste, and then left entirely as game cover.

Another reason which often accounts for small woods not showing much profit, is the fact that they usually occupy the poorest ground that can be found round about them. This is, no doubt, as it should be, for the chief function of forestry is to utilise ground which cannot be profitably grazed or cultivated, and if fencing could be dispensed with many poor patches of ground might be planted up with advantage. But when plantations occupy the face of steep banks, patches of boggy ground which require a good deal of drainage, the summits of hills, or the bottoms and sides of gullies and ravines from which it is difficult to remove the timber, it is obvious that profit is not easily obtained from them. The growth of timber on banks and hilltops is not so rapid as in a large plantation which takes in a considerable portion of fairly good ground, and from the interior of which the wind is excluded, and the soil preserved from loss of leaves and moisture. The cost of making and keeping clean drains throughout a rotation of eighty or a hundred years amounts to a considerable sum per acre, and is much higher than it would be in a plantation on average ground. The removal of small lots of timber from ravines is always a factor in reducing the price per foot obtained for it, owing to the extra trouble and cost involved, while small wood and fagots in such situations are often unsaleable.

The indifferent results of English forestry are due to many causes, but the principal one is the absence of any definite objective in the management of woodlands. Woods suffer considerably from being parts of estates, and not estates in themselves, and therefore have frequently to become subservient to other estate departments which, in

the owner's eyes, may be of greater importance. It is very rare to find the stock of timber on the wooded area of an estate up to its normal strength, and it is also rare to find energetic measures being taken to make it so. Where woods are, or have been, fairly well stocked with timber, a policy has been too often inaugurated of annually reducing the stock under the plea of thinning, while clear fellings have been delayed as long as possible in order to avoid the necessity of replanting. The general result is that the majority of estate woodlands bring in little more than will cover the cost of maintenance, while, where extensive replanting operations have at last become imperative, the income may merely equal or even fall short of the expenditure.

There is no doubt that this state of matters has given rise to an impression that woods are unprofitable, or at any rate that the profit derived from them is too small to make it worth the owner's while to seriously undertake their improvement. When once allowed to fall into bad order, or become thin and patchy, their restoration is a question of time and money, and when a proprietor has other and more urgent demands upon his purse he is not likely to pay much attention to the replanting of his woods. That planting or replanting goes on more or less on most estates is well known, but it is rarely carried out on such a scale or in such a way as to bring English forestry up to the desired standard of perfection. The ultimate value of a plantation at the time it is planted is seldom seriously taken into consideration, and the general tendency is to treat the prospective value of a young plantation as an unknown quantity, and as too problematical to be worth studying so many years in advance. The highest ambition of the modern planter seems to be the conversion of bare ground into something tall enough for pheasants to roost in, and, that accomplished, he feels satisfied with his work. It is evident that the neglect of sound forestry principles in forming plantations at the present day is not conducive to the improvement of English forestry, and it is much to be regretted that such should be the case.

In the old days, as we have seen in a preceding chapter, the planter always had a definite aim in view—usually the

production of oak for the navy, combined with coppice or underwood. The majority of species which usually form a modern plantation nowadays were then unknown, or were too scarce to be used in ordinary planting, and indigenous species had to be used almost exclusively. Pheasants and ground game were not the chief reason the landowner had for maintaining woods, and the economic value of the latter was a primary consideration, although silviculture was imperfectly understood and its principles not always recognised.

At the present day the landowner usually maintains his woods with an eye to game preserving as much as timber growing, and it will usually be found that their management is indirectly, if not directly, influenced by the opinion of the gamekeeper. The aim of this functionary is to get as large a head of fur and feather on the area allotted to him as possible, and it is easily understood how impossible anything like economic forestry becomes under such conditions. Under existing social conditions, country sport has developed from a luxury into a necessity for the wealthy classes, and it is difficult to see how any substitute can be found for it. Shooting is one of those recreations which can be indulged in by both young and old, and it is a recreation peculiarly associated with woods. Any suggestion which is likely to affect this sport unfavourably has little chance of being acted upon, and, whatever system of forestry be adopted, its most essential feature must be its capability of existing in the company of the pheasant and rabbit. It is to be feared that many forestry enthusiasts lose sight of this fact. They are apt to argue that the proper function of woods is to produce timber, and that game should be a secondary consideration only. Theoretically this is, no doubt, correct; but facts cannot be denied, and in English forestry these all point to the opposite conclusion. The rearing and existence of pheasants do not interfere necessarily with successful forestry, but experience proves that rabbits and pheasants invariably go together, and that it is useless to rely upon repressive measures against rabbits being maintained so long as they are entrusted to the gamekeeper. Although a pretence is made of keeping them down by ferreting in the spring, after the regular shooting season

is over, nothing of a really effectual nature is done unless the strictest orders are given by the proprietor in person, and then only when backed up by threats of punishment in default. The gamekeeper considers rabbits as much worthy of protection and encouragement as pheasants, and, as a good stock of them can be got up without the least trouble to himself, nothing but compulsion will induce him to suppress them.

Unfortunately for the cause of forestry, very few proprietors realise the enormity of the damage done by rabbits in English woods. It is not alone that they destroy young trees which have not yet acquired a coat of rabbit-proof bark, but they devour millions of seedlings which would otherwise grow up and take the place of mature timber, and which would render the nett returns from woods very much greater than they are at present. To protect trees against large numbers of rabbits entirely precludes the possibility of any profit attending forestry, unless clear felling is resorted to; and this is often objected to by proprietors who have a sentimental regard for their woods. Even with clear felling, and the netting round of the planted area, it often happens that the netting is removed before the trees are safe from attack, the result being that many of the most valuable species are practically exterminated. Under such conditions the forester has an uphill task at the best, and success is as often a question of accident as of good intention.

Another feature of modern English forestry is the sentimental value placed upon woods as features in the landscape. This is a feature which even the professional forester can appreciate and sympathise with, for an English landscape is almost unique in European scenery, and one of which every native should be proud. Many estate woodlands have been planted, so far as their situation goes, almost entirely with a view to landscape improvement; and any clearing on a large scale would, in some cases, temporarily interfere with the effect they produce. Although skill and judgment can easily avoid any disfigurement which might result from wholesale clearing, it is difficult to get proprietors to realise this, and they frequently prefer to leave old woods

standing, which have been thinned up to vanishing point, rather than clear and replant the ground.

Unfortunately for large landed estates, the Finance Act of 1894 placed them in a worse position, so far as forestry improvement goes, than they were in before. At the death of each life tenant of an estate, death duties are charged on the capital value of the property, which amount in many cases to 6 or 7 per cent. This means, in plain language, that the average proprietor loses about three or four years' income at the commencement of his tenancy, and which must come out of the estate by fair means or foul. The first and foremost step towards meeting these death duties is invariably that of cutting down as much timber as possible, or, in other words, to cut into immature woods long before they are financially ripe. The result of this step is invariably that of reducing the capital value of estate woodlands in more ways than one. Not only is the stock of timber reduced far below its normal quantity, but all working expenses, planting operations, drainage, and general maintenance of woods and fences, are reduced and suspended for a number of years, according to the necessities of the new life tenant or his inclinations, as the case may be. Indirectly this Act has done more to hinder the improvement of English woodlands than any event which has occurred during the present century. It may not have prevented planting up to the present, because, as we have already seen or shall see, this work does not altogether depend upon financial considerations. It has undoubtedly resulted, or will result, in the returns which ought to follow that operation being reduced to a vanishing point on a large number of estates. No landowner can be expected to take that lively interest in the improvement of his estate, when the fact that its capital value is put at so many thousands is made the excuse for a tax which cripples and hampers his financial position for probably the greater part of his life. Whether the Act be good or bad in principle we do not pretend to say, but so far as estate woodlands are concerned it undoubtedly produces the effect upon them described above, on many, if not all, estates which feel the effects of it.

CHAPTER III

PROSPECTS AND POSSIBILITIES OF ENGLISH FORESTRY

IN considering the possibility of any important increase in the area of English woodlands, three important points present themselves:—*1st*, The existence of suitable land for planting; *2nd*, The financial result of planting it; and *3rd*, The provision of the necessary capital. The suitability of land for forestry purposes is not determined by its ability to grow good timber alone. If this were so, then we might select the most fertile and sheltered tracts in the country, and success would be practically assured. But in England, or, for that matter, in any thickly populated country, agriculture must of necessity occupy the first place in land utilisation, for the feeding of the population takes precedence of all other branches of rural economy. From the landowner's point of view, the most approved method of utilising land is that which will bring him in the best and most direct return. By far the greater part of the land of the country is used for agricultural purposes, and its value depends directly upon its fertility, the landowner reaping the benefit in the form of rent. The rent of ordinary agricultural land ranges from £3 per acre in the case of fertile pasture land, down to 2s. 6d. per acre in the case of hill pasture, sheep walks, etc. It is obvious that a landowner in receipt of an immediate nett return of £1 or more per acre has no inducement to turn his attention to other means of utilising it under average agricultural conditions, and certainly would not give it up in favour of growing a crop which would take at least fifty years to mature, and involve the locking up of capital for that period, if not longer.

But in the case of the poorer classes of agricultural land, such as, for instance, those which bring in less than 10s. per acre, the immediate return is not such an important matter in the owner's eyes, although it is still one which requires considerable reflection before being relinquished for a deferred return. The first thing the owner of such land would take into account would be the probable increase in its value which a change of utilisation would bring about. To give up a present annual return of 10s., 7s. 6d., or 5s. per acre, as the case may be, for a deferred rent of the same amount, would be no advantage to himself nor to the estate. The increase in value must be sufficient to compensate for the loss of rent during the non-productive period, and the increase must also be sufficient to justify the risk which would attend the operation.

In considering the suitability of such land for timber growing, therefore, the whole question turns on the yield that may be expected from the timber crop under the prevailing conditions of soil, climate, elevation, aspect, market prices, and so on, which, in the case of ground which has never before carried a crop of timber, are all unknown quantities, and can only be approximately gauged by experience and analogy. Experience teaches that if a certain soil and situation in a given climate and at a given elevation has produced a certain crop of timber, a similar soil under similar conditions will produce a similar crop elsewhere. The weak point in the inference lies in the fact that the analogy is rarely, if ever, complete. The various factors which combine to produce a given yield of timber are rarely, if ever, found in the same combination twice over, and it is only approximately that an estimate of the yield or value of a particular crop can be made. But, for all that, we are fairly safe in predicting that land on either side of an existing plantation will produce a similar crop to that found in the latter, provided soil and all other factors are apparently the same. Basing our calculation on data of this kind, it is not difficult to anticipate the approximate result of planting different classes of soils throughout the whole of England; and although accident may affect the accuracy of the prediction in one case, an undiscovered

difference of soil in another, and the future values of timber be an unknown quantity in all, yet the present state of the timber trade, and the steady exhaustion of all known sources of supply, render the planting of certain classes of land no more risky a speculation than hundreds of investments made in the financial world day by day.

But the fact that much land of low agricultural value is suitable for planting must not be taken as an indication that the whole of the poorly rented land of the country can be profitably utilised in this way. A glance at hundreds of existing plantations throughout England will convince the experienced forester that they have failed to return the money originally invested in them. They may have produced trees, and even timber, but their rate of growth has been so slow, or disease has made much havoc among them, that they cannot be considered examples of profitable forestry by any means. Reasons for such cases have already been given, and the only way to avoid their repetition in the future is by a careful selection of soils to plant, and species to plant them with, for the former is as important as the latter.

A careful examination of instances which are supposed to represent profitable forestry reveals the fact that the agricultural value of land affords no safe criterion of its value for forestry purposes. A soil which may let readily at 10s. to 15s. per acre when under pasture, such as stiff adhesive clays, may not be worth 2s. 6d. for growing timber when the various costs of growing and marketing the crop are considered. A great deal of land, on the other hand, which is not worth 2s. 6d. for grazing purposes, is capable of growing coniferous timber to the value of 10s. to 20s. per acre per annum, and thousands of acres of such land are lying idle in different parts of the country. Such land will almost invariably prove to be deep gravels with a poor surface soil which cannot be profitably cultivated, or soils which occupy steep hillsides and ravines, or the surface of which is so broken up with rock or gravelly hillocks that they can neither be grazed nor cultivated with much advantage to either landlord or tenant. It usually happens that the soil lying between the interstices of rocks is of the very best description, and trees are about the only form of vegetation

able to take advantage of it. In gravelly or sandy soils, again, they are able to reach the plant food lying within a considerable depth of the surface, and the aridity and poverty of the surface stratum do not affect them in the same way as agricultural plants are affected.

Such soils as these are not peculiar to any particular geological formation, but will be found more or less on formations ranging from the primary rocks to the gravel beds of recent origin. It must, however, be admitted that the geological formation has a decided influence on the chemical composition of the soil, and to a less extent on its physical condition, and these affect the growth of different species to a marked extent. It is a well-known fact that plants closely allied botanically often show a marked difference in their liking for particular soils. The Austrian pine, for instance, delights in a calcareous soil, while Scots pine rarely lives to great age in it, and the pinaster almost refuses to grow in it at all. Certain species, again, seem quite indifferent to the chemical character of the soil, but are easily affected by its physical condition, especially as regards moisture and porosity. Ash on a dry shallow soil is shortlived, and at the same time rarely thrives in a stiff wet clay. Shallow-rooters, such as spruce or larch, are affected as much by climate as soil, and so on. Any attempt to judge the fitness of soil for forestry purposes from the geological formation on which it rests must give results of little practical value, for clays, loams, gravels, sands, and peat are found on all formations. But when the physical or mechanical property of a soil is known, together with the geological formation from which it has been derived, we are in possession of data which enable a fairly accurate estimate to be made of its suitability for forestry purposes, although actual inspection of the ground is the only safe guide in the case of a specified area.

As a general principle, it may be stated that no land can be considered suitable for growing profitable forest crops which has less than 2 feet of gravel, sand, or other soil overlying the solid rock. We may get trees to grow on almost bare rock, but, unless that rock is so shattered and broken up to a fair depth as to resemble gravel in character, we never yet saw trees grow on it at a profitable rate, unless

in the case of a self-sown crop on otherwise worthless ground, when growth of any kind which pays for cutting must be considered profitable. Scots fir will exist on sandstone, beech on chalk, and even oak in the crevices of slate cliff, but for a profitable growth to be made, a certain depth of soil or porous stratum is absolutely essential, and the depth necessary to maintain a given rate of growth will vary, to a certain extent, with the supply of soluble plant food which the porous stratum contains. A thin but rich soil will sustain more growth than a thin and poor soil, and in this respect the geological formation may be of importance, for any soil is simply powdered rock. When we know that the rock from which a soil or superincumbent stratum has been formed is rich in mineral plant food, such as potash or phosphoric acid, we may infer that the stratum itself is of superior quality to one formed of almost pure quartz or carbonate of lime. Greensand or granite soils, for instance, are richer in mineral food than those from millstone grit or chalk, and soils formed from the former are usually more productive than those from the latter. But, even here, moisture or mechanical condition may affect fertility, and a soil which ought theoretically to be fertile may be actually poorer than one which might be supposed to be poor.

But, as a general rule, a knowledge of the geological formation, the depth of porous stratum, and the average rainfall, will enable one to form, as already stated, a fairly accurate estimate of the value for timber production of any large tract of country which cannot be utilised for agricultural purposes except at nominal grazing rents.

The gravels and sands of the Tertiary Period, the poor and stony soils on the Greensand, the lower slopes of hill ranges formed by the Mountain Limestone, Millstone Grit, Silurian and Metamorphic rocks, etc., present extensive tracts which are capable of growing profitable crops of timber, evidence of which is found in plantations already existing on them. As a general rule, the more finely a rock is laminated, and the more easily it weathers down, the more valuable it becomes for timber growing; for the roots of trees are able, in themselves, to force their way into stratified rock, and secure both food and foothold when once

thoroughly established. It is common knowledge that thousands of acres on the above, and other formations equally suitable, are lying as more or less waste ground, although the planting of such ground with trees would render it a source of profit to the owner, and give employment to a great deal of unskilled labour in country districts. We do not assert that the whole of the waste land of the country is fit for afforestation, even if no obstacles existed for using it for such a purpose. But there is little doubt that the area of English woodlands might be doubled without taking one acre of useful ground from the farmer or grazier. Devonshire, Somerset, Dorset, Hants, Sussex, and Surrey, in the south; Northumberland, Cumberland, Durham, Yorkshire, and Derbyshire, in the north; and many parts of the eastern and midland counties, contain extensive tracts which might be afforested with advantage to all concerned, and prove a source of national strength in the shape of a strong and hearty woodland population.

THE FINANCIAL RESULTS OF PLANTING.

Coming to the second point,—the financial results of planting on a large scale,—we are treading on more uncertain ground. As already said, the existence of flourishing and profitable plantations justifies the belief being entertained that the same results which have been obtained on a small scale would be equally possible where larger areas were being dealt with. But it is as well not to indulge in expectations which may never be realised. No reasonable individual who has studied the forestry question with an impartial mind sees any reason to doubt the financial success of intelligent planting operations. But it must also be remembered that the bulk of the land under consideration is characterised by great variations in depth of soil and sylvicultural fertility, and that it does not always follow that the return per acre possible from a plantation occupying a hundred acres of carefully selected ground would be also possible from one or two thousand acres in the same locality. With soils that vary comparatively little in depth, such as

deep beds of sand and gravel, the yield per acre would probably be fairly uniform, as we find it to be in most cases where such soils are concerned. But where the solid rock comes within 2 or 3 feet of the surface, as it does on a great deal of mountain and hill land, a difference of 1 foot in the depth of the surface soil or gravel, as the case may be, may make a material difference in the yield of timber per acre. The presence of springs or iron pan is another frequent occurrence on hillsides, and affects the returns to a great extent also.

In short, the larger the area dealt with, the greater the probability of having to enclose more or less unprofitable ground becomes, and the smaller the probability of obtaining a high yield per acre. The principle of calculating the prospective returns of unplanted land from those derived from existing plantations of small extent may be quite as misleading as calculating the probable yield of farm crops per acre from the produce of a few square yards, and, in the absence of large areas of woodland to guide us, it is well to allow for the yield of large areas being lower than that of existing plantations of small extent. This, in itself, is no argument against planting on a large scale, as, although the acre yield may be low, the working expenses are, or ought to be, low also, and the nett returns are usually higher than when the expenses swallow up a large share of the gross returns, as they invariably do on small areas of woodland.

In attempting to calculate the probable financial result of planting waste land, any approach to exact figures is of course out of the question. All that is wanted is that the planter should be furnished with a reasonable guarantee that the time and expense involved in such an undertaking will not be abortive, but yield an adequate interest on the capital expenditure. Take the case of a landowner possessing ten thousand acres of "mountain or heath ground," as the Agricultural Returns term it, and which bring in a nett return of 2s. 6d. per acre, and the bulk of which is well adapted for planting purposes. Before embarking on planting operations on a large scale, say up to 1000 acres or so, he may possibly be curious to know how such a proceeding

will affect his own personal interests, and the interests of the estate generally. He will, or may, take it for granted that the operation will not immediately benefit himself financially in the least, for it will be twenty or thirty years before any appreciable return will be forthcoming. But regarded in the light of an estate improvement, and assuming that the cost of the work is looked upon as an investment, how will the final results compare with other kinds of outlay, such as that on building, draining, road-making, and so on, and also with the present rent of the land? We believe 3 per cent. is about the average interest obtained, or expected, on the capital value of agricultural estates generally; and if the result of planting is equivalent to 3 per cent. on the total outlay, then it may be considered that the money has been well expended. But it must be borne in mind that the present rent of 2s. 6d. per acre is probably obtained without any outlay whatever, and it is therefore more in the form of a royalty than a rent, except so far as it may involve the fencing of a part of the ground. In the case of the ground being planted, not only has this rent to be given up, but a capital outlay of from £2 to £5 per acre must be sunk for a long period, and other expenses on maintenance incurred from time to time.

It is evident, therefore, that the financial aspect of planting waste or other land does not appeal very strongly to the individual who plants it. It is by no means certain even that his lineal descendants will derive the chief benefit from the work, for the changes in the ownership of estates in the course of half a century are often radical enough to render the labours of the grandfather of little value to the grandson. We must find other inducements, with more immediate advantages attending them, if the planting of rent-yielding land is to become a favourite occupation with the average landowner. Fortunately such inducements do exist, and they are such as estate owners usually appreciate strongly. In the first place, plantations add enormously to the residential and sporting value of an estate, much more so than many realise. The term "well-wooded" occurs so often in auctioneers' descriptions of those "desirable freehold properties" which come on the market from time to time,

that it is evident that a property which is not well-wooded is not altogether desirable, and that woods, apart altogether from the market value of the timber they may contain, have an æsthetic value which cannot be ignored by the most prosaic individual. Unfortunately for the landowner, the general public find it only too convenient to ignore them, although they are not averse to enjoy the benefits to be derived from a well-wooded country.

But the proprietor probably reaps the most benefit from the increased sporting value of a well-wooded estate. Shooting rents, although they seldom exceed 5s. per acre, are comparatively high when the agricultural value of poor grazing land, upon which most modern plantations are made, is considered, and their value is probably not less when the proprietor keeps the shooting in his own hands. Apart from the timber-growing value of the land, therefore, its sporting value when stocked with trees is an item which cannot be ignored in dealing with the total returns obtained, and it is probable that many proprietors are quite satisfied if their woods simply pay for their maintenance, so long as they are available for the preserving of pheasants.

It is obvious, therefore, that the average planter of poor land is not exacting in the way of pecuniary returns. He certainly does not look for them during his own lifetime, and it is only with the idea of satisfying himself that he is making a sound and profitable investment that he takes the trouble to inquire into the financial aspects of estate forestry. As 3 per cent. has been mentioned as the interest on outlay which is sufficient to recoup an estate for the cost of forest planting, the question simply amounts to this: Will the returns obtained from ordinary forest crops enable a sum which represents the value of land and cost of planting and maintenance, accumulating at 3 per cent. compound interest for a period of fifty or sixty years, to be repaid? In answering this question, it must not be forgotten that a reasonable allowance must be made for the benefits in the way of landscape effect and the sporting value of woods already referred to. These benefits ought to be worth at least 1 per cent. of the 3 per cent. mentioned; and if the landowner who plants land worth less than 5s. per acre for agri-

cultural purposes gets 2 per cent. on his capital outlay, he ought, we should imagine, to regard the investment as a sound one, taking into consideration the indirect benefits which follow planting operations. If we can find, therefore, forest crops which will return 2 per cent. on the cost of raising them, we shall at least satisfy the average landowner, and have proved that estate forestry is not a losing undertaking, as so many seem to imagine. To afford this proof, we have not only to give instances of crops which have already yielded that rate of interest, but to give reasons for supposing that those about to be planted will be able to do the same.

We do not propose to give individual instances of profitable plantations,—in the first place, because we have not the necessary data to work upon; and, in the second, because they would not be believed if we gave them. But what we can and shall prove is, that certain species of timber trees will produce, on given soils and situations, sufficient timber to pay that rate of interest, provided reasonable costs of production only are incurred.

On the soils and situations which have already been described as suitable for economic planting, the following species may be said to yield the quantity of timber per acre and per annum shown below:—

CONIFERS.

Species.	Rotation.	Yield. Cubic Feet.	Average Price Per Cubic Foot.
Douglas Fir	50- 80	50-100	6d.-9d.
Larch	40- 80	40- 60	9d.-1s.
Corsican Pine	70-100	40- 80	6d.-8d.
Weymouth Pine	80-100	40- 70	6d.-9d.
Scots Pine	70-100	30- 60	4d.-8d.
Spruce	60-100	40- 80	4d.-6d.

HARDWOODS.

Ash	60- 80	30- 60	1s. 6d.-2s.
Spanish Chestnut . . .	40- 60	40- 60	9d.-1s.
Beech	70-100	40- 80	6d.-9d.
Oak	80-120	20- 40	1s. -2s.

The above species may be said, under ordinary conditions, to be profitable in this country, and that they will cover the cost of production where reasonable economy is observed. These costs of production vary, of course, in individual plantations with different species, and in different parts of the country; but, without going into minute details, it may be said that they average from 10s. to 20s. per acre per annum, according to species, soil, locality, etc. etc. It will be seen that the lowest annual production given in our list is that of Scots pine, which at 30 cubic feet at 4d. per foot only equals an annual yield of 10s. per acre. Allowing that the costs of production are the same, it follows, therefore, that this species may pay its way and no more; but as 30 cubic feet is the minimum yield, and the price given the lowest that ought to be expected, average yields even from this tree ought to be higher. With all the other species a profit certainly ought to be expected, though what that may be will depend upon the length of the rotation to a certain extent. With long rotations the return per cent. is usually lower than with short ones, and the yields per acre and per annum are also lower. On the other hand, it must be considered that long rotations favour lower costs of production, and probably, within reasonable limits, there is not much to choose between them.

Dr. Schlich, in his valuable little book entitled *Forestry in the United Kingdom*, gives a table showing the rate of interest which may be expected on capital outlay from the planting of different qualities of land with larch, ash, Scots pine, spruce, beech, and oak. According to this table less than 2 per cent. is only obtained when land worth more than £25 per acre is planted with beech and oak. With larch 5 per cent. may be returned when the land can be bought as low as £2 per acre, while ash also yields $4\frac{1}{2}$ per cent. on land of the same value. He compares this rate of interest very favourably with that obtained from British Consols, which give nominally $2\frac{1}{2}$ per cent., but fluctuate in value considerably.

If the above conclusions are correct, therefore, it is evident that it is not difficult to obtain 2 per cent. from money

invested in forestry, although this return may be deferred for a length of time which takes it out of the reach of the original investor.

PROVISION OF THE NECESSARY CAPITAL.

However profitable estate forestry may be in the long-run, it has been clearly pointed out that it does not benefit the individual who plants or improves his woods by replanting. The average estate owner does, and always will, study his own individual interests to an equal or greater extent than that of the estate generally; and it is perhaps only natural that he should do so. In his capacity as life tenant of an entailed estate, he is entitled to the proceeds or interest which that estate yields annually or periodically, less the cost of maintenance which is necessary to retain it in the condition in which it was handed down to him. What this condition is—good, bad, or indifferent, as the case may be—depends not upon himself, of course, but upon his predecessors, and it is a well-known fact that he is often in a position which makes it extremely difficult for him to secure that income which he is popularly supposed to obtain, and at the same time set apart the necessary sum for the upkeep and maintenance of the estate.

A landowner who plants, therefore, on a large scale is paying away money which he can, if he so chooses, put in his own pocket, where it at any rate benefits his personal interests to some extent or another. His inducements to plant from a selfish point of view are consequently *nil*, and we may take it for granted that a planting proprietor has a certain surplus income over his immediate needs, or is actuated by a public spirit which the British public do not generally give him credit for. That “bloated aristocracy,” which figures so largely in the democratic mind, does not exist in anything like the same degree as some would have us believe. A landowner whose income is purely derived from an agricultural estate has seldom more than enough to keep up the dignity and position which the country generally expects him to do; and when we ask such a man to

plant waste land, we certainly ought to consider the means by which he is to do it.

The first and most natural facilities for work of this kind are afforded by the Board of Agriculture in connection with the various Land Improvement Acts which have been passed during the last twenty or thirty years. These Acts provide for the granting of loans for estate improvements, amongst which forestry is included. The interest on these loans is charged at $3\frac{3}{4}$ per cent., with an additional $1\frac{1}{4}$ per cent. as a sinking fund. In round figures this interest amounts to 4 per cent., and as we have seen that the average landowner does not expect, and probably does not receive, more than $2\frac{1}{2}$ per cent. on an average from his woods, it is clear that these loans do not assist him in a financial sense. This in itself might not be an insuperable obstacle to them being used for the purpose in question, if a more direct and immediate return were forthcoming from the work referred to. But such is not the case; and the borrower under these Acts is therefore converted into a rent-payer for the rest of his natural life, in order that the estate may benefit after he has left it. The general result of this is, of course, that loans are seldom granted, or at least asked for, for planting purposes, the landowner preferring to bear the cost of this work out of his own pocket, or to leave it alone altogether.

Can the above state of affairs be remedied? We believe that it can, but only by a more liberal and public-spirited application of Government money than is now accustomed. When we consider that every estate contains a stock of timber which is worth many thousands of pounds in value, but which the life tenant cannot realise or raise a loan upon in the ordinary form of a mortgage, it is evident that a source of capital exists on his estate which cannot be made use of except when cut and sold to the timber merchant. The latter, of course, he can only do in a limited degree, and whatever he does in that direction is usually done to meet more urgent demands upon his resources than those due to planting operations. But if Government would only advance the money for the express purpose of planting waste land or woodland improvement on the security of the standing timber, his difficulties might at

any rate be removed so far as the financial side of the question is concerned and his own personal pocket is influenced.

By a system of Government loans, with a low rate of deferred interest on the security of the standing timber which is increasing in value from year to year, an inducement or opportunity would be afforded landowners of embarking more largely on forestry operations which would benefit the capital value of the estate in time to come. No doubt, the Government has as many calls upon the Exchequer as can be met with the approval of the taxpayer; but if the general public were educated on the question of afforestation to an extent commensurate with its importance, we believe that few difficulties would be experienced in devising a workable scheme for allowing the landed proprietor to increase the capital value of his land, and at the same time the wealth of the country generally, afford employment for a large number of labourers in our rural districts, and stimulate the fast decaying timber industry in Great Britain, all of which are objects worth the careful consideration of rural economists.

In conclusion, it may be stated that the improvement of existing woods depends almost entirely upon the freedom with which the clearing of old and worn-out woodland, and the replanting of the ground on correct principles, is conducted. It is practically impossible to convert a worn-out plantation into a young and satisfactory crop by the process of planting single trees or small clumps at intervals over the woodland area. Not only are the young trees unable to develop into satisfactory timber specimens, but the cost of planting, protecting the trees from ground game, and tending generally, is out of all proportion to the value of the crop produced. Probably the conversion of underwood or coppice, which occupies so much of the existing woodland, into ordinary plantation is the most important operation in the process. Compared with the ordinary planting on bare or clear ground, it presents many difficulties, owing to the impossibility of grubbing the old stools at anything like a reasonable cost. The only practical method seems to be that of cutting down the stool shoots annually, both before

and after the ground has been filled up with young trees. On ground well adapted for ash this is not such an expensive process as in the case of most trees, as ash is a rapid grower, requires little space for the first twenty years, and is usually capable of taking care of itself when well established. It is also a tree which requires plenty of light and space for crown development, and, as it rarely becomes coarse and knotty with moderate freedom, that close order which is essential in growing most timber trees by a silvicultural system is not required. Douglas fir is also another tree particularly suitable for replanting coppice, as its rapid growth quickly places it out of the reach of all competition with the coppice shoots, which is the great trouble with most species. This tree, planted at 6 to 12 feet apart, will, in the course of fifteen to twenty years, form a thick and close plantation, and practically annihilate the stools of the original crop.

In fact, the majority of either fast-growing trees or those capable of bearing a good deal of shade, such as beech or silver fir, can be successfully employed in converting an old coppice into ordinary plantation—a step which we suppose no one will doubt the wisdom of, unless it be the gamekeeper.

CHAPTER IV

PROFITABLE TIMBER TREES, AND METHODS OF GROWING THEM

THE definition of a profitable timber tree is not an altogether easy matter, profit being dependent upon many factors which are apt to be lost sight of after a number of years, and which cannot be foreseen many years in advance. But the two principal factors are undoubtedly the cost of production on the one hand, and the value of the crop produced on the other. These two factors must always be considered in conjunction with one another, as in the case of farm or garden crops; for it is an obvious fact that the expenses of cultivation must first be paid before a profit can be claimed, and the smaller these are, the greater the chance of profit and the smaller the risk of loss. A great deal has already been said on the subject of profitable forestry which need not be repeated here, although it has a close bearing on the subject generally. All we need deal with in this chapter is the consideration of those trees which can be planted at a reasonable cost per acre, and which in the present state of the market have a fair probability of selling readily when mature. No tree can be called profitable which cannot be readily sold when mature, and which does not grow at a rate which represents a fair rate of interest on the sum necessary to establish the crop and maintain it for the necessary period. As it is practically impossible to say how a particular kind of timber will sell in fifty or eighty or more years hence, the only guide the intending planter has is the present state of the market. No one can say, with absolute certainty, whether a species which sells at 1s. per cubic foot to-day will be

worth the same price in fifty years' time or not. It may be worth 6d., 1s., or 2s. per foot, according to the supply of and demand for it. But all this is unknown to the man who plants that species to-day, just as its present price was unknown to the planter of fifty years ago. Take, for instance, woods which to-day are practically worthless for selling purposes in many parts of England, such as spruce or poplar. A special use for such woods, such as pulp manufacture, may increase their value 50 or 100 per cent. Or, again, the value of a timber may depend, as it often does depend even now, upon the quantity to be disposed of in the district. Small lots may be comparatively worthless owing to the extra cost in dealing with them, and their inability to meet a steady and constant demand; whilst large quantities give rise to special methods for profitably dealing with them, as, for instance, chair-making in beech districts, or hoop- or hurdle-making amongst coppice woods. The starting or cessation of a colliery, again, may render small timber and poles profitable or valueless, as the case may be, and may completely upset preconceived ideas or estimates.

But, accepting the situation of affairs in the timber trade in the same way as all human affairs have to be accepted—with faith—the planter of timber trees has every reason to anticipate the continuance of a demand for good clean timber of those species which are adapted for various purposes in the numerous industries of the country. That new industries may arise and new uses be found for many woods which are now of little value is quite likely, but it is better policy to rely on the existing and probable than on the non-existing and unknown uses of British-grown timber trees; and we may reasonably leave possibilities until we have dealt with probabilities, and briefly glance at those species which are capable of yielding a profit at present prices.

Of the hundreds of trees, both coniferous and broad-leaved, introduced during the last three hundred years, very few can be said to have proved themselves more valuable than indigenous species for economic planting in England. In many cases their non-success may be due less to their specific rate of growth and quality of timber than to their

failure to obtain a footing on the English timber market. The timber trade, like many other industries, is greatly ruled by custom and architects' specifications, and the launch of a new wood upon the general market is attended with more difficulty than the entrance of a new pill or ointment into public favour. The character of our ordinary English timbers is well known, and the timber merchant who buys or the tradesman who uses them knows within certain limits what they will turn out, and how they will behave under given conditions. With a new species all this has to be found out, and the ordinary tradesman or merchant cannot afford the time and risk which would attend the necessary trials and experiments for establishing the reputation of a particular timber.

But the chief drawback in securing a ready sale for most exotic timbers is the fact that they have hitherto been grown in small quantities, and more as ornamental specimens than timber trees. The few trees offered now and again for sale are neither in sufficient bulk nor of sufficient quality for the buyer to differentiate in the matter of price, and his usual figure for all doubtful or unknown timbers is about 6d. per cubic foot, which can hardly be termed a risky speculation. But, although the bulk of our foreign trees cannot be considered of economic importance, there are several which an experience of at least over half a century has proved capable of being profitably utilised in forming ordinary plantations, and which yield, when mature, timber of equal quality to that of the average British timber tree. When we allude to half a century's experience we only refer of course to North American introductions, for most of the commoner European species have been on trial for a much longer period, and fewer differences of soil or climate exist to render their growth in these Islands other than what it would be in their own native habitats. Larch, spruce, silver fir, Corsican and Austrian pines, all exhibit more or less the same characteristics of growth in this country as at home, although larch perhaps may be considered more an exception to this rule than the remainder.

Of the numerous species of trees which are represented in English woodlands, not more than a dozen can claim to be

indigenous to these islands. The remainder are introductions from Europe or various parts of the world which enjoy a temperate or sub-Arctic climate. Since the sixteenth century our list of introduced trees has been steadily increasing in length, until to-day it numbers something like two hundred species, which are practically capable of growing to a fair size in our climate. Our strictly indigenous forest trees are the oak (sessile and pedunculate), ash, birch, wych elm, gean or cherry, alder, willow, aspen, abele, and Scots fir. All these may be considered as genuine natives, while beech and hornbeam might be added as trees which are negatively indigenous, in so far as no record exists of their having been introduced, while, on the other hand, their distribution as constituents of primeval forest is too limited to place them in the list of undoubted natives. The Romans are supposed to have introduced the English elm, lime, sweet chestnut, plum, and walnut; but this is conjecture only, and it is possible that the scanty references in which this conjecture originated may have been based on personal and incomplete knowledge. That the English elm was introduced by them is very probable, however, for it is most abundant to-day in those districts in which the Romans had their chief settlements. The sixteenth and seventeenth centuries saw most of our European forest trees, such as the spruce, silver fir, larch, etc., introduced as garden specimens, while the cedar of Lebanon appears also to have been brought in about this period.

Parkinson, in "A Corallarie" to "The Orchard," a section of his work published under the title of *Paridisi in Sole Paridisus Terrestris* in 1629, mentions the larch "nursed up but with a few." "Not believed to bear cones in England," and a pine "which is planted in many places of our land for ornament and shelter." "Great straight bodies covered with a greyish-green bark, the younger branches are set round about with very long whitish-green leaves." This was probably the stone pine. He also mentions the spruce ("grown with us to be more frequent of late days for the building of houses than ever before"), the linden, and the great maple or sycamore.

Evelyn mentions the spruce, silver fir, pinaster, larch, cedar of Lebanon, and a species which was probably the

stone pine. The Weymouth pine came in in 1705, the Corsican pine in 1759, the Douglas fir in 1827, and the Austrian fir in 1835, the Menzies spruce in 1831, etc.

Miller published his *Gardener's Dictionary* in 1737, and in it we find mentioned the forest trees known at that time. These included *Pinus sativa* ("the manured pine"), *Pinus sylvestris* ("the pinaster or wild pine"), *Pinus sylvestris foliis brevibus glaucis* (the Scotch fir), *Pinus Americana foliis praelongis* (the cluster pine), *Pinus Americana ex uno folliculis* (Lord Weymouth's pine), *Abies taxifolia*, the silver fir, the cedar of Lebanon, larch, and others. The sweet chestnut was said to have been "formerly in greater plenty amongst us than at present, as may be proved by the old buildings at London."

The introduction of deciduous hardwoods, which may be termed timber trees, took place on a much more limited scale, and even at the present day, except black Italian poplar, scarcely one can be called an ordinary English timber tree, except those introduced in the earliest periods. The great attention paid to introduced conifers was and is due chiefly to their rapid growth and evergreen character, rather than to any superiority of their timber over indigenous trees. Until the nineteenth century the use of any introduced tree, except larch and spruce in ordinary plantations, does not appear to have been universal. This can easily be accounted for by the comparative dearness of both their seed and seedlings, and the great difficulty of raising and transplanting them. Public nurseries were few and far between, and facilities for transit were neither numerous nor cheap.

Beginning with our indigenous species in the first place, a brief review of the comparative values of what, in our opinion, are the species worth growing for profit at the present day may be given, together with their behaviour under sylvicultural and climatic conditions, and on different soils and situations.

THE COMMON OR PEDUNCULATE OAK (*Q. pedunculata*).

The British oak has long been the most typical representative of the forest trees of this country. Our earliest recorded religion is supposed to have been associated with it, and the Druids to derive their name from the tree. It formed the staple timber of our earliest builders of dwelling-houses, ships, and bridges; its acorns fed the deer and swine of our Saxon ancestors, and its bark tanned the hides which shod and partly clad most classes of the Middle Ages. Many centuries ago, when the wants of mankind were of a more primitive nature, the oak was held in respect more for the sake of its acorns than its timber. Acorns fed the deer of the forest, and the swine and sheep of the agriculturist, and in days when there was little or no distinction between the forest and the public grazing grounds of the entire community, it was to the interest of all parties to protect a tree which invested these grounds with their chief economic value. It is also stated that the acorns served as human food in times of famine or scarcity, and it is possible that the uses to which they were put had some connection with the tree being associated with the Druidical religion.

The earlier efforts in British oak-growing seem to have been directed towards the production of naval timber, both in the royal forests and on private estates. In the sixteenth century a few plantations appear to have been formed by sowing or planting in the New Forest, Windsor Park, and probably many other parts, although, except in one instance, precise records of such work may not exist. In the New Forest and the Forest of Dean the planting of oak was probably better attended to than in other royal forests, but even in these only spasmodic action would seem to have been taken from time to time, and according as the political affairs of the country were disturbed or otherwise. Both agriculturists and politicians were constantly drawing attention to its growing scarcity in the sixteenth century, but it was not until the Civil War and the ravages on Crown and private woodlands by the Parliamentary forces that the subject became of serious importance to the country. There is little

doubt that sowing the acorns on the site of the plantation was the prevailing method of raising oak to within the last hundred years or so.

The Hon. G. Lascelles, in a "Brief History of the Arboriculture of the New Forest," contributed to volume xiv. of the *Transactions of the Royal Scottish Arboricultural Society*, tells us that acorns were sown in the New Forest at the end of the eighteenth century, in the following manner:—

"Pits or beds of three spits of ground each were dug a yard apart, and three acorns planted triangularly in each bed. Half a bushel of acorns were allotted for each person to plant in one day: two regards attended every day during the time of planting to see that it was properly done, and, after the ground was fully planted with acorns, it was sown with hawes, hollyberries, sloes, and hazel nuts, and drains cut where necessary, and traps were set to catch mice, and parsons attended daily to re-set the traps and keep off crows and other vermin."

Evelyn of course gives us copious directions on the subject, which amount to the principle of sowing *in situ* and transplanting to thin and patchy spots. He describes the various steps necessary in forming a seminary or nursery, the sowing of the acorns and their protection from vermin, and the subsequent attention to the young plants and transplanting. But the treatment of the wood from youth to maturity, Evelyn says little about, and he seems to have fulfilled his object upon laying down the principles of forming a plantation.

Marshall, the author of *Planting and Rural Ornament*, published in 1796, also has much to say about the raising of oak woods. This writer is an advocate of keeping the ground sown with acorns cleaned and cultivated for the first few years, and using the intervals between the rows for potatoes, cabbage, and turnips. The seed is to be sown with a corn crop, and the latter reaped, not mown. As the plants increase in size they are to be thinned out by chopping out the weaker individuals with the spade, and, where blanks occur, they are filled up with plants from the thick patches. Where groves are the object in view, rather than the prevailing coppice with standards, it is recommended that ash should be sown alternately with the oak, and the former cut

out from time to time to make room for the oaks. Marshall publishes a letter written by Speechly, gardener to the Duke of Portland at Welbeck, to Dr. Hunter, the editor of an edition of Evelyn's *Sylva*, in which the system of sowing oak and other trees on the Welbeck estate is described. It is there stated that the birch had been found a valuable nurse to the oak. The ground was first planted with two thousand plants of various kinds to the acre, and then acorns were sown all over the ground in short drills of about a foot in length, and the writer is of the opinion that the plants from these acorns make the best trees.

Until the last hundred years or so the British oak was considered the secret of our maritime supremacy, and it took equal if not greater rank with coal and iron as the foundation of our commercial prosperity. While all other timber trees had to rub along as best they could, the oak seems to have always received a fair share of protection from the old forest laws and legislation of a later date, as far as it was possible to protect trees by Act of Parliament. If we inquire into the causes which brought this tree into general popularity in more modern times, the explanation is not far to seek. In the old days builders of houses and ships had one great aim in view—that of investing their work with strength and durability. Economy of time was not the all-important object that it is to-day, and expense was made subordinate to quality of workmanship. The early craftsmen soon discovered that, of all British trees, oak alone combined the three essentials for constructive purposes—size, strength, and durability. Ash could give them strength and size, but not the rigidity and durability necessary for solid work. Yew could furnish durability but not size, while no other timber tree had the necessary qualifications for such work. The builder of the fourteenth and fifteenth centuries found oak timber at his call and as easily procured as any, and it is hardly conceivable that he should have chosen any other for his work. That his choice was justified we have the proof before us to-day, and many an old farm and manor house still exists in a habitable condition after the lapse of five hundred years.

At the present time, however, British oak no longer holds the high place it occupied in olden days. Its timber retains

the same qualities, and our soil and climate are quite as capable of growing it; but its use in many industries and for many purposes has been largely replaced by other materials. Iron has taken its place in ship-building and bridge-building; iron and lighter and cheaper wood combined in architecture; larch takes its place to a great extent in rural fencing work; while even oak from Europe and America is imported and given the preference to the native product, owing to the greater ease with which it is worked. Its bark is replaced by foreign barks, and bark extracts which do their work quicker if less efficiently, and its acorns are now looked upon more as a nuisance than as a blessing, owing to their injurious effect on grazing cattle.

The question often presents itself to the student of English forestry: Is the oak worth growing as a timber tree for profit? The answer to this question is not easier to answer conclusively than one referring to any other timber tree in this country, for the simple reason that we cannot foresee the state of the future market in this or any other kind of timber. But there are special features relating to the oak which do not occur with all trees, and which have a very important bearing on the question. In the first place, the oak is not only one of our slowest-growing forest trees, but also takes longer to mature than any. This means that neither the planter nor his immediate successors reap any benefit from the crop except such as is afforded by the bark and timber of immature thinnings. To plant oak pure or as a main crop tree is a slow, risky, and more or less unprofitable business, unless an exceptionally rapid rate of growth and exceptionally good market can be attained; and this cannot be guaranteed beforehand.

But another, and in some respects more serious, objection to oak lies in its refusal to flourish on anything but the best soil and situation. Land which will grow good oak at a fairly rapid rate will usually grow anything, and to lock such land up for a hundred years or more is a proceeding which few proprietors care to undertake on anything but a limited scale. One hundred and fifty years ago, when most of our present oak woods were planted or developed, in the form of coppice with standards, conditions were very different to

YOUNG SPRUCE WOOD.

COPPICE WITH STANDARDS.

what they are to-day. Not only was oak, as we have already seen, an indispensable factor in our economic and political pursuits, but the coppice or underwood with which it was associated had a real instead of a nominal value, which is all that can be said for it to-day. While the oak was steadily maturing, therefore, the land was at the same time carrying a crop which could be reaped at short intervals, and there was thus an actual as well as a prospective return from the soil. To secure the same benefits now, we must adopt other systems of silviculture than those of the eighteenth century. Coppice with standards not only gives us a crop for which there is no demand, but produces oak of a nature which does not meet with modern requirements. Short stems and crooks are no longer wanted, but long clean boles with as little crown as possible. These can only be produced in what is technically known as "high-forest," in which the trees are drawn up by close contact with their neighbours. Oak must therefore be planted thickly, or mixed with other species which will effect the same purpose. Oak is not only a slow grower but a light-demander, and, planted with most species and left to take its chance, usually results in its becoming annihilated after the first fifty years. Even with a comparatively slow-growing species like beech, oak is unable to hold its own, except perhaps on strong soils in which the former does not thrive.

Whatever species are used, therefore, care must be taken to keep it in check until its height-growth is practically over, and yet at the same time avoid that degree of open order which would defeat the object aimed at. Simple as this looks on paper, it is probably one of the most difficult things in practice to grow clean oak in a mixed plantation without overcrowding it on the one hand and giving it too much room on the other, and it is especially difficult under the conditions prevailing in English woods. The finest oak timber has usually been grown in pure woods or groups, or by a favourable combination of circumstances which cannot be provided on a large scale. Planted pure, it is neither profitable to the planter nor to itself, for it thins itself too rapidly to begin with, and before its thinnings are of much value, or its height-growth has

culminated. The great difficulty with oak when planted with other species of a profitable nature lies in its tendency to throw out adventitious shoots from the stem and get into a stunted state when the wood is thinned and light is admitted to the boles of the trees. Not thinned and left to fight its own way, rarely results in more than two or three trees per acre developing into big timber, and even then a much longer period is required to mature them than most species with which they are mixed. Planted pure or with subordinate species, such as beech, it is, as already said, unprofitable as thinnings, and involves a long wait before anything can be returned to the planter. It is not a tree adapted for the quick profits which are looked for nowadays, nor is it one which will give good results with careless thinning and long periods of neglect. This, together with the class of soil necessary to bring it to perfection, renders oak, although one of the most valuable as timber, yet one of the least profitable species for the planter in this country.

Bad as the results of oak-planting usually are on the best soils, however, they are much worse on unsuitable ones. On a deep naturally drained clayey loam, out of the reach of every spring frost and the most exposed situations, the oak can often be grown without loss, if with little profit. On deep sands or light loams, or even gravels, mixed with beech and larch, it may produce small but clean timber useful for fencing and cleaving, and help to raise the average price of the crop. But on low-lying, stiff, and wet clays, or shallow soils of any kind, oak is one of the worst trees to plant with any idea of profit, and many thousands of pounds have been thrown away in the past in an attempt to grow it on such soils. On clay soils, it is true, little fault can be found with its soundness, but unless they are well drained its growth is too slow to yield more than a few feet per acre annually, and much of this is often of inferior quality. To drain such soils artificially not only means a heavy outlay at the start, but a heavy annual or periodic expenditure throughout the rotation. How great a drag upon an otherwise profitable crop draining becomes, is rarely realised by foresters as it deserves to be, and, as often as not, heavy draining expenses are augmented by extra labour on

rides and roads, which are more troublesome on wet than dry soils.

Yet, in spite of all its disadvantages, the temptation to plant oak on all deep and fairly good soils is strong in the forester's mind, whether from instinct or reason it is difficult to say. For many generations it was the tree which occupied the first rank as a producer of valuable timber, and as a species which was closely bound up with our national life. Oak and ash were the only suitable trees for growing in coppice, and coppice woods practically constituted the bulk of English woodlands until comparatively recent times. An ordinary plantation even was not considered perfect unless it had its due proportion of hardwoods which were eventually to form the main crop, and of which oak was considered the most desirable species. It is little wonder, therefore, that the average planter still likes to put in his usual quantity of oaks, on the chance of their turning out of some service in the long-run, which perhaps 1 per cent. may do on the average. To say that such a custom is wrong is going too far. To say that it rarely meets with much success is probably the truth, for it cannot be denied that really fine oak woods, or even timber, in this country are comparatively scarce.

The best samples of oak, as already said, are usually found in small groups, or as single trees here and there in coppice or high forest. Why such examples should not be more common it is difficult to say off-hand. That they are due chiefly to soil on the one hand, and just the correct amount of crowding or close order on the other, is probably a statement as near the truth as can be. But to define the most suitable soil and the most suitable degree of crowding is another matter. Fine oaks may be found on deep sand and in stiff clay, that may be found in an open park or hedgerow and in a thick wood. Between these respective extremes innumerable variations occur, yet we do not doubt that the resultants of the various forces at work will point in the same direction in nearly all cases. A light soil may be balanced by a wet climate, or some chemical constituent in the soil itself which is not apparent on the surface. Or it may be that the subsoil is of a

different nature to that on the surface, or that pockets of deep or good soil occur amidst shallow gravels and sands. No greater mistake is made than that of assuming that the surface soil is any indication of what is below, or that either surface or subsoil can be gauged by the nature of that existing a few yards away. An inspection of any quarry, gravel pit, or railway cutting proves how rapidly and constantly the soil varies after the first foot below the surface, and it is such deep-rooted trees as the oak which feel and are influenced by this variation. There is little doubt that this accounts in a great measure for those exceptionally fine trees which occur here and there in almost every oak copse or plantation, and which are often surrounded by inferior and stunted individuals of no great value. Occasionally we meet with a clump of such trees, or they may exist more or less regularly on an acre or two of ground; but it is seldom that any uniformity exists in a mature oak wood such as we find with most species grown under similar conditions, and there is a good deal of probability that soil is largely responsible for it.

But while soil may effect variations in the size of trees grown on the same system, of equal influence are the varying sylvicultural or arboricultural conditions which surround each individual to a greater or less extent. Few trees in any plantation receive exactly the same amount of light, or are influenced in exactly the same way by the light which they receive. On good soils and sunny situations trees will bear more crowding than those growing under opposite conditions, and it is impossible to regulate thinning in such a way as to ensure each tree getting exactly what it requires. Oak being very intolerant of too much shade, and its height-growth, on the other hand, being easily checked by too much space and light, the happy mean is almost as often due to chance as good management; and this is probably why small groups or naturally grown clumps often show the best specimens of oak timber that can be found. The outside trees of such groups bend outwards and form a one-sided crown reaching to the ground. The next row rises higher and suppresses the lower branches of the tallest trees, which in their turn

form crowns above them which check their upward growth and prevent undue encroachment upon these leaders of the group. The stems of these latter are thus gradually drawn up and shaded by their own kind until the smaller individuals no longer compete with them, and they are then able to develop their crowns unchecked, and add bulk to the stem which has attained height under such conditions. Such conditions are very difficult to secure in ordinary plantations, but are possible in coppices which ignore that regular distribution of age classes which constitute the ideal of the orthodox forester, or in woods worked on the uneven-aged group system; and where we have the requisite soil, climate, and situation, the cultivation of oak in some such manner may be accomplished with success.

THE SESSILE-FLOWERED OAK (*Q. sessiliflora*).

Although this sub-species of the British oak has never received any different treatment from the pedunculate variety in English forestry, there can be little doubt that its physiological peculiarities entitle it to be treated as a distinct species in silvicultural operations. Botanists have always recognised its distinct type of inflorescence, shape of leaf, and so on; but there the distinction stops, and it is left for the forester to note the more important differences which affect the economic values of the two species. The botanical characteristics of the tree, which differ from *pedunculata*, are chiefly the sessile flower on the axis of inflorescence, the long footstalk to the leaf, and the wedge-shaped base of the latter. These characteristics are always present in the true sessile-flowered type; but there exist a great number of individuals which exhibit a more or less intermediate stage—probably the result of cross-fertilisation. This has led many, whose knowledge of forestry is more or less limited, to the belief that the two trees are simply extreme types of different varieties of the same species, and it is certainly a fact that the mere botanical examination of the trees gives a good deal of colour to this theory. But when we come to their habits of growth and behaviour under

the same conditions of locality and treatment, a forester quickly recognises important distinctions which affect the value of each for different soils and situations. Professor Fisher, of Cooper's Hill, has done much to call attention to these differences from a purely sylvicultural point of view, and in various articles in the *Gardener's Chronicle*, and elsewhere, has emphasised the importance of the question in practical forestry.

It is patent to all observers that *sessiliflora* will grow faster and to a larger size on fairly dry or sandy soils than *pedunculata*, and is therefore a profitable tree to plant where the latter would prove a failure. Many of the gravel soils in low-lying districts in the south of England might be used for growing this tree in company with the beech or Spanish chestnut with advantage, and when once established its reproduction would be an easy matter for all future time. Such soils as those found on the London Clay, which consist of alternating beds of gravel, sand, and clay, are peculiarly fitted for this tree, and many examples of it may be seen on them in Bucks and Berks, although it is supposed to be more common in the north of England than the south. The great difficulty, so far, has been to obtain either acorns or seedling trees. Nurserymen do not take the trouble to keep the two species distinct, although they may quote them in their catalogues, and the seed they get from their collectors may be either one or the other, as the case may be. The only way to make sure of it is for the forester to collect his own seed from selected trees and grow it himself, and, although the trouble of doing so may receive no recognition in his own lifetime, there is little doubt that the extra production of timber from such seed will repay the estate some day.

The sessile-flowered oak has a rounder and more leafy crown than the pedunculate, the leaves are larger and more polished, and the general appearance of the tree when in leaf is sufficiently distinct for the practical forester to recognise it at a glance. The bark is usually darker and the fissures deeper, the branches are more thickly set, and are often set at an acute angle in the upper part of the crown and at right angles lower down, so as to invest the

tree with a character which is more easily recognised than described. In short, the general appearance of the tree is more pronounced than minute details, although this difference, owing to the prevalence of intermediate forms, may not be detected by the untrained eye. But that this difference is not entirely external is proved by the fact noticed by several observers from time to time, namely, that this species is rarely attacked by the oak-leaf roller moth. It is evident that botanical characters do not concern a caterpillar to any appreciable extent, and that this discriminative taste must be due to some peculiarity in the flavour of the two species which mark them out as distinct, and the insect thus unconsciously supports the botanist and forester.

Why its numerical strength should fall so far short of the pedunculate variety it is difficult to say. It is much more plentiful in certain districts than in others, but the same thing may be observed in other genera of plants. In the case of cultivated woods the preference evinced by all the older writers on forestry for *pedunculata* may be responsible for a certain amount of selection in the collection of the acorns when sowing was the prevailing practice, and when both operations were probably performed by the same person.

THE ASH (*Fraxinus excelsior*).

Next to the oak, the ash probably comes as the most widely distributed of British trees. Both in hedgerow, copse, and natural woodland we invariably find it more or less represented, and on high-lying chalk or limestone it is probably more common than the oak. Unlike the latter, however, its life is more limited, and we rarely find surviving individuals of these trees which helped to form the forests of two or three hundred years back, it being more liable to internal decay and fungoid attack than the oak. The uses of ash in olden times seem to have been more of an agricultural nature than most trees. Its toughness, lightness, and elasticity fitted it for the manufacture of agricultural tools and implements, while the pikes and lances of our

ancestral warriors were made of this wood—"the tough ash spear, so stout and true" of Sir Walter Scott. The twigs and branches of ash were used for the feeding of deer in the forests, and known under the name of *Browse* wood, and leaves were dried and fed to cattle in the winter. Evelyn says that the ash was sometimes preferred to oak for building purposes, but probably only for rafters, etc., out of the reach of rain. Indeed the wood of ash had so many uses, that Evelyn enjoins every lord of a manor to sow one acre in every twenty with ash or acorns, being little inferior to the oak in usefulness or value.

At the present day the ash is held in as much estimation as ever, and is probably the most profitable hardwood tree we have on suitable soils. It is still an important wood with the wheelwright, and implement- and tool-maker, for its toughness and lightness combined render it the only suitable wood where elasticity and strength are required. The price of first-class ash timber exceeds that of the oak, but it is a tree which soon deteriorates in value if allowed to stand too long, and at the same time is as good in quality when young and small as when of mature age. It is therefore particularly adapted for planting as a quick crop by itself or for coming out as thinnings in oak woods, which take a long period to mature. It has one failing as a tree for mixing with oak, however, and that is its light-demanding nature and its quicker growth. Unless precautions are taken the oak is apt to get overtopped and overdrawn; and although it may be a question whether the ash is not of as much or more value than the oak it is intended to nurse, this is a point which can only be decided on the spot and by the objects of the planter.

The soils best suited for ash are those fairly strong, deep, moist, and well-drained ones so often found in chalk and limestone districts, and which most frequently occupy the slopes and the bottoms of ravines and valleys. In such situations the ash often grows with incredible rapidity, and produces timber of superior quality; and as these sites are often unsuitable for cultivation and are frequently too wet for high-class pasture, they cannot be more profitably utilised than by growing ash upon them. But for ash timber of superior toughness, soils which favour a comparatively slow

rate of growth are best. Stiff clays and pure peat are not suitable for this tree, neither are thin, dry, gravelly, chalky, or rocky soils. But on deep sands and loams, and not too stiff clays in which the trees can get sufficient moisture to carry on a moderate growth, ash timber can be grown of superior toughness to that produced on better and moister ground, although the latter may pay the planter better, and give a larger yield per acre in a given time.

The silvicultural system best adapted for ash depends a good deal upon the class of timber wanted. In olden days poles and small timber seem to have been in greater demand than trees of large dimensions, and coppice or standards in coppice appear to have been the favourite way of growing it. Evelyn says: "But if you would make a considerable wood of them at once, dig or plow a parcel of ground as you would prepare it for corn, and with the corn, especially oats (or what other grain you think fittest), sow also a good store of keys, some crab kernels, etc., amongst them. Take off your crop of corn or seed in its season, and the next year following it will be covered with young ashes, which will be fit either to stand (which I prefer), or be transplanted for divers years after." The ash has always been a favourite tree for coppicing, and turners use large quantities of the boles for various purposes. Grown on a rotation of about fifteen years and with little or no big timber over it, it still pays well where these industries are carried on, and as much as £10 or £12 per acre can be obtained for a piece of good wood kept clear of rabbits for the first year or two after cutting. But the most profitable system, where big timber is required, is that of planting it pure, or mixed with oak or larch, according as the soil is adapted for the former or the demand exists for the latter. In high forest the trees can be grown cleaner and taller than as standards in coppice, and although individual trees may not put on timber quite so rapidly, yet the quantity produced per acre will be much greater and the ground better utilised, while the timber will be of superior quality for most purposes.

In growing ash in high forest, however, more care is necessary to prevent overcrowding than with any tree we know of. For the first twenty years no crop will carry more

plants to the acre than one of ash, and up to that age the thicker it stands the better. But after that period gradual thinnings must be made for the benefit of the dominant trees; for if these get into a weak and spindly condition, they rarely, if ever, recover their full vigour afterwards. What is wanted is to keep the leading shoot growing vigorously as long as possible, and thus prevent large crowns on short boles. The ash is particularly sensitive to late frost, and when the terminal shoot is injured by this or any other cause, double leaders are apt to arise, and the stem divides. Grown in partial shade until the tops are above the frost line, they usually escape injury, and in the very best ash soils the trees can be grown pure as uneven-aged high forest with advantage. Such a system closely resembles coppice with standards in which the latter are unusually thick, and even-aged high forest can be easily turned into it after the trees approach maturity.

Some may possibly think coppice with standards preferable, but with this the coppice either becomes practically valueless, or the standards stand too far apart to form an adequate crop. Good ash is such a profitable crop that it seems a pity to waste really suitable soil on anything else except when first planted, and then larch might be used to shelter it and to furnish profitable thinnings. But, when once a wood has been formed, nothing is easier than to keep gaps filled up as they occur with strong well-rooted plants 3 to 8 ft. high, and paint or otherwise protect them from rabbits for a year or two. As uneven-aged high forest it adapts itself wonderfully well to natural regeneration, and, if rabbits are kept down, little if any planting need be done to keep ash woods in a perfectly stocked condition. We have always noticed that the existence of the wild garlic (*Allium ursinum*) is an almost certain indication of good ash ground, both tree and bulb appearing to favour the limey nature of the ground, on which the latter at anyrate is invariably found.

In order to get the best returns from ash woods, care must be exercised to fell the timber at the proper time. This must neither be during the period of its most profitable growth, which is usually between the fortieth and eightieth

YOUNG BEECH ON THE CHILTERN.

MATURE BEECH WOOD.

year of its age, nor after it has begun to deteriorate at the heart. On the best soils ash may remain sound and white at the heart to an advanced age,—one hundred years or more in some cases,—and so long as the trees are making a good growth they may not suffer by being left. But on dry chalk or gravelly ground, or on wet peat or clay, they get black-hearted at a comparatively early age—even before the fiftieth year on inferior soils. When this happens, nothing is gained by leaving them standing, for they will fetch as much as 6d. to 1s. more per foot while the wood is still white, than when discoloured by premature decay. If ash can be cut at that critical period when it is just on the point of deteriorating at the heart, it will give the owner the greatest possible return, both in cubic contents and price per foot. To know when to cut to secure this in the case of every tree is impossible, but observation will generally enable the most suitable felling age to be fixed within certain limits. In coppice woods many ash standards are allowed to grow up from stool shoots, and these always become ripe earlier than trees on their own roots, and must be cut accordingly. For trees on their own roots or maidens, an average age of seventy years is usually the most profitable, provided they make a fair growth up to that age and are not injured or deformed. On peaty ground ash rarely keeps sound beyond fifty years of age, and the quality is not so good as on firmer ground, although, when the latter lies at no great depth below the peat, it is often better. Dry shallow soils are not suitable for ash, and it should never be planted on them, although it will often come up on such ground spontaneously. But its growth is invariably slow, and after a few years it usually gets cankered and deformed.

As in the case of oak, ash has the disadvantage (from an economic point of view) of requiring the best class of ground. But it will flourish more frequently than oak on land which, as already said, cannot be always utilised for high farming. Plenty of first-class ash ground will not return a nett rent of more than 7s. 6d. to 10s. per acre, and some even less. Such land is far more profitable planted with ash, which, unlike the oak, is one of the

quickest to mature or arrive at a profitable age. If properly stocked and managed, land of the right sort should yield from £1 to £2 per acre annually, allowing for an average annual production of at least 50 feet per acre, and an average price of 1s. 6d. per foot. Small areas will often do more than that, but uniform quality over a large area is rarely found. Timber, again, suitable for the wheelwright often makes up to 2s. 6d. to 3s. per foot, and 1s. 6d. is a moderate estimate of the value of good stuff. Like the oak, however, foreign rivals have affected its value to some extent of late years. American ash, hickory, lancewood, etc., have taken its place for many purposes, but in spite of all, good British timber rarely wants a buyer long, and it is one of the most reliable species in which the intending planter can invest. Even as a hedgerow tree, provided it does not adjoin arable land and is not allowed to stand too long, it might be more profitable on the right soils than elm. On arable land, or in the neighbourhood of pipe drains, the ash is not a desirable tree, and much of the bad name it gets in that capacity is due to its habit of finding out every crack and crevice which holds either soil or moisture, and leaving nothing for other plants within reach of its roots. It is also said to be an undesirable tree where milking cows are kept, owing to the leaves they eat giving a bad taste to butter; but as this can only happen for a month or two in the year, it does not form a serious objection.

THE BEECH (*Fagus sylvatica*).

Whether the beech is a genuine native of this country or not is a matter of little consequence to the forester nowadays. That it grows and matures its seed as well as most trees is a well-known fact, and for all practical purposes may be looked upon as an indigenous species. Plentiful as the beech is as a park and clump tree, however, its existence in English woodlands is much more limited than that of the oak and ash, except in certain districts with a soil unsuitable for the latter, but exceptionally well adapted for

itself. Thus, on the Chiltern and Cotswold Hills and the chalk downs in the south, beech usually constitutes the prevailing plantation tree, not so much because it succeeds in these localities, but more on account of its being amongst the few trees which will live to any great age on the poorer soils of this class.

Evelyn had a poor opinion of beech as a timber tree, and wished its use could be prohibited in manufactures, chiefly on account of its readiness to take the worm, or become infected with grubs of *Anobium* species. Except for firewood and for its nuts for swine and deer, the beech seems never to have been held in much esteem, and even now, although its use is more general, it only ranks as a second-rate timber in the market. For that reason its cultivation was never paid much attention to, and it was planted more for shade or shelter than anything else. In the eighteenth century, and especially in the days of Kent and Brown, beech was very extensively used in landscape planting, and the majority of Brown's much abused clumps and belts were formed of this tree. A more unsuitable tree could hardly have been selected for park clumps, especially when planted in the manner that most of Brown's clumps are; but this will be discussed elsewhere.

In ordinary English forestry the beech cannot be said to occupy an important position. It is still planted on chalk, oolite, and thin limestone soils, as the only tree which can be depended upon to live to a great age and grow to a large size. But its use in this country cannot be compared to that made of it in French or German forestry, in which countries it is grown more for the benefit of other species and for improving the soil than for its own value. That similar benefits would follow its use in England there is little doubt, but the chief reason which prevents it being more extensively used is its invariable tendency to shade the soil and exterminate ground vegetation; and this renders it unpopular with keepers and sportsmen. In the comparatively small woods which prevail in England an attempt is made to utilise their area for game preserving to the greatest possible extent, and this can only be done by encouraging the growth of surface weeds and shrubs as much as possible

by excessive thinning. As everyone knows, the nature of beech renders woods composed of it chiefly or entirely thin and bare on the surface, and rabbits rarely make such woods their home, nor will they form cover for pheasants. In very large woods, where all age classes are more or less represented, this characteristic is not of so much importance, as soil, accident, and the age of the group will produce a great deal of temporary cover which will serve the purpose. But small and even-aged woods of beech contain from the pole stage up to maturity practically nothing that can be termed cover, unless ruined by excessive thinning. Without rabbits, the constant crops of seedlings, which manage to exist wherever a little light can reach the ground, improve matters to some extent; for young beech, keeping its leaves for the first ten and fifteen years through the winter, provides more cover than most deciduous trees. But where these seedlings are kept down, as they usually are where ground-game is preserved to any extent, a beech wood, or one in which beech predominates, usually gets a bad name from the gamekeeper and sportsman, and, where game cover ranks before timber, it is easy to see what weight this objection to beech carries.

But the planter can usually introduce beech into his mixtures without advertising the fact too extensively, and, when grown clean and tall, its presence is not noticed so much in a mixed plantation, and fewer objections are raised to it. As already said, its uses are great in assisting other species on dry soils, but probably oak and larch are the two trees which benefit most from its company, although one is a deep- and the other a shallow-rooting species. In both cases its leaves act as a mulch on the surface, and it keeps in moisture and keeps out weeds; but its chief value with the oak lies in its dense shade about the stems of the trees, and effectually checking that growth of water-shoots which do so much to check the vigorous growth of that tree after middle age. Tall clean oaks will often be found amongst beech, which could not have been produced by any other means, and even its own timber, when clean, is not to be despised as a rent yielder. Grown with larch, it keeps that tree much more healthy than when grown alone or with other species,

for the roots of larch, running almost on the surface, find a layer of beech leaves a cool and grateful mulch on dry soils. In fact, all trees on dry soils are benefited by a sprinkling of beech, and the forester, unless prevented by reasons given above, should make a point of using it to a reasonable extent in most planting operations.

But it is on the Chiltern Hills that we must look for beech at home, and as a recognised inhabitant of the woods. Here, although the woods are not often large in themselves, they are fairly numerous, and the majority of them consist of little but beech with a sprinkling of oak, holly, etc., between and beneath them. The peculiarity of these Chiltern beech woods is that no record exists of their having been planted. They are supposed to be the remains of natural forests which once covered these hills, and are perhaps one of the few existing instances of woods having directly descended, without artificial sowing or planting, from the native forests of Britain. Whether this is so, for a fact, no one can say with certainty, as the introduction of a tree from the continent of Europe would not be a great or difficult event in the earliest times, and would easily be lost sight of as time went on. Be that as it may, the beech is now thoroughly at home on the low loam and flint-covered hills round Wycombe, Chesham, etc., and, if properly managed, costs next to nothing for maintenance and replanting.

The system under which most of these woods are managed is somewhat as follows:—At periods of fifteen to thirty years, according to the needs or ideas of the proprietor or agent, sections of the woods are gone through, and all timber which is supposed to be of a marketable size is taken out. The particular limit as to size or proportion of standing crop removed varies with the wishes or requirements of the owner or his representative, and while one wood may be stripped of everything saleable, another may only be lightly thinned of its heaviest timber. Between each felling seeds spring up more or less annually in the gaps made in felling, and the wood is thus composed of a succession of age classes ranging from one year to the oldest age up to which the timber is allowed to stand.

The success or failure of the system depends a good deal

upon the judgment shown in the selection of the periodic falls. If these are confined to all large-headed, badly shaped, faulty individuals, together with a few of the ripest trees, the wood in time becomes composed of tall, straight, and fairly clean trees of various ages, or, in the most satisfactory examples, of groups of such trees. But where the wood is thinned merely with a view to make money for the time being, and regardless of its future condition, while a large proportion of worthless trees are allowed to remain and prevent seedlings coming up where they stand, the wood quickly gets into a condition for which the only remedy is more or less gradual clearing of the old crop, and a fresh growth of seedlings in order to form a new wood. It is not difficult to understand, from the above description, that a great difference in the condition of these woods exists, and whilst some are able to yield a fair return to their owners, and at the same time carry on a useful crop for the future, others contain little but worthless trees, and no adequate crop of seedlings to grow into useful timber.

One reason for the unsatisfactory condition of some of these woods may be traced to the altered state of the market for beech in this district. Up to within the last fifty years or so the consumption of beech was not more than a moderate supply could meet, and the trees were allowed to reach a fair marketable timber size before being felled. But since the advent of steam, and the consequent development of the chair-making industry, the demand has greatly increased, and now the supply fails to meet it. That this fact has altered the conditions under which these woods at one time existed, there is little room to doubt. Their management has undergone a change with the increased demand, and the timber is now cut much smaller and younger than was formerly the case. This has not affected its value per cubic foot to any great extent, as for turning purposes small beech is equally as valuable as large. But it has affected to a very great extent the yield of the woods per acre, owing to the fact that the majority of the trees are felled at an age when they are making their most profitable growth, and therefore the annual increment per acre is much below what it would be if the trees were allowed to stand

another twenty or thirty years. A beech wood grown in close order may be expected to make its most rapid increase in timber between fifty and a hundred years of age, and before that period to be chiefly occupied in lengthening and cleaning its stems. Worked on the system that now prevails, close order over a large area is of course impossible, and that cleanliness of stem can rarely be obtained which is characteristic of ordinary high forest; but when an attempt is made to encourage the growth of the trees in groups of even-age, it is possible to obtain a fair proportion of clean stems which grow under somewhat similar conditions to those prevailing in even-aged woods, and produce the same class of timber. But when cut to excess and not given time to develop clean stems, these groups are thinned out and interfered with to an extent which opens out the wood and allows the development, or partial development, of individual trees at the expense of those round about them, and we then get that picture of badly shaped trees in the older-age classes, and the suppression of the young crop by their low and spreading crowns. In this way many woods which have produced useful crops of timber in the past are now rendered valueless for the time being, and the surface of the ground choked with brambles, coarse grass, and weeds, which prevent the plentiful crops of seed from germinating as they do where the seed bed is preserved by thick shade.

There is little doubt that the most profitable and satisfactory way of dealing with beech woods is that system known as the "shelter wood compartment system." This system may be briefly described as follows:—Twenty or thirty years before the final felling an attempt is made to bring about a crop of self-sown seedlings, by thinning out the trees to about half their previous density. This thinning not only conduces to heavier crops of seed on the remaining trees, but also improves the condition of the surface by allowing the raw humus to decay. The first good seed year after this thinning usually results in a plentiful crop of seedlings, and the future treatment of the old crop consists in gradually removing it to allow these seedlings to develop. For the first eight or ten years little is required, but after that the old trees are again thinned to admit light to the

young crop, and this is repeated until the former are removed entirely. The wood thus becomes double-storeyed for a certain period in early and late life, and even-aged in middle age, instead of all ages being represented, as by the Buckinghamshire system. Naturally, a heavier and cleaner crop is the result.

The yield per acre from a wood worked on the above system, and growing on deep sand, light loam, or chalky subsoils, may be expected to average 50 feet per annum on a rotation of eighty to a hundred years, the nett value of which to the owner may be put at 25s. at the least. But, when worked on the Chiltern Hills system and the timber cut long before it is mature, such returns over a long period are out of the question, although they are often quoted as being attained for short periods. To get good returns from beech or any other shade-bearer, it must be grown clean for the first fifty years or so, or until its height-growth has culminated. Judicious thinning is then of great benefit by promoting a more rapid increase in girth, and allowing a part of the crop to be realised early. It is, however, with beech as with all other trees, poor economy to realise the best part of a crop before it is ripe.

THE SWEET CHESTNUT (*Castanea vesca*).

The sweet or Spanish chestnut is not often regarded as a common timber tree, although its occurrence in woods and parks is common enough. It is rare, however, to find it grown in masses over a large area, except as coppice, and in old age it is chiefly looked upon as an ornamental rather than a useful timber tree. As a general rule, after it has passed a certain age its timber becomes too twisted and shaky to be of any great service, and it is one of the few instances of a timber tree which deteriorates in value as it increases in size. There is little doubt that the sweet chestnut was originally introduced to these islands, and probably by the Romans. Like the beech, however, it may be said to be a perfectly acclimatised tree, so far as the south and west of England are concerned. In these parts

it ripens its fruit in most warm summers, and attains a size which would render it one of our most valuable trees if only the quality of its timber kept pace with its growth. In the north of England and Scotland ripe nuts are rarely seen, and the annual growths are sometimes cut back by frost during a severe winter, and the tree is there rarely seen to perfection.

There is good reason to believe that the Spanish chestnut seldom meets with the treatment necessary in order to render it profitable in English woodlands, for we feel convinced that it is a fairly profitable tree when correctly planted and managed. The point most frequently overlooked is the fact already mentioned, that it deteriorates with age, and that, like larch, on unsuitable soils it must be cut early if a profit is aimed at. For this reason it is best adapted for mixing with hardwoods or conifers on suitable land, and in such a way that it can be taken out about the thirtieth or fortieth year, or when individual trees contain from 10 to 20 feet of timber. Cut about this age, it proves very useful for estate fencing, pit-wood, or other purposes where durability and strength are required, for we know from experience that it is little inferior to oak for outdoor work. Another good point which Spanish chestnut possesses for mixing purposes is its heavy leaf-fall and soil-shading qualities. The beech is usually considered the best soil-shading hardwood we have, but up to a certain period Spanish chestnut is not far behind, and, for the first ten years at anyrate, probably excels it in this respect. It is not quite such a good shade-bearer as the beech in middle age, perhaps, but will bear a good deal of it when young on suitable soils, and for mixing with larch we consider it almost as effective and certainly more profitable than beech. Apart from the superior quality of its timber for outdoor work, few hardwoods grow at a more rapid rate than this tree on warm deep soils, and there is little danger of its getting partly suppressed and weakened when planted with larch or pines; or, even if such should occur, small poles are of considerable value of a size at which beech or oak would be useless.

As already hinted, the soils for Spanish chestnut are deep well-drained loams, sands, or even gravels if not too

hard and sterile. Wet soils of any description are not suited for it, nor are cold and bleak situations or frosty hollows. The best examples of Spanish chestnut are probably found on the deep sands and gravels of the Greensand formation in Kent, Sussex, and Hampshire, where it is usually grown as coppice; but it may be taken as a fact that the particular nature of the soil is not of great importance, provided its physical condition is good and the climate warm and dry. It may be regarded more as a local British timber tree for extensive planting, and even then only as a so-called "nurse" tree for other species, or for short rotations when grown as a main crop tree.

BLACK ITALIAN POPLAR (*P. monolifera*).

The black Italian poplar is probably the fastest-growing broad-leaved tree that can be grown in the British Islands. It is a native of Canada, but was introduced into Italy at an early date, and from thence into England. Unfortunately its timber is not in great demand at the present time, and the trade in it is rather a speciality, except for such uses as packing-cases and so on, which are worked up at prices which compel the maker to buy the raw material at next to nothing in order to secure a profit. Still, on wet and swampy ground, liable to floods and difficult to drain, black Italian poplar and alder are about the only trees suitable for planting, and, growing at a rapid rate, are fit to cut long before more valuable but slower maturing species; and as the cost of planting or replanting such land is usually low, and its value for other purposes practically *nil*, the financial results of such crops are usually good if well managed. We know or have heard of trees containing a hundred feet of timber at forty-five years of age, which at only 6d. per foot represents a fair annual rent for land worth less than 10s. per acre for agricultural purposes.

The black poplar, like most of its class, is not a particularly long-lived tree, and requires to be cut at a comparatively early age to be profitable. About fifty years is long enough to allow it to stand, and, with a rapid

growth, trees of this age are large enough for anything. The great mistake often made in planting is that of giving it too much room, and dotting it about at wide intervals amongst slower-growing trees. In such cases the poplar suppresses everything round it. Planted at 6 feet apart and unmixed with other trees, a much cleaner and heavier crop can be obtained, although individual trees will not be so heavy as when allowed more room. Probably the worst feature of the tree grown in this way is the difficulty of disposing of the thinnings until they become of a timber size. In pit-wood districts, where poles of any kind can be disposed of without difficulty, even poplar thinnings can be got rid of at a price, but elsewhere the only outlet for them seems to be rough fencing and such purposes, and, when dried and creosoted, poplar posts and rails are as durable as most woods.

THE WHITE POPLAR (*Populus alba*).

The abele is also a rapid-growing tree, and in certain situations is longer lived than the black Italian. Some of the largest trees in the country of this variety stand in the grove in Longleat Park, the measurements of the largest being as follow:—Height, 120 feet; girth at five feet, 15 feet; while others are little behind this in size.

This tree propagates itself rapidly by suckers, and a few trees in a wood will always ensure a crop of young poles, which will develop into timber in time if able to get their heads up. Whether it pays to leave them or not is a question which must be decided upon the spot. On good ground they must be considered more or less as weeds, as they take the place of more valuable timber, but on cold sour clays and wet swampy bottoms the presence of this tree can be turned to good account if properly managed, either by growing it as large pole wood or timber. In such cases the best method is that of growing it alone as much as possible, and allowing the suckers to develop in groups of as near one age as can be. They then grow tall and clean, and can be thinned according to the size it is desired to obtain. Thick

crops of twenty to fifty years' growth, where an average price of 6d. per foot can be obtained, pay well compared with species which require replanting in the ordinary way and are of slower growth.

THE BIRCH (*Betula alba*).

This tree, although famed for the beauty of its silver trunk and graceful weeping branches, is looked upon with contempt by most foresters as an unprofitable tree, and for this reason is rarely planted in any quantities. It forms, however, the natural growth on thousands of acres of waste or semi-waste land in the British Isles, and especially such as are covered with heath and bog plants, and it has the not too common merit of growing almost equally as well on very dry as on wet ground. In the remote districts of the Highlands of Scotland, and in many parts of England as well, the birch was of considerable importance in early days. Many of the rough huts, hovels, sheds, etc., of the poorer classes were made of this tree, or at anyrate their roofs, the long clean poles being used for rafters, and the bark took the place of lath and plaster. Wine was made from its sap, its branches served as fuel, and the early Briton used its bark for his canoes, and its branches and fibre for rough cordage.

As a timber tree the birch is principally used for turning and furniture work, such as chair- and bobbin-making. For temporary fencing it is useful on estates, while in pit-wood districts long clean poles meet with a ready sale at from 6d. to 8d. per foot, or about 15s. per ton. It is not sufficiently profitable, however, to justify its planting beyond the margins of plantations, or on patches of land where nothing else will thrive, as in peaty and swampy ground, or on dry poor knolls where ordinary timber trees get hide-bound and stunted. Planted thickly, it soon smothers the surface vegetation, and forms a humus layer of moderate depth; and, as it is rabbit-proof after the first three or four years, it is well adapted for planting on poor tracts of land which are practically given over to rabbits and rough shooting.

But probably the chief value of birch in economic forestry lies in the freedom with which it sows itself on land

ABELE POPLARS IN AN ENGLISH PARK.

recently cleared of Scots fir or other conifers. Where this occurs on a large scale, as in extensive fir woods where the soil and herbage are adapted for natural regeneration, this may sometimes be a disadvantage, as the birch effectually prevents the growth of pine seedlings on the same area. But in districts where birch poles can be easily disposed of, and where moderate clearings of Scots fir are made, a self-sown crop of birch which will cover the ground for twenty or thirty years is not to be despised. It is often difficult to replant Scots fir successfully for several years after the old crop has been removed, owing to the attacks of weevils, beetles, and other vermin, while the thick layer of peaty *débris*, which invariably collects under Scots fir, is very unsuitable material for planting young trees of any kind in. A few years under birch or any other hardwood allows this peaty layer to decay and an ordinary humus layer to take its place, and renders the soil much more suitable for ordinary planting than when first cleared of pine.

The value of such crops can be greatly increased by mixing them lightly with larch when the birch is about a foot or so high. The former will grow into useful poles in any case, and should the soil happen to be one suited to the larch, a plantation of that tree may eventually result by reversing the usual order of things and treating the hardwood as a "nurse," which can be cut away from time to time as necessary. By netting in the area so treated, or by using larch plants able to take care of themselves where rabbits are scarce, a crop of larch can thus be raised at one-third the cost of ordinary planting, although it can only be considered a profitable proceeding where a thick crop of birch and a ready sale for the poles exist.

THE ALDER (*Alnus glutinosa*).

The alder was at one time of considerable importance in connection with the manufacture of gunpowder, and its cultivation for that purpose was an important feature in English forestry of the sixteenth and seventeenth centuries. In early references to English woodlands, particularly in

the Parliamentary Surveys, "alder moors" are distinguished from ordinary coppice, and they seem to have been fairly numerous throughout the country. Evelyn mentions that owners of such moors often went to great expense in grubbing them up, and were then at a loss to know to what better use to put the land. Much the same might be said to-day of considerable areas of low-lying swampy ground which are more or less occupied by this tree; but the fault lies less in any inclination to grub them, than in neglecting to give them the little attention which would convert a practically waste piece of ground into one of some value to the owner. The alder has a great advantage, so far as most woods are concerned, in being little injured by ground game; and hence is it that it often forms the most valuable part of a mixed coppice which has suffered from ground game during the first year or two of the rotation.

The uses to which alder wood are put are much the same now as they have been for over a century. Clog-making, brush-heads, broom-handles, piles for strengthening the banks of rivers, have long depended upon this wood for raw material; "pumps, hop-poles, water-pipes, troughs, sluices, small trays and trenches, wooden heels," says Evelyn; while a recent use has been found in the manufacture of woodpulp. But the value of the wood quickly deteriorates if left with the bark on, and it decays quicker than almost any wood when cut and left to lie on the ground. For this reason, turners and others who work up the poles usually bark them as soon as possible after cutting, so that the wood may dry before decay begins. The brush-wood is one of the best for making small fagots for kindling purposes, and it is seldom that a particle fit for this purpose is left to rot on the ground, however bad the general trade for firewood may be.

In the case of pure alder coppice, the most suitable rotation is from ten to twenty-five years, according to the size of pole most in demand. With a good thick crop of stools, from £10 to £20 per acre can usually be obtained in most districts; but too often, as already said, the coppice is neglected, becomes gappy, and the yield is not more than

half that of a full crop. With a little attention a crop of alder will pay better than many crops on better ground, and it has the great advantage of neither requiring replanting nor much expense in the way of draining, and even on unfenced ground we have seen it grow into useful poles, for few animals seem to care for it. Evelyn states that the alder propagates itself by suckers; and it does so to some extent, but rarely so freely as poplar when growing on stiff ground. In peaty soils, or on the banks of ponds and streams, where the roots are near the surface, suckers are more plentiful.

One peculiarity of the shoots of alder stools is their straight upright growth when standing at wide intervals, and not confined in any way. Most stool shoots are apt to spread out on all sides, and become crooked and branchy; but this the alder rarely does, and this renders it all the more valuable in neglected coppice. When planted at the outset, the trees should not be more than 6 feet apart, although an average distance of 10 feet apart constitutes a thick coppice in the later stages, and when the stools are well developed. Worn-out or decayed stools may be easily replaced by laying bare a few roots and inducing suckers to spring up, or by cuttings, as in the case of willows. Suckers can also be induced by cutting down old stools to the surface of the ground, so as to concentrate the energy of the roots in that direction.

CONIFERS

THE LARCH (*Larix Europæa*).

Although this tree has not been an ordinary forest tree in the country more than a hundred and fifty years, it is highly probable that larger numbers of it have been planted than of any other one species alone. Before the larch disease made itself such an undesirable reputation, planters of almost all kinds of soils were almost universally in favour of this tree; and although a little more discrimination is shown regarding the soil and situation it is planted in to-day,

it cannot be said that its popularity has fallen off to any appreciable extent. The reason for this is not far to seek, when the requirements of English estates as regards fencing timber are taken into consideration. The larch seems, by some mysterious freak of nature, to have been expressly moulded, both in quality of timber and habit of growth, for furnishing, at all stages, poles and timber for the construction of fences. Whether it be to supply the slim sapling for stopping a temporary gap in a hedge, or the substantial fence of sawn posts and rails, the larch is equally able to meet the demand, and no timber is more durable or more easily converted for such purposes. Apart from its use as mining timber in certain districts, practically the whole of the larch grown in this country is used for outdoor fencing, and it is substantially correct to say that its value for any other purpose is comparatively unimportant.

The chief quality upon which its value depends for such purposes is found in the fact that it forms durable hardwood at an exceptionally early age. A pole of fifteen to twenty years' growth will often consist of two-thirds of heart wood, while in any other species, such as Scots fir or pines, hardwood at such an age will hardly exist at all. Another quality it possesses in a marked degree is the regular distribution and moderate development of its side branches. In pine and spruce the side branches are arranged in whorls, which in the case of young trees form stout and bulging knots at each whorl, rendering the pole coarse and irregular in shape. In the larch the side branches are set on fairly evenly all up the main stem, and their development during the first twenty or thirty years is small compared with that of the latter. This gives them a comparatively clean and cylindrical bole, even when allowed plenty of space for crown development; and as the side branches can be removed with the back of a billhook or axe more easily than by cutting them in the ordinary way, the preparation of a pole for fencing purposes is not a difficult matter.

The average rate of growth in the larch is also a valuable feature, especially when taken together with its early arrival at maturity. An average production of 50 cubic feet of

timber per acre per annum is not an exceptional occurrence in healthy larch woods, and when it is considered that the value of a crop per cubic foot is often as great at twenty or thirty years of age as it is at fifty or sixty, the opportunity it presents to landowners to get a quick return for their money is self-evident. For either pit-wood or fencing purposes pure crops of larch may be advantageously cut at forty years of age in many soils; and it is very doubtful if it pays as well to grow heavy timber by allowing it to stand seventy, eighty, or a hundred years, as it does to grow a thicker crop for about half the time and then clear it off the ground at once. Of course, where an ideal larch soil exists, it is a pity not to take advantage of it and allow the crop to stand as long as it is growing and keeping sound at the heart. But in the majority of soils sound larch, after it has reached fifty years or so, is the exception rather than the rule, and when once it begins to decay at the heart no useful purpose is gained by keeping it standing.

The date of the first introduction of this tree to England is not known with certainty. Parkinson mentions it as being cultivated as a garden specimen as early as 1629. Evelyn praises its good qualities, but more on the strength of what was known of it in Europe than experience of English-grown timber. There is little doubt that its introduction on a large scale, and its universal planting as a forest tree, was due to the Duke of Atholl, who, in the period from 1774 to 1829, planted about fifteen thousand acres chiefly with this tree. In 1783 the Society for the Encouragement of Arts and Manufactures offered a gold medal annually to planters of four hundred larches in England, and we learn that about 1,240,000 trees were planted from 1783 to 1805, more or less through this agency.

For the last sixty or eighty years the planting of pure larch plantations in England has gone on to a very great extent, and, although many of the original plantations have now disappeared, a few remnants occur here and there as evidence that this tree had a very wide and general distribution in the early part of the last century. But the finest specimens of old larch in this country occur in most cases where they were planted amongst hardwoods, or in situations

outside the ordinary plantation, such as pleasure-grounds, the margins of streams, and so on, where they have accidentally met with the conditions they love and have escaped the axe of the woodman. We know of some exceptionally fine trees being cut a few years back which were grown amongst oak and Scots fir on a loamy gravel, and were just over a hundred years of age. These trees contained from 50 to 100 cubic feet of timber, and the butts were perfectly firm and sound, and showed little of that foxy character so common in the timber of modern larch woods. It is more than probable that the frequent complaints of disease and heart-rot in the trees of plantations nowadays is greatly due to this change in growing them, as the shade and humus layer which hardwoods produce, especially beech, keep the surface soil in a better condition for the roots of a surface feeder like the larch than the humus layer produced by conifers, which is invariably dry and musty.

The soils on which larch will thrive or fail are so numerous, and the situations in which it succeeds or becomes diseased are so varied, that it is an extremely difficult matter to describe the exact conditions which are necessary for it to succeed or which bring about failure. Good and bad specimens may be found in pure sand and in stiff clay, in wet soils and in dry, on the summit of a hill or the bottom of a ravine. One is rarely justified in saying, therefore, that any hitherto unplanted soil will or will not grow larch, and the uncertainty is greatly increased owing to our limited knowledge of the conditions of things below the surface. A dry soil may surround the site of hidden springs, or a bed of gravel may underlie a clay surface soil. A trial hole here and there may settle the point in an imperfect way, but we cannot always be sure by such means as to whether such spots are fairly typical of the situation or not.

It has long been an established belief that the best soil for larch is a porous, well-drained, but fairly moist gravel, such as is frequently found on hillsides, which are covered more or less by the *detritus* of the solid rock beneath, and that fallen from higher levels. Such soils are usually kept cool and moist by springs and natural reservoirs fed by winter rains, and approximate closely to those in which the larch grows

in its native habitat. The coarse material of which they are composed allows air to circulate freely through, while more or less constant percolation of water from higher to lower levels prevents all acidity and the formation of compounds due to stagnant water and air. There is little reason to doubt the accuracy of this belief, but it does not necessarily follow that the larch will thrive nowhere but in soils and situations of this kind. We find first-class larch on perfectly flat ground, and we also find it badly diseased on hillsides, and abundant evidence exists to prove that the selection of larch soils on arbitrary principles alone is a fatal mistake. This becomes the more evident when the fact is recognised that the conditions for ensuring success in the growth of any tree are many and varied, and that one condition may balance or counteract the effect of another. A wet climate may counteract the effect of a dry soil, or a steep slope on which the weather is always acting may do away with the usual effect of a stiff and compact clay. Any particular soil or situation must be judged on its merits, and not according to any theoretical formula, which cannot fit in with all cases.

In order to understand clearly the conditions upon which the larch depends for its success, it may be worth while to study a few of its peculiarities and characteristics, for it is largely upon the demands made by these being satisfied that its welfare depends. When a larch seed germinates it behaves in the same way as any other tree seed, and sends down a radicle or tap-root as far down into the soil the first season as it can. But after the first season the growth of the larch tap-root is no longer a prominent feature of the growing root system. The lateral roots, which in the case of most trees occupy a subordinate position until the fifth or sixth year after germinating, grow out in the case of this tree in a more or less horizontal position, and in a very short time become the main support and means of nourishment to the stem. Several conifers, such as the spruce, Scots fir, etc., develop their lateral roots in the same way, so far as their horizontal growth is concerned; but the larch has this peculiarity of its own, and that is the development of a few lateral roots only to an enormous size and length, rather than the growth of the usual network of roots of medium

size to a moderate distance from the stem. An examination of the stem of an old or middle-aged larch tree will reveal this fact at once. The main stem appears to divide into three or four at the surface, and to form enormous tentacles, which creep along, rather than under, the surface of the ground to a great distance. If the tree happens to stand on a bank, the upper parts of these roots are practically exposed to the atmosphere, and resemble downward extensions of the main stem rather than roots.

The natural habit of the larch is, therefore, that of a surface feeder in the fullest sense of the word, for if other conditions are suitable it will live on almost bare rock or the thinnest layer of soil. The natural inference from this peculiar root system is, that it is a tree better adapted than most for growing on rocky acclivities, and the sides of ravines where ample surface space but little depth are at its disposal. Under such conditions it grows in the Alps, and it doubtless owes the gradual evolution of its root system from that prevailing in ordinary coniferous trees to these peculiar conditions.

With the above facts before us, it is not difficult to imagine the most suitable kind of soil in which larch will probably come to perfection. On dry soils its shallow roots will be unable to obtain the necessary amount of moisture, and it is not surprising to find it fail after a few years when planted on them. On soils, again, which are thick and close in their texture, like clay, and the surface of which is covered with a rank growth of grass and weeds, development of the roots is checked on the surface, while the soil beneath is either too impervious to air to promote their healthy growth. Old arable land, which after the first few years after planting is loose and porous, but which gradually settles down close and compact, while the subsoil becomes waterlogged through the choking of drains, cannot be expected to grow larch of any age, as in such cases the roots are encouraged to develop at depths which afterwards prove unsuitable for them, and the trees get into an unhealthy state. Soils which contain large quantities of iron are usually unsuited for larch-growing, as compact pans are formed which check aeration and favour stagnation.

Loose surface soils which contain sufficient moisture in

dry summers to meet the requirements of the tree, and which are sufficiently clean and free from other growth to prevent the surface roots being interfered with, are the best that can be found for larch. On flat ground surface moisture is apt to be stagnant, and hence does not so often furnish desirable sites for larch. Hardwood plantations, in which the surface of the soil is kept clean and moist by shade and leaf-fall, often prove suitable for larch mixed with them, and good specimens may often be found under such conditions. In these cases the roots are often able to run between the surface and the humus layer, and can obtain their moisture from the latter. Clayey gravels, moist sands, and soils on the edges of streams and brooks, usually produce the healthiest and soundest larch, and most damp soils on slopes and banks where water cannot accumulate are more favourable than flat ground, etc.

It will readily be seen that the accurate description of ground which will or will not grow healthy larch is by no means easy, and the most likely predictions may not always be verified. We have seen good sound larch on stiff clay and on dry, deep sand. Some of the finest trees we ever saw were growing in liquid peat on the edge of a Scotch burn, and we could point out plantations doing well on soils full of iron. Yet with these apparent contradictions,—and many more might be mentioned,—we have not the slightest doubt that the question of soil and situation is of the greatest importance, and that careful attention on this point would prevent many failures and a great deal of disease. Planted on the right soil and treated in the right way, larch is, and probably always will be, the most profitable tree the English forester can have, and even on the wrong soil it may possibly pay to grow it for certain purposes.

On favourable soils the yield of larch woods in timber is often heavy, and the financial returns are invariably good. As much as 50 cubic feet per acre per annum will be found an average growth on good larch soils for the first fifty years, and, as this timber sells readily at 1s. per foot, there can be no question about a properly managed plantation paying. In addition to the yield of the main crop, the thinnings from the twentieth year onwards will be of considerable value, and

the more so if no attempt has been made to obtain returns before that time. The value of small thinnings from larch or other coniferous woods is greater when they are composed of suppressed trees only than when dominant trees with large crowns are taken out. The former are not only much cleaner, but, having grown slowly from the start, the wood is composed of narrow rings, and is consequently more durable.

As larch is particularly liable to be abused through over-thinning in the early stages, a system of planting and thinning it may be mentioned here which we have found to answer well when a large extent of young plantations has to be dealt with.

In planting (where pits have to be dug) stout one- or two-years' seedlings, two-year transplants are put in at 4 feet apart, working in any other species used in every other row, and at such distances apart in the rows as may be desired. For slitting "two-year, one-year" plants are large enough, and may be put in rather closer.

For the first three or four years after planting the plantation is gone through in each spring, and all sickly or diseased individuals taken out and burnt, and the gaps filled up with strong plants.

After this, practically nothing is done until the twelfth or fourteenth year after planting, when the ordinary woodmen are sent through with hand-bills, and ordered to take out all dead or suppressed trees, and clean off as many of the dead branches on the remainder as possible. After this cleaning process, an intelligent man or foreman is then sent in to mark all trees that can be safely spared, picking out any blistered, badly-shaped, or broken-topped individuals in the first place, and then selecting a few of those pressing too closely on the dominant trees. These marked trees are then taken out from time to time, when they are wanted, or a certain area is gone through annually, so that the quantity of thinnings may not exceed the local demand for them. This prevents a large number of smaller poles lying about until they are rotten, for the demand for poles under fencing size is often limited and uncertain. If not wanted, these marked trees do little or no harm by standing, and,

so long as they are alive at all, they increase rather than deteriorate in value, and will come in for something one day.

No doubt many would consider such an irregular and uncertain process of thinning a source of danger to the health of the main crop, and likely to favour disease. But, although thick larch plantations are popularly supposed to be hotbeds of disease, an observance of facts will at once dispel any such illusion on this score. More often than not, those parts of a plantation supposed to be most in need of thinning are the healthiest in the wood, while the thin portions are most diseased. Let this be as it may, we contend that the less thinning a larch plantation gets until it is twenty years of age, the more profitable it will prove in the long-run. After the twentieth year the gradual removal of suppressed trees may go on at the forester's pleasure, and they will then be found to pay for the labour of removal, and the supply will rarely exceed the demand. But when, as sometimes happens, a plantation is allowed to stand thick at first, and then suddenly thinned heavily, bad results invariably follow.

One of the most important factors in profitable larch-growing is the cutting of the crop at the right time. As is well known, the most troublesome feature in the larch crop is its liability to heart-rot at any age. When once this rot becomes universal, the only economic course is to cut the crop clean, for every year it stands it deteriorates in value, although it may be adding to its bulk at the same time. Grown thick, and cut before serious damage is done in this respect, a crop of larch may be made to pay at twenty years of age, although none would cut it so early unless compelled. The proper time to cut, when the trees keep sound, is a few years after height-growth slackens off, and when the annual rings begin to get narrow at the butt. Rotations of from thirty to fifty years for small timber and from fifty to eighty years for large will be found most suitable, and it will generally be found that a thick crop of long clean poles of moderate size turns out more profitable than an open crop of large but coarse timber. The uses to which the greater part of larch timber are put do not

require trees with a mean quarter girth of more than 8 to 10 inches, and trees of this size can easily be grown in forty to fifty years on suitable soils.

As suitable trees for mixing with the larch, when regarded as a main crop tree, beech and Spanish chestnut amongst hardwoods, and spruce amongst the conifers, may be mentioned. Beech should only be used in the case of long rotations, fifty years and over, as it is of little value under that age. Being a slow grower for the first few years, the larch gets well away at first, and, by the time the beech catches up with it, it is too late to do it much harm. Spanish chestnut may be used in rotations from thirty to fifty years, and will furnish useful trees for fencing purposes in that time. Spruce should only be used on damp ground, and in districts where pit-wood pays for growing. In such cases very heavy crops of poles may be grown with this mixture, as after a few years the spruce constitutes a second storey, and both species can grow practically unaffected by each other. In windy districts a sprinkling of spruce amongst the larch is also useful in sheltering the latter and preventing damage from storms, as spruce branches develop easily under the thin shade of larch; but where such shelter is needed on dry soil it is probably better to grow the spruce in the form of belts along the margins of rides, and greater resistance to the wind will be given them if a double row of them be planted a few feet apart, so that the windward side of each tree is the one best furnished with branches.

Although a great deal has been heard from time to time of substitutes for larch, a satisfactory substitute has yet to be found. There is no tree, either hardwood or conifer, which can show the same quality of timber and be put to the same uses at the age of ten to twenty years as larch, and this practically constitutes its chief value.

The Japanese larch has been boomed very extensively of late years, and provided it continues to grow at the same rate as that at which it starts, it may prove a useful tree where the European species is a failure. But it has not been introduced into this country long enough to justify an optimistic statement being made about it at present. It

is quite possible that it may succeed on dry soils better than the common variety; and if it does not prove subject to the heart-rot so detrimental to the other tree, then it may deserve a share of the praise so lavishly meted out to it by some foresters and others. Its disease-resisting powers, whether actual or supposed, are not of such importance, perhaps, as might be supposed, for the attacks of *P. Wilkommi* on European larch must be considered as much the effects of bad health as the cause of it.

The Corsican pine and larch make a good mixture on deep gravels, especially when they contain a small quantity of clay or deep loam. Both being rapid growers, and the Corsican not given to develop side branches for the first twenty years, heavy crops may be grown with this mixture. The Corsican pine being a tree that can usually be depended upon to grow to maturity, the ultimate success or failure of the larch is of less importance when mixed freely with this tree, for it is in little danger of getting suppressed, and when the larch is at last removed a crop of stout healthy Corsicans remains to grow on as long as desired.

SILVER FIR (*Abies pectinata*).

Although the silver fir is one of the handsomest of our European trees when properly grown and fully developed, it cannot be said to be in any great favour as a commercial timber tree. One reason for this is its coarse and knotty nature, when given the slightest freedom in the way of crown development. It has in the past been invariably grown amongst other species, and in such a way as to present few or no obstacles to the formation of side branches. This, combined with the few useful purposes to which its timber can be applied, has almost erased it from the list of profitable timber trees.

On deep dry gravels or sands, and in fairly moist localities, the silver fir grows to an enormous height and bulk. In the Longleat woods silver firs of 130 feet in height, and containing from 300 to 400 feet of timber, are fairly plentiful, and these dimensions have been obtained

in the course of a hundred and twenty years. At a price of 6d. per foot, such trees are of course fairly profitable, as a considerable number can be grown to the acre, but the difficulty lies in securing a customer who is willing to take trees of these dimensions. They not only require considerable horse or traction power to remove them, but their great diameter entails a great deal of labour and trouble when they come to be converted. In fact, in many parts of the country large and knotty silver firs are practically unsaleable, and it is not a species which can be strongly recommended under present conditions.

THE SCOTS FIR (*Pinus sylvestris*).

Although the Scots fir is popularly more closely associated with Northern Britain than England, its distribution is so general as a park and plantation tree in all parts of the country that the term "Scotch" is scarcely appropriate at the present day. Not only as a legitimate plantation tree, but as a natural growth on thousands of acres of heath land, the Scots fir has changed the character of many districts in Hants, Surrey, and other parts of England, with poor gravelly soils not grazed by sheep. Whether any forests or tracts or woodland still exist which can claim to be covered by the *direct* descendants of the indigenous Scots fir of England, we do not know; but in the Highlands of Scotland numerous remains of natural fir forests still exist, or have existed within recent times, and the timber they produce is equal in quality to that produced in any part of Europe. With abundance of land fit for nothing but growing this tree on the one hand, and the enormous imports of Scandinavian fir timber on the other, it seems an anomaly that so little attention should be paid to its growth for commercial purposes, and that even the best of that now grown should be put to merely subordinate uses and command the lowest of prices. That this is due to any inherent infirmity of the native species or strain there is little reason to suppose, and it is evident that a more systematic and intelligent method of growing it would produce timber fit

to be used for three-fourths of the purposes to which imported wood is applied. Yet the present attitude of the English forester towards this tree is one of undisguised contempt, and any reference to it as a profitable timber tree is received with ridicule.

Before describing the method of growing this tree in a way likely to prove profitable, it may be advisable to define clearly its position in the forest economy of this or any other country. Scots fir may be said, together with birch, to be the advance guard of forest vegetation in Great Britain, and the more closely it is confined to poor soils the better the quality of the timber it produces, and the better the financial returns are likely to be. Planted in rich good soils, it probably deserves all that can be said against it. Its timber is coarse-grained, knotty, and decays rapidly, and is not suitable for any but temporary and unimportant uses. But on dry gravels and sands which are often too poor for most trees, Scots fir timber, if grown thick and close from the start, is invariably of good quality, and equal, when properly seasoned, to a good deal of that imported.

Of course, so long as foreigners can send us this wood thoroughly seasoned, and cut into sizes most convenient for the joiner and builder, at prices which leave nothing for the costs of artificial production, it is difficult to attract the attention of timber merchants to home-grown Scots fir. In all building specifications, foreign wood is invariably stipulated for, and it would be quite useless for any timber merchant to attempt to cater for the timber trade with acknowledged home-grown timber under present conditions. But will these conditions continue? Will improved methods of silviculture raise the quality of the home-grown Scots fir on the one hand, and will the supply of foreign wood either fall off or its quality deteriorate on the other? We firmly believe that both these questions may be answered in the affirmative, and that the prices obtainable for home-grown Scots fir timber fifty years hence will well repay the cost of cultivation and leave something over.

The qualities which builders and joiners prize most highly in pine timber are freedom from knots and uniformity of

texture; and this is the timber which commands the top price in the market. For joinery work especially this latter quality is of the first importance. Fir timber of uniform texture does not warp or shrink unequally in drying, and warping is a fatal fault in the joiner's eyes. An examination of any high-class deal joinery reveals the fact that the timber used in it is composed of extremely narrow rings—so narrow in many cases that fifty or more will be found in an inch of cross section. This uniformity, or narrowness of ring-breadth, together with freedom from knots, means that the tree or trees from which the timber has been cut were of slow growth and considerable size and age. Ring-breadth and diameter-growth are one and the same thing, and freedom from knots means that the timber was taken from a part of the tree some distance away from the pith or centre, for it is in the neighbourhood of the pith that knots are situated, and no tree can be grown without them. An ideal pine for joinery work is one, therefore, which possesses a timber bole containing the greatest proportion of knot-free wood made up of narrow rings.

To produce such timber, the trees must be grown extremely close, so that the side branches are killed off to the desired height at the earliest possible stage, and allowed to stand until a great age, in order to obtain the desired dimensions; and this is only possible on poor soils, because the better the soil the faster the growth, and the quicker the individual trees assert their supremacy, and secure crown room for themselves by smothering their weaker neighbours. On poor soils growth all round is less vigorous, and side branches will be both smaller at a given age and more easily killed off by a given amount of shade than in fast-growing trees. Now it is impossible in practice to grow every tree in a plantation of the desired size and quality. Individual growth is always varying, and, if it were not so, crowding would ultimately destroy the entire crop before it reached a useful size; for the farther the crown is cleaned up, as will be seen under "Thinning," the smaller the supply of sap available for the roots. In any plantation not artificially thinned, therefore, a certain proportion of individuals will be found with the remains of side branches

which were not killed soon enough, and a certain proportion which had them killed too soon. The mean between these two extremes is what the forester aims at in thinning.

But with very slow growth due to poverty of soil, trees cannot attain a great height, and the shorter in height the clean bole is, the smaller the space for putting on knot-free timber. With fast-growing trees and large knots, the farther the latter extend from the axis the more growth must be made to give a certain quantity of clean wood. The production of the latter, composed of narrow rings, is consequently a long process at the best, and, in the case of artificially grown wood, means an expensive process.

In the case of natural forests it is the result of a combination of favourable conditions which can only exist to a very limited extent, and the time must come when the supply of first-class pine will only be kept up by sylvicultural methods, and the cost of production, which is now a more or less neglected factor in fixing the price, will come into play. It will then be seen whether properly grown British Scots fir will be so much behind the imported timber as is now assumed, justly or unjustly, to be the case.

That the greater part of the Scots fir now put on the market is inferior to that imported, there is little reason to doubt. In the first place, it is seldom planted pure, but either mixed with larch or other conifers, or put in as a nurse to hardwoods, and allowed to stand when the latter happen to fail or become crushed out through neglect. In such cases it is crushed out and weakened when unable to keep pace with the other species, or it becomes branchy and coarse when mixed with slower-growing hardwoods which allow it to develop a large crown. Grown in this way, it is only by accident that it obtains the necessary conditions for growing into useful and high-class timber, and it is little wonder that the timber actually produced has a poor reputation. But even when pure plantations of it are formed, which is very seldom, the production of good timber is often prevented by early or excessive thinning. In colliery districts especially, where small poles can be turned to account, the plantations are often heavily thinned when thirty or forty years of age in order to obtain pit props,

the consequence being that the main or rather remaining crop grows into coarse timber with diminished height-growth.

Good Scots fir timber cannot be produced by either of these methods. To grow timber of the quality imported from Scandinavia it is absolutely necessary to keep the proper development of the main crop steadily in view from the first, and not allow it to be ruined for the sake of a few shillings per acre from early thinnings or premature fellings. Where the production of pit-wood alone is the aim in view, it may, and probably does, pay to thin fairly heavily after height-growth culminates, say at thirty or forty years of age, because quality is of little or no importance where the value of the wood is calculated by weight. By thinning at this age a large yield of props is obtained at the time, while the remaining trees increase more rapidly in size from the increased supply of light and air to their crowns. But where large tracts of Scots fir land exist in districts more or less remote from colliery districts, it seems a poor policy to have no higher aim in view than the production of mining timber which commands little better than firewood prices in the wood. For example, there exists a well-known Crown forest in the south of England which employs a staff of high-salaried officials to grow pit-wood for collieries at least sixty or eighty miles distant. Surely the Government of Great Britain is in a position to set English landowners a better example of economic forestry than this, and it would be a more dignified proceeding to grow really first-class fir timber; or, if this is impossible in this country, as some maintain, demonstrate that fact beyond all dispute.

No timber tree is more easily managed in plantations than Scots fir. The sole and only secret of growing it to perfection consists in planting or sowing it thickly at the outset, then leaving it entirely alone. No thinning should be done whatever beyond the taking out of dead or dying trees at periodic intervals, and this should be done as much with a view to remove the breeding grounds of injurious beetles as with any idea of ordinary thinning. Grown in this way for seventy or eighty years, abundance of timber would be produced fit to be compared with any foreign wood ever

brought into this country. It must of course be grown on poor land, which induces a slow and uniform growth, and not on rich ground, which calls out the coarse nature of the tree to the utmost. There are thousands of acres within fifty miles of London, now lying more or less waste, capable of growing the very best Scots pine timber; and we know of examples of self-sown crops on such land which leave nothing to be desired as object-lessons of ideal forestry. Yet it is no exaggeration to say that if such crops came under the care of the average forester they would be at once ruined by thinning, as the Crown authorities are ruining their self-sown Scots fir wherever they happen to possess any.

The yield of timber that may be expected from Scots fir on poor gravelly soils varies from 20 to 50 cubic feet per acre per annum. A thick crop at eighty years of age ought to contain at least two hundred trees to the acre, with an average contents of 20 feet per tree. Grown in the manner described above, such a crop ought to be worth, at 6d. per foot, £100 per acre. Scots fir being one of the easiest and cheapest crops to plant, no great difficulty ought to be experienced in obtaining a nett rental of 7s. 6d. to 10s. per acre from land which is otherwise not worth more than 1s. for other purposes. Of course, land of this description varies a good deal in quality, and it often happens that more or less of it is practically useless from one reason or another, and this brings down the average return on a large area. But there is no good reason for supposing that the poorest gravels in the south of England could not be made profitable to their owners by means of this tree, and that timber will eventually pay better than pit-wood in districts where less than 6d. per foot can be obtained for the latter in the wood.

THE CORSICAN PINE (*Pinus laricio*).

This tree has proved itself, on a variety of soils and situations, one of the best producers of pine timber in this country. It will thrive on sand, chalk, clay, or peat, but the best timber is probably produced on soils similar to

those adapted for Scots fir, deep and fairly moist gravels, which maintain a moderate rather than a luxuriant growth. Where pit-wood pure and simple is required, few if any species excel Corsican pine for that purpose, for its upright growth and small crown for the first twenty or thirty years enable very heavy crops to be grown in a short time. Where heavy timber is aimed at, it should either be grown pure in the same way as Scots fir, or mixed with larch or spruce, which can be taken out when suppressed, or when more room is wanted for the pines; for there is little danger of the Corsican either getting crushed out by other species in a mixture, or developing a coarse head when allowed plenty of room. Compared with Scots fir, the timber of Corsican pine is of better quality when both are grown rapidly, being heavier and more durable, and containing a larger proportion of summer wood in the annual rings, while the yield is about 50 per cent. more.

The Corsican pine has one failing in the eyes of planters, and that is the large percentage of failures among recently transplanted trees. The roots of young plants have very few fibres, and when the two or three bare straggling roots they possess get dry or injured, the plants often succumb before they are able to throw out new ones. In transplanting this tree two important points should always be attended to: one is, never to let the roots get dry if it can be avoided; and the other, never to transplant them in mid-winter. Early autumn or late spring should always be the time chosen to move them, so that the plants can either get established before cold dry winds (the terror of all recently transplanted evergreen trees) set in, or the season for such winds be over before they are moved. If these rules were carefully attended to, combined with careful planting, failures would not be much more numerous than with other species.

THE WEYMOUTH PINE (*Pinus strobus*).

Although this pine is not so well adapted for such a variety of soils, nor such a free grower as the Corsican, it is certainly one which deserves to rank as an important timber

tree on certain soils in the south of England. It is said to have been first planted at Longleat in 1705, and it was planted extensively as a timber tree at that place about 1780. It was also planted freely at Woburn Abbey, probably about the same date, and at both of these places it has produced useful timber. It succeeds best on deep, dry, sandy, or gravelly soils, and in situations fairly well sheltered from strong winds, as it does not possess that robust hardy habit and strength of timber characteristic of the Scots or Corsican pines. Its timber, as the "white pine" of America, is highly prized for indoor work, and that produced in this country is equally well adapted for the same purpose. Weymouth pine grown on the Longleat estate has been sold for 1s. per foot, and it is greatly valued for indoor fittings in the estate buildings. As a timber producer it probably falls short of the Scots fir in the long-run on exposed sites, but exceeds it on most sheltered soils, especially for the first fifty years. It may either be grown in pure groups, or mixed with larch, as it is a better shade-bearer than that tree, and is not likely to suffer from overcrowding. The Weymouth is probably the only example of a pine which will reproduce itself under its own shade or that of Scots fir, when not destroyed by rabbits at the outset, and, in the case of large woods of it, it might be possible to turn this to practical account.

THE DOUGLAS FIR (*Pseudotsuga Douglassi*).

Few introduced coniferous trees have jumped more rapidly into favour than the Douglas fir. Although it has not been introduced into this country more than ninety years, numerous specimens may be found in most districts surpassing in height all other trees in their vicinity, whether indigenous or foreign. It is adapted for most dry soils and sheltered situations, apart from those containing chalk or lime (which are practically fatal to it), and its timber, in spite of the bad effects of rapid growth, is equal in quality to most coniferous woods for outdoor work, such as posts, rails, etc., and is only surpassed by larch. The chief difficulty, so far, has been to grow it close enough to produce clean timber.

Even seedlings have been too high in price until quite recently to be planted in large quantities in ordinary plantations ; but that difficulty has now disappeared, and they can be obtained at prices which, if still comparatively high, are at any rate not prohibitive. Still, even now Douglas fir is not cheap enough to plant at such close distances as larch or Corsican pine, without raising the cost of planting to a high figure. One thousand to the acre (at about 8 feet apart) is the smallest number that should be used where clean timber is aimed at, although three hundred at 12 feet will form a close plantation in about twenty years, and will enable a large number of larch or other trees to be grown into poles or small thinnings, and taken out when suppressed.

The Douglas fir grows away at such a rapid rate from the start that no other species can keep up with it, while its shade-bearing qualities enable it to develop side branches to an undesirable extent, unless planted at close distances. Where cleanliness is not of the first importance, the wider distances will enable the plantation to be more cheaply formed at the outset, but where damage by wind is at all likely, thick planting is undoubtedly the best and safest method. The liability of the tree to get flat-topped when it reaches a height of 60 to 80 feet on even fairly sheltered ground is a well-known feature, while on situations at all exposed its leading shoot gets crooked or broken at an early age, and for this reason it is not adapted for exposed situations or for high-lying flat ground. On sloping or undulating ground it should be confined to the valleys or to slopes with a northern or eastern aspect, so that the effect of prevailing winds may be avoided as much as possible. On flat ground Douglas fir should be planted in thick masses, or in small or narrow clearings in old woodland, which protect the young crop until its leading shoots are level with the older timber. The only species suitable for mixing with Douglas fir for a permanent crop are silver fir or spruce.

As regards soils, chalk or lime, as already said, is fatal to this tree, and it fails on both the chalk and oolite formations, unless superficial beds of gravel or loam overlie them. Wet stiff clays are also unsuitable, and, in fact, wet soils of any kind. Deep sands and gravels are the soils on

which it is found to succeed best, and it may frequently be seen doing well on those poor Scots fir soils alluded to when discussing that tree. On well-drained peat, Douglas also does well for a time, but it is not likely to grow to a great age nor to produce high-class timber.

The yield of timber from a well-grown and close crop of Douglas fir exceeds that of any other coniferous tree. Dr. Schlich calculated the contents of the Douglas fir plantation at Scone at 3700 cubic feet per acre at thirty-two years of age. At Longleat pure groups of Douglas fir on the Greensand contain, calculated per acre, 2500 cubic feet at twenty-six years of age. Most of these groups were planted at 12 feet apart, and filled in with larch to a distance of 4 feet. Had they been planted closer, heavier crops and cleaner timber would have been the result, but, as it is, it will be seen that an average yield of 100 cubic feet has been obtained without taking the larch thinnings into account. Valued at 10d. per foot, it will be seen that a gross return of £4 to £5 per acre is possible on suitable sites, and that it is a valuable addition to our list of foreign trees. Its chief failing at present lies in the extra cost of the plants, although this may disappear in time, while its rapid growth allows a greater latitude in this respect than in the case of a slow-growing species.

But an objection to the Douglas fir being planted on a large scale will probably come from the gamekeeper. A crop of trees which excludes light to the extent that Douglas fir does when pure is absolutely useless for game preserving. Rabbits cannot live under it, and pheasants will not stay in semi-darkness either summer or winter. Whether this will affect its popularity or its silvicultural treatment remains to be seen. Planted in clumps here and there throughout a wood of 200 or 300 acres, its presence may not be taken much notice of; but in small woods, that desire to make them as fit for game as possible will probably check any extensive planting of Douglas fir on silvicultural lines. A tree or clump here and there is rather favoured by the gamekeeper than otherwise, for they afford warm roosting trees for pheasants, but beyond this they are not likely to meet with his approval and that of the game-loving proprietor.

THE SPRUCE (*Picea excelsa*).

Whether the common spruce can be termed a profitable timber tree or not may well be doubted by most foresters. The experience of most is that it is difficult to dispose of at any price, and many consider themselves fortunate if they can get 6d. per foot for it. It must be admitted, however, that a really clean crop of spruce is not often met with in this country. Like Scots fir, it is too often stuck in as a so-called nurse to other species, with the result that its lateral growth is unchecked, and its stem is coarse and knotty. Most timber merchants look upon coarse and knotty spruce timber as the dregs of the home market, and will scarcely have it as a gift, and it is equally useless for most estate purposes. Grown in close order, however, from the start, home-grown spruce ought not to be such an unsaleable article after all, although anything like a high price per cubic foot is of course out of the question. Its chief virtue, such as it is, lies in its capability of producing a heavy crop of timber on heavy cold soils, which will grow little else to advantage. It being one of the shallowest of rooters, it will grow on a thin surface soil, or one which is waterlogged a foot below the surface, and where deeper-rooting trees would languish and die in a few years. On such soils it forms a network of roots on the surface of the ground, and will furnish a dry footing on the stickiest of soils.

Many heavy clay soils which have been planted with oak or ash at one time or another within the last two or three hundred years, and which have yielded next to nothing in the shape of timber, would have produced crops of spruce of a more profitable nature than the hardwoods, had the former been properly grown from the start. The low value of the timber would have been more than balanced by the increased yield, for a crop of 6000 to 8000 feet of spruce at eighty to a hundred years of age is better than 1000 to 1500 feet of oak in the same time, and it is nothing uncommon to find oak plantations of eighty years of age with not more than 1000 feet of timber in them per acre. Even putting the spruce as low as 3d. per foot, a value of £75 to £100 per acre

is possible, while the oak at 1s. per foot is not worth more than £50 per acre. In such cases, or any other of a like nature, it is obvious that spruce may be useful in turning land to account which cannot grow more profitable species, either by reason of its waterlogged subsoil, or its extreme shallowness, as on rock or hard gravel. Few foresters would plant spruce if they could grow something better, but, when it rests between a heavy crop of this tree and a meagre and stunted growth of something else, common sense favours the former.

However badly spruce may sell in the timber market, it can always be turned to account in the estate sawmill. Rafters for out-buildings, fencing poles, rough planks for wheeling barrows on, poles for scaffolding, etc., create a constant, if limited, demand for home-grown spruce, and for such purposes it is well worth 6d. per foot, and for certain purposes even more. A limited area of land stocked with this timber is not such a great misfortune therefore after all, the main point being to grow it thick and close from the start, and thin slowly and sparingly throughout. In mixtures it should either be grown with beech, hornbeam, silver fir, or Menzies spruce, or be mixed with quick-growing light-demanders, which keep it in subjection until a late age; but, as already said, clean spruce must not be looked for in mixed plantations of light-foliaged trees.

THE MENZIES SPRUCE (*Picea sitchensis*).

This tree may almost be termed the Douglas fir of wet soils. Its rate of growth on damp cool soils is extremely rapid, and it might well take the place of spruce, or be mixed with it on those heavy soils mentioned in connection with that tree, although it probably makes its best growth on damp but porous soils of a peaty nature. Like spruce, it must be grown clean to be of any commercial value, and until it can be produced at a cheaper rate it is not likely to be planted close enough on a large scale to effect this.

In addition to the trees mentioned above there are about a hundred species which are described in nurserymen's catalogues as "producing valuable timber," "likely to become a valuable timber tree," "grows so many feet in height in its own country," etc. etc. Considering that these species cannot be planted on a silvicultural scale under £3 to £5 per acre for plants alone, and that their growth in this country is more or less an unsolved problem, they may well be left in *pineta* or ornamental clumps for the present, or until species which have hitherto proved themselves valuable fail or become extinct.

CHAPTER V

PLANTING AND NATURAL REGENERATION

PLANTING.

THE practice of planting or transplanting trees from one site to another is a very ancient one. It is dealt with in the Greek and Roman classics, and is probably as old as any branch of agriculture or horticulture. But, regarded from a forestry point of view, it cannot be said that any evidence exists of it having been carried out on anything but a limited scale until comparatively modern times. During the fifteenth and sixteenth centuries the practice of planting went under the name of "setting," and young trees or plants were known as "sets." The term still survives in the word "quick-set," usually applied to a hedge composed of thorns or quicks, and probably first used to distinguish such hedges from the more common ones, composed of dead bushes or branches, which were universal when enclosures were only of a temporary nature. But although the name only survives in connection with thorns, there is little reason to doubt that it was applied to the planting or sowing of all trees, plants, or seeds; and there is nothing surprising, therefore, in the scanty references to planting in the works of the older writers, and which might possibly be taken as evidence that the practice was quite a modern one.

As understood at the present day, the word "planting" signifies the removal of young trees from the nursery or seed-bed in which they have been raised from seed, and replanting them upon the site on which it is desired that they should establish themselves and develop into large trees. This work may deal with trees of only a year or two old, or what are

technically known as seedlings, or it may be applied to trees of twenty or thirty years of age and as many or more feet in height. In the latter case, planting becomes a branch of arboriculture or horticulture, and is only applicable to parks or pleasure grounds in which expense is a secondary consideration. It is only when trees are transplanted at an early age that the operation can be accomplished with an expenditure of time and money which is sufficiently small to render the ultimate results or returns profitable to the planter; and it is with this class of planting that we now propose to deal.

PRELIMINARY OPERATIONS.

Preparation of Ground.—Before the actual operation of planting is performed it is often necessary to prepare the ground in some way or another in order that the young trees may not be interfered with by other growth, or their development checked by adverse conditions. In the case of waste ground this preparation usually consists in burning or grubbing strong woody growth which already occupies the ground, such as gorse, broom, bracken, heather, etc.

Gorse is the most difficult growth to deal with successfully, as it seeds so plentifully, and burning does not destroy the plant below the surface. Where it is plentiful, therefore, considerable expense must be incurred before the ground is in a fit condition for planting. Probably the cheapest plan in the long-run is that of grubbing it in lines or strips about 4 feet apart, so that the trees can be planted in the grubbed portions. The growth on the intervals should be cut over at the same time, and left on the ground until the seeds present have germinated, when the whole should be burnt in the early autumn, previous to planting. When so dealt with, the growth of the old stumps still left in the ground is weakened, as the shoots they make after cutting are checked by the tops lying on them, and the burning not only destroys these shoots, but also the seedlings which have come up around them.

Broom, brambles, etc., should be dealt with in much the

same way, but are less troublesome on account of their more open growth. Heather gives little trouble, and can easily be burnt; and this should be done a couple of years before planting, so that the caked condition of the surface which follows burning may have disappeared. Bracken should also be taken in hand at least two years before planting, and its growth weakened by repeated cutting.

In the case of old pasture or ground with a grassy surface, it is often advisable to break it up before planting. Turf acts like a blanket on the surface of the soil, keeping out both air and moisture, and appropriating all plant food in the upper six inches. Wherever possible, the best plan is to break it up, a year or two previous to planting, by either deep ploughing or cultivating. A crop of roots, rye, or corn can be sown on the ground afterwards, and the plants slitted in the following autumn or spring, if the soil is adapted for this method. A thin scanty turf on sloping ground, however, is an advantage on light soils, as it prevents washing or denudation of the surface, and in such cases it is better to allow it to remain undisturbed.

FENCING.

It is not necessary to deal with the fencing of ground against cattle or sheep, as this branch of work has no particular application to forestry. But fencing against ground game is an almost invariable preliminary to planting or replanting ground of any kind. Experience proves over and over again that the neglect of this precaution almost always ends in the young crop being destroyed during the first five years. Protection in the shape of wire netting, therefore, is usually imperative, unless the labour and expense of planting are to be thrown away.

Common as the custom of erecting wire netting is, it is rather the exception than the rule to find it erected properly. Either the mesh used is too large, the netting is not let deep enough into the ground, or the width is too small to effect the desired result. If too large a mesh is used, young rabbits crawl through it; if not set properly

into the ground they burrow underneath, and if not wide or high enough they jump over. It is much better economy, therefore, to do this work thoroughly at the outset, than to run the risk of loss and disappointment afterwards.

In the first place, netting of more than $1\frac{1}{4}$ in. mesh should never be used. Most people imagine that $1\frac{1}{2}$ in. is quite small enough for anything; but young rabbits easily get through it, and the result is that, in about two years after planting, the ground is fairly well stocked with rabbits which have entered when small, and grown too large to get out again. The netting should be fixed into the ground by taking out a trench from 6 in. to 9 in. deep, at the bottom of which the lower edge of the netting should be placed and the soil or turf returned. In very light or sandy ground it is advisable to bend the netting down in the bottom of the trench, so that when rabbits burrow down they come upon and are stopped by the horizontal portion. The width of the netting should not be less than 48 in., or from 39 in. to 42 in. above ground. The upper edge should be tied to a No. 6 or barbed wire, supported by stakes from 9 to 12 feet apart; and we have found it a good plan to drive these stakes in about 6 in. from the netting at the surface of the ground, so that it projects outwards and leans away from the plantation at the top, as, when so fixed, rabbits are less likely to climb over.

The cost of erecting the netting in the above manner amounts to about 8d. per yard, including material. With an excessive number of rabbits, however, more expensive netting may have to be used, which chiefly differs from the above in its size of mesh and width.

DRAINING.

The question as to what extent ground to be planted should be drained is one which is rarely considered so carefully as it should be. Whenever a patch of swampy ground is noticed, the forester invariably considers it his duty to cut drains through it until all superfluous moisture

has been removed. In many cases, no doubt, this is the correct thing to do, but instances do occur where little or no return is obtained from the outlay thus incurred. Such instances are where the soil rests on a rocky formation, which prevents any deep-rooting tree from securing a firm hold upon it, or where the soil is of such a poor and inferior nature that it is practically sterile, and not worth the trouble and expense of the draining bestowed upon it. A certain amount of judgment is necessary, therefore, in undertaking drainage work on a large scale. To expend £2 or £3 per acre in the form of drains, without any probability of rendering the ground capable of growing a profitable species, is poor economy, and it is probably better to plant a great deal of wet and swampy ground with birch, willow, poplar, or any other moisture-loving tree, confining the draining to a few deep cuts here and there, which will enable the surface moisture to get away as quickly as possible. On the margins of rides, or in any other spots where the presence of moisture is particularly undesirable, draining of course must be conducted from other motives, but in ordinary cases a careful examination of the soil as regards depth and chemical qualities should be made before thorough and expensive drainage is taken in hand.

Apart from the above considerations, the drainage of ground to be planted is much the same in principle as the drainage of agricultural land, and needs no particular description, it being of course understood that open drains are the only ones permissible in woods.

PLANTING.

Ordinary forest-planting may be conveniently divided into two classes, according to the nature of the ground to be planted. The planting of deep rich ground, covered with a rank growth of grass or other herbage, must be gone about in a different way from the planting of a bare hillside with a thin soil, and covered with a scanty or slow growth of short grass or heather. In the former case the obstacles to successful transplanting consist in the natural growth

which already occupies or is more or less indigenous to the soil. This growth may reach a height of two or three feet in the course of the summer, while its roots ramify through the best part of the surface soil and appropriate its plant food and moisture. Under such conditions a young weak seedling would have little chance of getting well established unless carefully attended to by cutting back the surface growth for the first two or three years, which may prove too expensive work.

In the case of hill-planting, on the other hand, the obstacles to success are of a different nature. On the prevailing class of soils on hillsides, finely divided earth, which is necessary for covering the roots of a transplanted tree, is usually scarce. The so-called soil often consists of gravel or broken rock, and, in ordinary transplanting, the roots must be given more or less unfavourable conditions at the outset by being placed in material which contains a relatively small proportion of moisture and plant food. The planter is therefore compelled to use plants of such a size as can find their requirements met by existing conditions. But a still greater objection to the use of large plants is the difficulty experienced in fixing them firmly in the ground. Large plants are invariably top-heavy, and on hillsides, where strong winds prevail to a greater or less extent at all times of the year, such plants are continually subjected to lateral pressure which they are not in a position to resist. Such plants, therefore, seldom succeed on hillsides, and small, stout, and comparatively young trees must be used for planting them.

Although the general principles of planting are the same in both the above cases, the methods employed in the one are seldom suitable and appropriate to the other. In the one case we must provide for the transplanting of large and top-heavy trees, which are at the outset in a position to contend with the surface growth. Such trees can only be properly planted by pitting. In the other case the method employed must be suitable for small-rooted trees, which are little affected by wind, and which have to be planted in a soil in which pits or holes are difficult to dig, unless at a comparatively high cost. The method best

adapted for such plants is that of slitting or notching. Almost all methods of planting are modifications of one or the other of these two classes, and will be dealt with in connection with them.

Pit-planting consists in taking out holes about a foot square or so, according to the size of the plants used. These pits should be dug previous to or at the time of planting. On cold stiff clay or loams they are best dug early in the autumn, and the ground planted the following spring, as frost is thus able to pulverise and sweeten the soil taken out. In dry loose soil, on the other hand, which contains none too much moisture, it is probably better to defer digging until the time of planting arrives, as the open pits are apt to become too dry in spring weather. A great point in connection with hole-digging is that of taking them out deep enough to allow the roots to be placed in their natural position, and without being bent at right angles at the bottom of the pit. When made too shallow, not only are the roots twisted to fit the hole, but the soil returned is apt to bake and crack in dry weather, or the holes will hold water in wet weather, which keeps the roots in a more or less waterlogged condition. The cost of pitting runs from 30s. to 50s. per acre, exclusive of plants, and, although this cost is high compared with slitting, it is probably the cheapest on stiff heavy ground, or soil overrun with weeds and surface growth.

Slit-planting consists in making cuts with an ordinary spade, lifting the turf adjoining them, and inserting the roots of the plant in the cuts so made. Two methods are employed—one known as the “L” and the other as the “T” system, both of which are too well known to require describing. The “L” system is much the best, as the roots can be placed perpendicularly in the cuts, without bending or twisting. The great thing, of course, is to employ skilled and careful workmen in the planting, as careless men invariably double up the roots, or neglect to tread them firmly in before leaving. The cost of slit-planting runs from 10s. to 15s. per acre, exclusive of plants, or from £2 to £3 less than that of pitting. Notching is a method employed with very small seedlings, and consists in making

a notch or hole with a sharp-pointed tool, and dibbling the plants in. It is best adapted for very rough stony ground, where the ordinary spade cannot be used, but is not such a good system as slit-planting under ordinary conditions.

Furrow-planting consists in taking out a deep furrow with the ordinary or a specially strong plough, and placing the plants in the furrow. It is merely a modification of pit-planting, in which the hole is taken out with a plough instead of the spade, and is only adapted to fairly level and deep ground, such as old arable or broken-up pasture. The cost of this method varies between pit-planting and slit-planting, or from £2 to £3 per acre, according to the size of the plants and the power required in ploughing.

The great point about all planting operations is the exercise of care in the removal of the trees. Every precaution should be taken to prevent the roots being dried or exposed to sun and wind, from the time they are lifted in the nursery until placed in their new position. Three parts of the failures which occur in ordinary planting operations arise from the neglect of this precaution, and a word of caution may also be said against the practice of leaving the plants tied up in bundles and laid in by the heels for several weeks at a stretch.

Another aid to successful planting is the employment of stout well-rooted plants with thoroughly ripened wood. In the process of transplanting, the plants have to rely upon the reserve material stored up in their tissues for the formation of new roots. Ordinary transplanting invariably destroys all those fibres or root hairs which are the active portions of the root system, and no growth can take place until these have been renewed. Another advantage of well-ripened wood lies in its power of resisting exposure with a greater impunity, and on sites at all exposed to strong winds this is an important point.

NATURAL REGENERATION.

The process of natural regeneration of forest trees is one which goes on in all parts of the world, and England is no exception to the rule. Left entirely to themselves, all

indigenous trees would reproduce their kind without difficulty, as they did before silviculture was practised in any shape or form. But most English woods contain an undue proportion of rabbits or ground game, which eat off seedlings as soon as they appear, or before they have any chance of reaching a safe size.

Another obstacle to natural regeneration in many woods is the dirty and weedy condition of the surface, owing to the thin crop of trees on the ground. Docks, nettles, thistles, brambles, bracken, grass, etc., clothe the surface of thin woods during every summer, and any seedlings that happen to come up are quickly suffocated. For natural regeneration to take place successfully, ground game must be almost or entirely absent, or it must be netted out of the area to be regenerated, as in the case of planting. Weeds and rubbish must also have been previously kept in check by the shade and density of the mature crop, or no seedlings will survive the first summer. In the absence of these two conditions, natural regeneration need not be thought of, and it is probably owing to their rare occurrence that this method of re-stocking woods is so seldom aided or encouraged. Yet, although it cannot become anything like general in English forestry, it is undoubtedly a fact that the necessary conditions do exist to a greater or less extent on every estate, and the lack of results is only due to the absence of all organised assistance in the direction described below. It is not asserted that the conditions referred to are general over a large area, or that the process can be depended upon to take the place of replanting generally; but no good reason exists why a part at least of our woodland area should not be reproduced from time to time by natural methods, which involve no expense and very little trouble.

The species adapted for natural regeneration are few in number, and these alone will be dealt with in detail. As principles which apply to all of them, it may be said that the most important are the provision of a plentiful supply of seed and the existence of a suitable seed-bed. Good crops of seed are produced at more or less regular intervals by all our common forest trees, and these depend a good deal upon the previous and current season. A well-ripened condition

of wood, due to a warm and favourable summer, tends to the formation of flower buds, while a spring free from late frosts favours the setting of the flowers and their development into seed. But, apart from climate, seed production is also encouraged by the crowns of the trees being exposed to sun and air; and this condition may be brought about by free thinning and comparative isolation of the best trees. Such a thinning is technically known as a "preliminary felling," and consists in taking out about one-half of a full crop of seed-bearing trees.

A suitable seed-bed consists in a loose and pliable condition of the surface, which allows the seed to sink easily into it, and which provides the seedlings with abundance of plant food when they germinate later on. In thick woods the dead leaves, known as raw humus, are apt to accumulate, and these afford no support to seedlings in themselves, and also prevent them from reaching the more suitable layer below. Time must therefore be given this raw humus to decay, and this can also be effected by thinning out the trees so as to reduce the leaf-fall, and also hasten the decay of previous falls by admitting sun and air. With some species, such as oak or ash, raw humus seldom accumulates, and the surface is usually in a suitable condition for the germination of the seed. In the case of beech, on the other hand, leaves are apt to fall at a faster rate than they decay, and under a heavy crop the surface may be covered by them to too great a depth for successful germination to take place. These conditions must be examined on the spot, and will vary in individual woods; but enough has been said to indicate their importance.

A few specific details regarding those species likely to be successfully dealt with by the process in question, namely, oak, ash, beech, and Scots fir, may now be given as follows:—

Oak.—Good seed years, with oak, occur on an average about every three or four years, and, as a general rule, no preliminary treatment is necessary unless the trees stand very thickly. The chief obstacle to successful regeneration is the consumption of the acorns by pigeons, pheasants, mice, etc., and it is necessary that they should be covered or

worked into the ground as soon as possible after their fall. When a large proportion of the trees can be felled in late autumn, this work itself will ensure a large number being trodden or pressed into the ground, and the majority of these will germinate at once, and appear as seedlings the following spring. For the first season or so oak seedlings will bear a good deal of shade, and the entire removal of the old crop may not be necessary until the second or third year after germination. After that time, however, the seedlings must have light to ensure their vigorous growth, and the sooner the entire crop of old timber is removed the better. During the early stages a crop of oaks should stand as thickly as possible, and beyond the filling up of blanks with plants from the thick patches or with larch or beech, little need be done for the first twenty years.

Ash.—Ash is one of the easiest trees of all to regenerate, so long as the mature trees are allowed sufficient space to produce abundance of seed, which appears on an average every second year. As is well known, ash seed does not germinate until the second year, and as the seed is not eaten by birds or animals to any great extent, it has every chance of getting worked into the ground without artificial assistance. In a mature ash wood, patches of seedlings will make their appearance from time to time if not eaten by ground game; and these should be given light by removing the old trees when the seedlings are from 2 to 3 feet high. Before that stage they are liable to be cut back by late spring frosts, and in spots exceptionally subject to these the old trees may be left much longer, provided the latter are not too wide or deep in the crown. As in the case of oak, young ash should stand thickly for the first twenty years, and gaps may be filled up with oak or larch.

Beech.—The production of beech seed in large quantities depends upon the partial isolation of the mature trees, which must be brought about by thinning in a regular and systematic manner eight or ten years before the young crop is desired. This thinning admits light and air to their crowns, and favours the development of flower buds, while the reduction in the number of stems affords the remainder

an extra supply of nourishment. Good seed years occur about every six years, when very heavy crops are sometimes produced. Although the seed is eaten in large quantities by pigeons, squirrels, mice, etc., there is always sufficient buried in the leaves, or left over, to provide an abundant crop of seedlings the following spring. The year 1900 was an extraordinary beech seed year, and the ground beneath the trees the following spring was literally carpeted with the silver and green cotyledons of the seedlings. After a plentiful crop of seedlings have made their appearance, the removal of the old crop should be gradually made at intervals of five years or so, until it has disappeared altogether. In the early stages the young beech likes shelter, and will not suffer much for the first twelve or fifteen years, after which their leading shoots will begin to grow crooked if not relieved.

Scots Fir.—This is a tree which requires little or no assistance beyond the provision of seed trees at suitable intervals, and a surface covered with heather. Without the latter it is practically useless to look for a crop of self-sown seedlings, for both grass and herbaceous growth choke them as soon as they appear. Another peculiarity of the Scots fir is its refusal to regenerate under the shade of the parent trees. The humus layer, consisting of dry or partially decayed needles, is fatal to seedlings, although they germinate on it in thousands, but on an open stretch of short heather Scots fir will come up freely, and there is little necessity to replant this tree on natural moorland, if the proper treatment is accorded it.

Two methods are practicable with this tree which would be out of the question with many. The winged seed enables it to be carried long distances by the wind, and mature trees are able to seed ground within a radius of 200 or 300 yards. The seed trees, therefore, may either be left standing at the rate of twenty or so to the acre, or the mature wood may be cut in narrow strips about 200 yards in width. In either case sufficient seed will be regularly distributed over the cleared area within a period of three or four years, and, if the conditions are favourable, a more or less regular crop of seedlings will spring up

SCOTS FIR.

ASH.

within six or eight years of the clearing of the ground. It is very probable that the best and heaviest seeds are not carried more than 100 yards at the most, and the method first described, of leaving single trees or small groups over the entire area, probably gives the best results, and should be followed as much as possible. It often happens that ground cleared of Scots fir gets wet or swampy after the trees are cut, and in such cases it is necessary to attend to existing drains, or to cut them if not already present, otherwise the growth of the seedlings will be checked, and their proper development prevented.

The natural regeneration of other species than those mentioned above is attended with a great deal of uncertainty, and it is doubtful if any good will be done by attempting it. No doubt, a large number of introduced trees ripen their seed, and reproduce themselves on a small scale whenever they meet with favourable conditions; but the crop likely to be produced in this way is invariably so small, and irregularly distributed, that its value is practically *nil*, although self-sown seedlings of all kinds are always interesting, and should be encouraged and protected whenever they occur.

CHAPTER VI

THINNING AND PRUNING

THE question of thinning plantations has probably received more attention, and been the subject of greater controversy amongst British foresters and owners of woodlands, than any other branch of the subject. In the early days of English forestry it does not appear that thinning was particularly attended to. Evelyn makes no mention of thinning beyond that of the seed-bed, and which consisted in drawing the best plants out of the thick patches in order to fill up the thin spots. This refers more particularly to the oak, which was to be thinned out to a distance of 40 feet, and "the intervals planted with ash, which may be felled either for poles or timber, without the least prejudice of the oak." This process, whatever it may be, doubtless corresponded to the thinning of the present day, but was probably not carried out in a very systematic way. Most of Evelyn's remarks, however, apply to coppice with standards, in which thinning does not play any precise rôle.

In the early part of the nineteenth century, writers on forestry appear to have held very diverse views on the subject, but no general principles appear to have been recognised concerning it. Pontey, Sang, Monteath, etc., all pay special attention to thinning, but none of them leave their readers very much wiser than they were before. Monteath believed in commencing to thin mixed plantations before the trees were more than 6 feet high, and in such a way as to remove all the firs gradually by the time the hardwoods were 12 or 15 feet, and leave the hardwoods at 10 feet apart. Pruning was then to commence, and

correct the errors of heavy thinning. In the case of pure fir woods, his own opinion was that they should be thinned regularly, although not to such an extent as hardwoods. The thinning here, however, should begin when the trees are at a height of 5 or 6 feet, and continue until they have reached a height of 20 to 30 feet, and at the time of planting ought to have been gradually so thinned that the trees shall not stand nearer than 20 feet from each other, if common Scotch, spruce, or silver firs.

Sang deals with the thinning of plantations under two heads—mixed plantations and fir plantations. The least valuable and the least thriving plants should first be taken out in the case of mixed plantations. In no case are the nurses to be suffered to overtop or whip the plants intended for a timber crop, and in bleak situations it is better to prune off the branches from one side than to remove the whole tree from the side of the more valuable species. Nurses such as larch should be retained in a certain proportion throughout the life of the plantation, but, when consisting of mountain ash or Scots fir, they should all be removed by the time that the plantation arrives at the height of 15 to 20 feet. The final distance apart at which the permanent trees should stand Sang puts at 25 to 30 feet, according to their kinds and manner of growth. Plantations of Scots fir, if the plants have been put in at 3 or $3\frac{1}{2}$ feet apart, will require little care until the trees are 10 or 12 feet high, and at forty years of age a good medium distance for the trees may be about 15 feet every way. After a certain period, perhaps by the time the plantation arrives at the age of fifty or sixty years, it should be thinned more freely in order to harden the timber.

Brown, in *The Forester*, gives a number of directions for thinning both mixed and fir plantations, which agree generally with the authors mentioned above. He draws attention to the fact that many foresters aim at giving a plantation a regular appearance, while leaving the trees as nearly as possible at a given distance from one another, without taking into consideration the ultimate welfare of the plantation. Brown, however, points out that the proper object should be

that of taking out the least healthy and vigorous trees, independent of their exact position in relation to their neighbours. Thinning should be carried out carefully in high and exposed situations, should be conducted at frequent intervals, and fir plantations gradually thinned as the trees advance in height and breadth until they are about forty-five years of age, after which they should not require disturbing.

The general idea which underlay the directions of the above authors appears to have been that of carefully attending to the requirements of individual trees rather than to the plantation as a whole. The general law which governs individual supremacy in all crowded colonies of living organisms, namely, the survival of the fittest, was ignored by them, and their efforts were directed towards the prevention of this law coming into play rather than taking advantage of it. Indeed the great mistake, from a modern point of view, that the older foresters made in all thinning operations, was due to too careful and painstaking attention to what they termed the "principals" of the crop. A certain but comparatively limited number of these (usually hardwoods) were planted to the acre, and the sole aim of the forester lay in attending to and aiding their development. Modern silviculture is more liberal in stocking the ground with the species it wishes to form the main crop, and is quite satisfied if a fair percentage of these ultimately come to maturity. It recognises the fact that length and cleanness of stem can only be attained in trees which have spent the greater part of their lives in a crowded wood, and that this crowded condition requires the constant presence of weak and partly suppressed individuals, which exclude light from the ground and lower parts of the stem, and which serve the double purpose of keeping the soil moist and free from weeds, and preventing the growth of side branches and adventitious shoots on the stems of the larger trees. The older foresters religiously removed these partly suppressed trees, and it was considered a sure sign of overcrowding when a few lower branches were killed off by shade. Any evils that arose from early thinning were supposed to be corrected, as we have seen, by pruning, while the growth of surface vegeta-

tion, which silviculture endeavours to exterminate, was not looked upon as a detriment to the growth of the crop.

Before condemning these older methods of thinning off-hand, it may not be amiss to investigate the origin of the prevailing ideas which were held so universally and for such a lengthened period on the subject. Amongst our forefathers were many men who possessed equal powers of observation to those possessed by the present generation, and it seems certain that general practices and customs did not arise without some just cause or reason. The most probable causes of overthinning seem to us to be connected with several matters associated with forestry in the early part of the nineteenth century, and may be summed up as follows:—

1st. The silvicultural requirements of oak suitable for the navy.

2nd. The influence of Scotch foresters and Scotch forestry upon English wood management.

3rd. The influence upon British forestry exercised by the extensive planting of larch.

4th. The influence of intensive game preserving in plantations.

That the silvicultural requirements of oak affected English forestry practice to a considerable extent, we know from the constant reference made to the cultivation of this tree in all the older works on forestry. Until the introduction of iron ship-building, about the year 1850, the supply of oak timber was considered of vital importance to our naval and commercial supremacy, just as the supply of English wheat was looked upon as our chief source of food. The cultivation of oak was the concern of all English planters on good land, not only on account of its suitability for heavy soils, but because it was regarded as the cream of English timber for all important purposes, while its bark was of great value for tanning. Thus we find this tree planted in all situations where its growth was at all possible, and both in the Crown woodlands as well as on private estates land was planted, if not entirely with oak, at least with the idea that this tree should ultimately become the main crop. As the value of the oak for ship-building lay

as much in its crooked branches as in its straight and clean stem, the aim of the old forester was the production of heavily branched and wide-crowned trees, and heavy thinning at a comparatively early age naturally became the rule. What was suitable for the oak was considered more or less so for other species, or possibly little trouble was taken to discriminate between their requirements in this respect. It is not at all certain, however, that excessive thinning was the universal mistake made in the old days. Crops of timber exist, or have existed within recent times, which prove that beech, Scots fir, and other species were allowed to grow up in close order, whether from design or neglect we do not pretend to say. But it is only reasonable to suppose that the almost universal cultivation of oak had a considerable influence upon the practice of thinning in general, which survived after the reasons for following it had died out.

The second cause we have given for the prevalent ideas on the subject may be regarded as savouring of bigotry, but we believe it is supported to a great extent by facts. It has already been stated in another chapter that comparatively little planting was done in England in the first half of the nineteenth century, for which reasons have been given. When the revival (if such it can be termed) of planting set in, a great change had come over the conditions of English forestry. Oak no longer held its old place, the bulk of the land which required planting was fit only for conifers, and landowners wanted trees which would form game cover as quickly as possible, while the larch had come to the front as a tree which would give a good profit in the least possible time. All these changes had their influence upon the ideas of landowners, and, when they contemplated planting, they naturally looked out for men accustomed to the altered conditions of things to do it. Brown's *Forester* probably led many to turn their thoughts to the north, to the inhabitants of which forestry is somehow supposed to be a natural gift and imbibed with their mother's milk. Scotch land agents had already crossed the border and remained across, and these gentlemen naturally recollected "Auld Sandy MacThis" or "Willie MacThat," the laird's

forester, whom they had known in their old homes, and whose sons and acquaintances were forthwith imported to teach the southerner how to plant, thin, and all the rest.

Scotch forestry differs to a considerable extent from English wood management, as most people are aware. Apart from national characteristics, however, Scotch foresters for the best part of a century had been largely devoting themselves to the cultivation of a tree which differs from a good many in its habits and requirements. For many years larch was looked upon in Scotland in much the same light as oak had been regarded in England at an earlier date. The Duke of Atholl, who did so much towards establishing the reputation of this tree, was a firm believer in wide planting and free thinning, and very probably this introduced the system of free thinning which Scotch foresters have applied to all species, more or less indiscriminately, according to the ideas of the thinner. No sooner had a plantation closed up its ranks and commenced that process of stem cleaning by suppression of side branches, than the opinion of three-fourths of the orthodox Scotch foresters in the country was that it required thinning. The idea, of course, was that an ideal plantation should consist of nothing but well-developed trees, and that the existence of weakly or partly suppressed individuals was an error in cultivation. Timber, in fact, was grown by the tree and not by the acre, and the process of natural selection was replaced by the axe and pruning saw. Probably the damage so often done by gales on the exposed sites and shallow soils of the north had a great deal to do with the fostering of this idea. Trees drawn up in a thick wood suffered terribly when once the wind made gaps in them, and quite possibly the large proportion of strong well-developed individual trees which free thinning produced, decreased to some extent the damage arising from this source. Then, again, larch and Scotch fir, which formed the bulk of Scotch plantations then, as they do now, were largely used for purposes for which cleanliness of growth and high quality were not of paramount importance, while the various uses to which larch of all sizes is put was a great temptation to thin early and freely. Both

the prevailing soil and climate tend to counteract the effect of thinning in Scotland to a greater extent than they do in England, and the same degree of thinning would have a different effect upon a high-lying plantation in poor soil in the one country to what it would on a low-lying plantation in England. The usual error of Scotch foresters, therefore, was chiefly due to a failure to discriminate between the different conditions which prevailed in the two countries, and was not altogether the fault of Scotch forestry itself.

But while Scotch foresters probably did much to introduce the modern practice of thinning, the fact must not be overlooked that the prominence given to the existence of game cover tended to work in the same direction. When the old coppice with standards was the prevailing form of silviculture, nothing more was desired by the sportsman or keeper for sheltering pheasants or ground game. But with the ordinary plantation all ground vegetation, which constitutes the most valuable form of cover, gradually disappears when close canopy is once established and the surface becomes as bare as a fallow. Perfect as such a condition may be for silviculture, it is far from the sportsman's ideal, and it was, and still is, often the forester's lot to receive orders to break up this canopy by heavy thinning, and plant shrubs or other game-cover plants below. In small woods such cover is regarded by the owner as more valuable than the timber which stands amongst it, and it is of little avail for the forester to point out the evils which follow such a course where pheasant rearing is the chief object the woodland proprietor has in view. Whether the increased value of the wood for shooting purposes compensates for the loss in quality and quantity of the timber produced, is a difficult question to decide; but one thing is certain, that the cost of replanting old woodland is at least doubled by the weeds and rubbish which accumulate during the latter half of the rotation in open woods.

The above are, we believe, the chief, and in many cases the only, reasons for the heavy thinning of woods under forty or fifty years of age, before which the trees are hardly large enough to be classed as timber or to be of much value. In larch plantations, or those in which larch has been used as

a nurse, however, thinning is often practised at an early age to meet estate requirements, and no pretence is made of regarding it as a silvicultural operation. Where poles and fencing are required for estate use, few proprietors or agents make any scruple of spoiling a young plantation in order to obtain the material required. No doubt, extreme measures are rarely taken, and the line is drawn at a point which many foresters would term "a good thinning." But, as we shall see presently, first-class timber does not result from any haphazard method of thinning, which varies between the removal of 25 to 50 per cent. of the total crop before height-growth has culminated; and it has always seemed to us a more sensible proceeding to clear a part of the plantation right off, when necessary, than to spoil the whole crop in order to obtain a few pounds' worth of poles. It frequently happens that poles of a certain size are wanted, and we know cases where the whole of the best trees in a plantation have been cut out to obtain them, leaving little but the weaker and partly suppressed individuals to stand for the crop. Such instances are only typical of the manner in which British woods are made subordinate to other interests.

The principles which underlie the practice of correct thinning are extremely simple, and if it were only possible to avoid all thinning which does not make for the ultimate good of the crop, any man in possession of them has no excuse for spoiling a plantation.

The cubic contents of a tree depend upon its length and mean transverse area. The former is produced by height-growth, the latter by stem-growth, or what may be termed ring-breadth. The object of thinning may be said to be that of maintaining these two factors in their proper proportion. With little or no thinning, and with trees of the same species and age, height-growth in a thick plantation is usually increased up to a certain period in the life of the trees, while ring-breadth gradually decreases until it reaches its minimum. The only uncertain element in this process is the difference due to individual growth, and it is upon this difference that the prolonged existence of a self-thinned plantation or group depends. All organisms living in a crowded state, and for which the available space is only sufficient

for a part of those present, owe their existence to their individual exertions, or, as it is commonly called, "the struggle for existence."

But this struggle leaves its mark on a certain proportion of those which have managed to secure sufficient space for their existence, but insufficient for their normal development. These middle-sized individuals, in the case of a wood left to itself, constitute a considerable proportion of the crop, and, when large timber is most in demand, lower its market value. If all the strongest individuals in a group or wood could be evenly and properly distributed over the entire area, the proportion of large trees would be increased, and that of medium individuals diminished, and the resulting crop would be fairly satisfactory. But when a crop is sown or planted at a very early age it is impossible to foresee the future development of individuals, and chance—that arch-enemy of uniformity—often distributes them irregularly or in isolated groups, which brings about irregular results and too large a proportion of small and improperly developed trees.

Herein lies the necessity for the interference of the forester. He must take the place of nature and decide the fate of individual trees, where there is any hesitation in taking the lead on their part. Crown development of crowded groups must be watched and encouraged by cautious thinning, while extra large individuals should be kept in confinement as much as possible. The aim should be directed towards ensuring just that degree of crown development which is necessary for maintaining the wood ring at its proper breadth, and no more. What the proper breadth is depends upon the species, soil, and situation. In the case of conifers a small ring-breadth is an advantage, as the timber made up of small rings is more durable and close in the grain. With hardwoods, such as oak or ash, too narrow a wood ring produces inferior timber, owing to the preponderance of spiral vessels in the wood. But the forester need rarely trouble himself about ring-breadth or crown development until height-growth culminates, which may be about the fortieth year on good soil and a little later on bad.

If careful thinning is not attended to at this stage, large timber cannot be expected in any quantity, while, if thinning

is done too early, coarse timber will be the result. To what extent this thinning should be carried out must depend upon circumstances, such as soil and species. On good soils, and with shade-bearers, less thinning is required than on bad soils and with light-demanders, and each species will behave differently under the same conditions. But, generally, the removal of all partly suppressed and a few of the damaged and unhealthy dominant trees in the crop will be sufficient to carry on growth until the trees approach maturity. The question of taking out suppressed trees entirely in a wood at this stage is a question which most foresters would consider too foregone a conclusion to trouble about. But we believe that such trees have not entirely fulfilled their purpose when the stem clearing of their stronger neighbours is accomplished. Their lower crowns help to keep out wind, shade the ground and stems of their neighbours, and, from an æsthetic point of view, give just that touch of variety which is needed in even-aged woods. So long as they are still healthy, their existence can do no harm, and in most cases we believe that they do a certain amount of good in the direction indicated, and are often useful in supplying sizes of timber which cannot always be obtained without breaking into younger woods.

With every care, absolutely correct thinning in any case is impossible, and reasonably correct thinning can only be practised in a plantation which has been properly planted at the outset, and which has never been thinned previously on faulty lines. Injudicious mixtures, or plantations planted at too wide intervals between the plants, can rarely be properly thinned, however painstaking the thinner may be. Correct thinning merely assists nature, and is not, as many suppose, a remedy which aims at effacing her efforts altogether. Just as the clever physician recognises that all his drugs are ineffectual in curing an illness unless they act in the same direction as the natural functions of the body, so the judicious forester sees clearly that the laws of growth must be humoured and obeyed if good results are to follow.

Take, for instance, a pure crop of seedlings of any one species, thin them out so that the largest individuals are equally distributed over the ground, leave them entirely

alone, and watch the result for forty years or so, and we have an object-lesson in correct thinning up to that age. One generation of men can rarely see the entire operation in one particular crop, from youth to maturity; but it is possible to see all the different stages in different crops or groups, and we are able to piece them together to form a whole.

Those seedlings which took the lead at the first start off will probably be found to retain that lead until they come in contact with each other. A struggle then ensues for a few years, which ends, sooner or later, in the survival of the fittest. The latter, again, go on developing until they meet once more rivals of the same size, and another struggle takes place as before, and with the same result, until height-growth terminates and puts a stop to it. The composition of the group then consists of the ultimate survivors, which maintain their position until wind or decay thins their ranks.

Such is what takes place in a wood left entirely to itself, whatever the species may be, so long as it remains in good health and is not broken into by wind. When, however, the distribution of these dominant trees happens to be very irregular, we may possibly get a number of small groups more or less isolated from one another, and in such cases each group exhibits in itself the same process of suppression by the stronger individuals as described above.

Again, the density of the mature crop—or, in other words, the proportion of individuals which have been suppressed in the perpetual struggle for existence—will vary considerably. With shade-bearers, such as beech, hornbeam, spruce, or silver fir, a much larger number will be present and a smaller number suppressed than in the case of light-demanders, such as oak, ash, or larch, owing to the partly suppressed trees of the former being able to live under conditions which would kill out those of the latter. The density, so far as individuals are concerned, will also vary with the quality of the soil and situation. On good localities the number of individuals will be smaller, but their size larger than on poor soils, owing to their dense foliage and the more rapid pushing ahead of the dominant trees. On poor soils, individuals are more evenly matched, and have a greater

capacity for weakening each other, and the struggle for supremacy, instead of being over in a few years, sometimes continues throughout the life of the plantation. Such variations will of course necessitate different methods and degrees of thinning, and it is in the discrimination between the necessities of different cases that the skill of the forester lies.

Let us glance at a process of thinning which would be applicable to a fast-growing crop of any one species, and which is expected to grow big timber, and has been planted at not more than 3 to 4 feet apart. In this case thinning is rarely necessary before the tenth or twelfth year after planting, according to the shade-bearing or light-demanding qualities of the species. At that stage the plantation may be gone through, and all rubbish, dead or sickly trees, taken out. This process is simply cleaning, and is only a preliminary to the first thinning. The latter may take place at any time between the tenth and twentieth year, according to the species. Beech, spruce, silver fir, etc., rarely require touching before the twentieth year, as close order is necessary if they are to produce clean timber. Mixed plantations in which larch has been used with oak or other slow-growing hardwoods will probably require attention first, so that the latter may not be weakened or overdrawn. The first legitimate thinning should be confined to the removal of suppressed or nearly suppressed trees, which can be removed without leaving gaps in the canopy above. Such trees will probably be of little value and scarcely pay more than the cost of cutting, but the temptation should steadily be resisted of endeavouring to make this thinning a more profitable operation by taking out larger and more valuable poles. In the case of larch mixed with hardwoods, the former should of course form the bulk of the first thinning, as the intention throughout is to render them subordinate to the permanent crop. A great deal can often be done to relieve the hardwoods by pruning the side branches of encroaching larch, without actually taking them out, and this is often preferable to forming gaps in the leaf canopy.

The following thinnings may take place at intervals of about ten years, until about the fiftieth year, when the

plantation should have attained its maximum height-growth, or nearly so.

The next point to consider is the development of the largest and most prominent trees in the direction of inducing the necessary thickening of the boles. The crowns of the trees at this stage will begin to assume a more or less flat or semi-spherical surface, which will, if encouraged by thinning, increase the leaf area. The larger the latter, the better, other things being equal, will the stem be nourished; but the actual increase of the clear bole in volume will depend upon its length and crown combined. It is generally found that thinning to produce the desired result must not be delayed too long, otherwise the development of the crown does not take place. The actual number of trees which should stand to the end of the rotation must therefore be fixed in a general way at this period of growth. With most species which are grown on a rotation of about a hundred years, a hundred and fifty trees to the acre are about as many as are able to develop properly. The selection of this number, therefore, should take place provisionally, and any smaller trees which are likely to interfere with their development be removed or marked for subsequent removal. It is just a question whether thinning at the culmination of height-growth should be carried out in one operation, or extended over a series of years. Much will depend upon the character of the species itself. In the case of oak, it is often found that severe thinning produces an objectionable crop of adventitious or water shoots, which check the growth of the tree and affect its value as timber. The thinning of oak woods, therefore, should always be carried out gradually and carefully, but with larch, beech, ash, and many other species this precaution need not be so carefully observed. Of course too great an opening out of the leaf canopy should be avoided in any case, but it is probably most economical, and more conducive to the rapid growth of the remaining trees, when a fairly heavy thinning is made about the fiftieth or sixtieth year in the life of the wood.

The effect of such a thinning is, as already said, to stimulate crown development, and this again in its turn increases the breadth of the annual ring throughout the

length of the stem. Where large timber is most in demand, therefore, this system of thinning has many advantages; but where, on the other hand, moderate-sized trees of long length and clean boles fetch as much or more per cubic foot than larger but shorter boles, it is probably as well to thin gradually and lightly to the end of the rotation.

Such a system of thinning could, we are convinced, be appropriately applied to every pure plantation in the country, provided it has been planted thick enough to begin with. This latter point is a more important one than many foresters suppose, but upon it is based the success or failure of the self-thinning system, which is either denounced or upheld, according to the personal experience of the observer. When planted too wide apart to begin with, however, the conditions are altogether different. In the first place, no real struggle for existence begins until the plants are strong enough to render this struggle a serious one for both the victors and the vanquished, and it has a far more weakening effect in the case of a plant of ten or twelve years of age than in a seedling of three or four or a stronger plant of five or six years. With trees standing 3 or 4 feet apart at, say, five years of age, the struggle begins before the side branches have acquired any great size or strength, and there is not much the matter; but, where this distance has been increased by death or other causes to 8 feet or so, one plant is able to weaken the other to an injurious extent when close order is reached, while the lower branches have acquired a strength which leaves nasty snags upon the stem for many years afterwards. The height-growth of such trees, again, will be considerably less than those crowded up from the start, as numerous examples, even in nursery lines, testify. Fully 50 per cent. of the height-growth of crowded light-demanding or deciduous trees is lacking in those which have been exposed throughout their growth, and, although height-growth is not always everything, it makes a great difference in the total value and cubic contents of the crop. With silver fir or spruce the difference in height-growth due to density alone is less marked; but here we get rough timber with an open order of growth, which is a worse feature than loss in height for some purposes.

In the case of mixed plantations, the main point supposed to be kept in view is the development of the most valuable species, or that one which is intended to form the main crop. In the average mixed plantation, we doubt, however, if even the planter himself could tell us what this is. If hardwoods and conifers are mixed, the former are, by universal custom, regarded as the principals, but for what reason none seem to be very clear, beyond the fact that they are usually longer lived. But longevity is not necessarily a virtue in a crop which is expected to pay a good rent for the land occupied, and which is probably cleared off long before its longevity is put to the test. But even supposing hardwoods are regarded as the most valuable members of the crop, it is more than likely that there are about a dozen of them to choose from, and one still has to decide which is to be the favoured one. Probably most people would say, Choose the one which is doing best; but, as most practical foresters know, it is not easy to say which particular species is doing best from an all-round point of view. If we adopt vigorous growth as our guide, then we are probably compelled to fix our choice on a comparatively worthless species, and one which has the further disadvantage of being coarse and branchy, from having dominated its neighbours from the start. If we try to select that species which exhibits the greatest number of best-shaped boles, we may find that a few individuals of most species will stand the test, but that no species in particular possesses the number requisite to make a full crop. If, again, the selection is based upon the timber value of the species, then we may find that particular species more or less crushed out before the first thinning is arrived at, unless special precautions have been taken to secure its welfare.

It is evident that the thinning of indiscriminate mixtures, on the principle of aiding the development of one species only, is practically impossible, therefore, and we are compelled to throw aside any definite system and follow the lead of the planter by thinning indiscriminately. All well-shaped trees, whatever the species, should be left as much as possible, while those which are the reverse shall be taken out. It is practically impossible to pick out all the so-called "nurses" alone, without reducing the proportion of well-grown trees

left and leaving a good many misshapen and worthless individuals, and the mixed plantation, in nine cases out of ten, will remain mixed until the end. In many cases even it is better forestry to let the conifers remain altogether, and let the hardwoods take their chance, than to leave a crop of the latter which are more or less ruined already.

On good deep soils which suit them, oak and ash may be raised in mixed plantations with fair success, and on dry soils beech will often fight its way through and succeed at the end. But the species mixed with them must be selected with some judgment, and on the lines recommended in Chapter IV. To mix Corsican or Austrian pine, black Italian poplar, etc., with oak can only end in failure, unless they are taken out at an age at which they are perfectly useless, and none with any knowledge of forestry would think of planting them together. But those with any knowledge of forestry do not plant indiscriminate mixtures.

A frequent cause of outcry in connection with thick plantations is the condition of certain crops which have been grown thickly for a number of years, and then suddenly thinned under the idea that the remainder of the trees are going to develop in the way in which those gradually thinned from the start are accustomed to do. Such a proceeding is of course usually fatal. A large number of the trees are either blown down with the first strong wind, or, in the case of oak or most hardwoods, develop a mass of adventitious shoots all up the stem, and remain in a stunted condition ever afterwards. Such cases constitute no argument against the self-thinning system, as it will invariably be found that one or the other of the conditions necessary has not existed. No one with any acquaintance of arboreal physiology would expect anything different from that which actually occurs. In the first place, the surface of the soil is exposed to the sun and wind, which dry up or carry away the humus layer that accumulates during the close order of the crop. This humus layer, or the soil immediately below it, is full of roots which supply most of the food available for the trees, and its destruction means the starvation of these roots. But the influence of sun and light upon the bare stems of the trees is, in the case of certain hardwoods, even worse. The oak is

especially injured by such influence, for its bark is full of dormant buds, which only require an excuse of this kind for breaking out and covering the stem with shoots. These shoots deprive the legitimate crown of most of its nourishment, and although they assist in adding bulk to the stem, they render its timber coarse and knotty, and induce stag-headedness on the poorer soils.

On good, deep, and fairly moist ground, of course, the effects of sudden thinning are not so marked, and in all cases they are less in inverse proportion to the previous thickness of the wood. But in scarcely any case does it do any good after the height-growth of the trees has practically ceased, except to a few of the dominant trees, which already have sufficiently deep crowns capable of further development. Trees which possess simply a tuft of foliage at the top receive, after height-growth ceases, as much light as they are capable of making use of, and sudden isolation simply means little more than an increased strain upon the roots in windy weather. To find a crop chiefly consisting of such trees, indicates either a poor soil or faulty thinning in the past, otherwise such trees would have been suppressed long before. In mixed plantations their presence is of course due to specific differences in shade-bearing power and rates of growth, and when light-demanders and shade-bearers are mixed and left to themselves, the final effect is the gradual crushing out of the former in this manner. But when things have gone so far the remedy of course is the removal of the crushed-out trees, and the remainder of the crop is little influenced one way or the other.

In thinning, much of course depends upon the class of tree required or most in demand. For small sizes, such as fencing or pit-wood, a different system of thinning is advisable from that adopted for large heavy timber. In the former case a large number of tall, clean, and moderate-sized trees to the acre will constitute a more profitable crop than trees with deep crowns and short thick boles. To produce such a crop the system of thinning adopted should closely approximate to the natural or self-thinning one. For the first ten or fifteen years the crop should be gone through and cleared of all suppressed or diseased individuals, and the trees

EFFECT OF OVER-THINNING ON BEECH.

CORRECT THINNING.

left should stand at as regular intervals apart as possible. Large crowned individuals, which exhibit too great a tendency to dominate their fellows, should either be removed, or their side branches shortened back to prevent their weaker neighbours getting overtopped, and every effort made to prevent gross individual growth at the expense of the general crop, and height-growth should be encouraged at the expense of ring-breadth. A crop grown in this way must be cut early, —about the fiftieth year, for instance, in the case of larch or fir,—for no great increase in ring-breadth takes place after that period, and the crowns of the trees are not large enough or strong enough to benefit from heavy thinning. It is, in fact, a crop which the average forester, with only one idea on the subject, would describe as ruined; and ruined it is, so far as the production of big timber is concerned, and any attempt to bring about its further development would be useless. But in pit-wood districts such crops pay a much better rental for the ground they occupy than those grown on long rotations, and in such districts profitable forestry is often a different thing to what it would be under ordinary conditions.

In all cases where thinning is contemplated, some consideration should be paid to what may be termed its side-issues. The duty of the economic forester is supposed to be that of making his woods pay; and although the production of first-class timber is usually the safest and surest means of attaining this end, there is a possibility, in more directions than one, of obtaining it at too great a cost, and thus defeating the very object in view. For instance, frequent and cautious thinnings, although undoubtedly correct from a silvicultural point of view, are seldom attended with much profit when all expenses connected with them are reckoned up. Apart from the extra trouble and expense involved in marking the trees, and making small fellings over large areas, must be reckoned the frequent damage that is done to rides and drains in taking out the thinnings, and the chronic state of untidiness which prevails where such work is going on. Where the entire management of the woods is conducted on pecuniary principles alone, untidiness may not be a serious defect, but on residential estates their pro-

prietors usually like to see things look neat and orderly, and, where thinnings are going on, this is impossible without additional expense being incurred. In a rotation of eighty to a hundred years three thinnings in the early stages and one after height-growth has culminated should do all that is necessary, and if the silvicultural condition of the woods is not quite up to the ideal, their financial results will be quite as good as when men are constantly pottering about in them. Every employer of labour knows that small jobs are always comparatively more expensive than big ones, and a thinning which takes out twenty to thirty trees to the acre can be carried out much more cheaply than one which takes out only five or ten, although the latter plan may be the more scientific.

PRUNING.

At the present day pruning plays such a small part in the plantation work of the English forester that it is a subject scarcely worth discussing. In the days of free thinning pruning was invariably called in from time to time to correct irregularities or check exuberance of growth which accompanied the prevailing conditions of open order, and which was responsible for the practice to a greater or less extent. This was especially the case in oak woods, in which the greater space allowed and the practice of growing them in coppice woods rendered that tree more susceptible than most to faulty habits of growth.

In the works of most of the old writers pruning occupies an important place. Evelyn treats the subject of pruning very fully, but it is evident that the definition of the term in his day was more or less mixed up with pollarding. Under pruning he includes all operations which lop or top trees without actually felling them, and he asserts, "'Tis a misery to see how our forest trees are defaced and mangled by unskilful Woodmen and mischievous Borderers, who go always armed with short Hand-bills, hacking and chopping off all that comes in their Way, by which our trees are full of Knots, Stubs, Boils, Cankers, and deformed Bunches, to their after Destruction." The tools of the tree-pruner he reckons

“to be the Hand-bill, Hatchet, Hook, Hand-saw, an excellent Pruning-knife, broad Chisel and Mallet, all made of the best steel, and kept sharp; and thus he is provided for greater or more gentle Executions, Purgations, Rescissions, and Coercions.” He then goes on to describe the use to which each tool should be put, and condemns the practice of leaving snags on the boles instead of cutting them close in to the trunk. Disorderly husbandmen are warned against “coveting to let their Lops grow to an extraordinary size before they take them off, as conceiving it furnishes them with more Wood for the Fire; not considering how such ghastly Wounds mortally affect the whole body of the tree.”

Further on, however, the subject of pruning as we understand it to-day is dealt with, for we are told that “it is by the Discreet leaving of the Side-boughs in convenient places, sparing the smaller and taking away the bigger, that you may advance a Tree to what determined height you like: Thus, bring up the Leader, and, when you would have that spread and break out, cut off all the Side-boughs, and especially at Midsummer, if you espy them breaking out. Young Trees may every year be pruned, and, as they grow older, at longer Intervals, as at three, five, seven, or sooner, that the Wounds may recover, and nothing be deformed.”

Coming to the publications which appeared about 1800 by Monteath, Pontey, etc., we find the subject dealt with in a more definite manner. Monteath directs the forester to commence pruning after the first thinning, when the trees are about 5 to 6 feet high, taking out all double leaders and keeping the main stems as clean as possible. Branches which grow at an acute angle to the main stem are to have stones or weights tied to their tops, and to let them hang downward, so that a cleft or forked stem may not be formed. Monteath states that “the value of the Oak, the Elm, and Spanish Chestnut depends a good deal on their being crooked, as they are all used in ship-building. If you have an Oak, an Elm, or Chestnut that has two stems, as it were, striving for the superiority, lop or prune off the straightest upright growing stem, and if a Tree that is not likely to be of much value be standing on that side to which the stem left seems to incline to a horizontal position, take away the Tree and give

it every chance of growing horizontally." Further instructions are given for making oak grow crooked, the author stating that ten crooked oaks are wanted for every straight one. As regards ash, beech, and chestnut, pruning should be done by the time the trees are 15 to 20 feet high, because when done when the trees are arrived at an advanced age, it not only has a tendency to injure them, but also leaves blemishes in them. The object with these species should be the production of straight stems. In plantations which have not been timely thinned pruning is advanced in conjunction with light thinning, and more especially are the tops of those intended to remain to be lightened to prevent top-heaviness.

"No species of Fir Tree whatever," says Monteath, "should be pruned, because in pruning they bleed so much that it very materially injures the growth of the Tree."

In a general way Monteath's views on pruning seem sound enough so far as they go, and, considering the times in which he lived, but too much prominence is given to the training of trees by pruning rather than close order. The great expense of frequent pruning operations and the difficulty of supervision on a large scale are ignored, and arboriculture rather than silviculture is evidently in the author's mind.

In 1805 William Pontey, who styled himself "Planter and Forest Pruner to the Late and Present Duke of Bedford," published *The Forest Pruner*. Pontey moralises a good deal on the erroneous ideas which had hitherto prevailed on the subject. Lawson and Evelyn are severely dealt with, but the bulk of his sarcasm is reserved for Mr. Forsyth, the royal gardener, who obtained a parliamentary grant for applying a plaster of cow-dung and other ingredients to some old elms in Kensington, and who advertised this composition as a remedy for all wounds and sickly trees generally. Nichol, the author of *The Practical Planter*, is next disposed of, and then Pontey proceeds to state his own case, which, briefly described, is the more or less universal pruning of all conifers, not merely of dead but also of living branches, up to a certain distance from the leading shoot. Pontey's chief aim was to get rid of dead knots, but he omits to mention the chief objection to artificial pruning, namely, its expense when

carried out on a large scale. Both he and Monteath advocate a great deal of practice, which would answer fairly well in a plantation of 5 or 10 acres, and with a staff of men which occasionally ran out of a job now and then. But in large woods, and in these days of dear labour, it would be better for the woodland proprietor to grow less valuable timber than to incur the great expense of extensive pruning, which depends for its proper execution upon the skill and care of the individual workman more than anything else.

Brown, the author of *The Forester*, devotes about twenty pages to pruning, and bases his arguments for its necessity on examples of neglected or over-thin plantations, and mixed woods in which hardwoods have been suppressed. As might be expected, his views are certainly more rational and up-to-date than those of the authorities cited above. He regards pruning as much an essential as thinning, and evidently considers that the two should go on hand in hand. Particular attention is paid to the pruning of oak woods, or those in which oak predominates amongst the hardwoods, commencing when the trees are from 5 to 8 feet high, cutting off all branches not exceeding two-thirds of an inch close to the stem for about one-third of the height of the tree. The large branches were then to be shortened back to within 4 inches of the stem, and all large top branches to about half their length until nothing but the leader was left. In two years' time the plantation was gone through again, and all the stumps left on at the first pruning taken off. From time to time the plantation was gone through in the same way, cutting off all for about one-third of the height of the tree, and shortening back strong shoots likely to compete with the leader.

No fault can be found with the above from a cultural point of view. But the fact is either ignored or lost sight of, that the necessity for pruning can be avoided in a great measure by silvicultural mixtures, or maintaining the crop at a proper density. The old idea was that close order meant the ruin of the crop, and a forester, even as late as forty or fifty years ago, would have been horrified at a thick plantation of forty or fifty years of age consisting of long clean poles. The usual remedy applied to such a crop would have

been an instant and thorough thinning, which in the majority of cases effectually prevented further growth, and resulted in half the trees being blown over at the first storm. With the effects of such treatment constantly before their eyes, and with the firm belief in their minds that the evil lay in the neglect of thinning rather than in the practice of it, the old-fashioned forester took the earliest opportunity of thinning out his trees to an extent which reduced their height-growth and favoured branch development to an undesirable extent. As pruning was the only remedy for this, and as free thinning was the order of the day, the former subject became a prominent feature in the work of the careful forester, until at last he believed that a good timber tree could not be produced without it.

It is quite possible that free thinning, combined with careful pruning, may produce a crop of timber containing a larger number of well-developed trees than the modern system of close order. But the forester on a large estate is rarely able, and is certainly not justified by the financial results of the work, to keep a squad of men swinging about, like monkeys, in the crowns of his trees with hand-saws or bill-hooks. In practical forestry the fact should never be lost sight of that every additional pound spent in the early stages of growing a crop of trees may be multiplied by five or six at the end of the rotation, and that needless expense is bad forestry, if nothing else.

While the above statement must be accepted as a simple fact under ordinary circumstances, it must not be concluded that all pruning is a mistake. Under certain circumstances it may prove a useful remedy for neglected or over-thinned plantations, and especially for the latter. In oak plantations, or in coppice with standards, again, pruning is an almost essential agent for producing good results; for in either case a certain amount of open order must be given the trees, and this leads to irregular growth and coarse side branches, which pruning alone can correct. Even in such cases, however, we believe such work should only be attempted on trees under fifty years of age, and that the bulk of it should be confined to those under twenty-five. To carry out pruning operations on old or middle-aged timber on a large

scale is not only expensive, but rarely leads to any satisfactory result, for it is only when a tree is comparatively young that its growth can be altered or improved by pruning. No harm can be done by taking off dead branches close to the trunk, and in plantations under middle age, which have been allowed too much room at the start, and have closed up about the twentieth year, a large proportion of these will probably exist. Apart from the benefit the timber derives from the removal of these branches, the appearance of the wood is immensely improved by it, and it is only a question of time and expense whether such work should be carried out generally or not. Plantations grown thickly and properly from the start rarely need it, and it should be regarded as an exceptional remedy for past neglect, rather than an operation necessary for the successful growth of all timber crops.

CHAPTER VII

SELLING, VALUING, AND MEASURING TIMBER

SELLING.

It is rarely within the power of the estate owner to create a market for his timber after he has grown it. The demands for particular kinds of timber often vary in each district, according to the particular trades and industries. Other kinds, again, vary little in value, except as influenced by situation and distance from market. In the one case there exists a local or limited demand, or want of it, as it may be; in the other, the timber can always find a market, but the price may vary according to period or locality. The staple timbers in the English trade are oak, ash, elm, and larch. These four species have a recognised position in the market, and will always sell at a price of some kind. Other species may sell if the right kind of buyer can be found, or a special market exists for them in the locality. The distinction between these two classes of timber is important when it comes to the question of selling them, for it is evident that a method which will sell the one will not always sell the other. In the one case, an announcement of the fact that the timber is to sell is usually sufficient to bring forward buyers; in the other, special means should be taken to bring the timber to the notice of the particular trades or merchants likely to find a use for it.

Of the various methods of selling English timber, three stand out fairly distinct. They are—*1st*, Sale by private treaty; *2nd*, Sale by tender; *3rd*, Sale by auction. The aim of the seller in each case is, one may assume, to get as much money in exchange for his timber, and the aim of the man

who buys it to get as much timber for his money as possible. Whether each party succeeds in his aim depends upon a variety of circumstances, a few of which we will endeavour to deal with.

SALE BY PRIVATE TREATY.

This method of selling timber is, in nine cases out of ten, the most satisfactory of any if the man who sells knows the value of his timber, and the man who buys is prepared to give its fair market price. By selling in this way, the owner can make his offer to, or accept one from, a respectable timber merchant who has a reputation for honesty and stability. He can make special arrangements for cutting or removing the timber from particular spots to suit the convenience of both parties, or can alter his arrangements to a reasonable extent should the occasion arise, and any difference of opinion can be dealt with privately, and probably amicably. He is able to transact his business with the minimum risk, and the avoidance of dealing with men he knows nothing about. He can withdraw from or add to his original offer in order to suit his own or the purchaser's requirements if desirable, and if subsequent events render it advisable. He sells his timber in full knowledge of the price he is to get for it, and he runs no risk of exposing himself to "rings" or other devices for buying timber below its market value.

The offerer has the opportunity of bidding for the timber at a price which will enable him to do something with it if he gets it, and, if he really wants the lot, it does not answer his purpose to bid too low, and run the risk of having another man called in to make him look a rogue or a fool. If he bids fairly he will give, in all probability, a sum fully equal, *on the average*, to that which would be obtained for it if sold by auction. In short, selling by private treaty is free trading in the fullest sense of the word, and is certainly the best method of disposing of small lots of timber at irregular periods when no regular markets exist, and which is growing on land which is easily damaged by careless felling or removal.

SALE BY TENDER.

This form of selling is usually adopted with standing timber only, and aims at securing the competition which exists in the case of auction sales, together with the opportunity of withholding the timber if a good price is not offered for it. The owner usually announces that he does not bind himself to accept the highest or any tender, and this condition very often ends in no sale taking place after all. The success of sales by tender depend greatly upon the class of timber and the quantity offered. If of first-rate quality, close to good roads, and offered in moderate lots, competition for it will usually be keen. If, on the other hand, it is awkwardly situated and of indifferent quality, *bona fide* tenders are often only made by one or two men who have arranged between themselves what they are going to give, and agree to divide the timber between them if they get it. If in too large lots, again, it limits tenders to men with the necessary capital, and thus reduces competition. Like auction sales, it is very subject to rings, and if all the tenderers work together there is little prospect of a fair offer being made.

The chief objection timber merchants have to tendering for standing timber is the uncertainty of the result. There is often a strong suspicion that the owner or agent does not intend to sell at a fair price, but invites tenders merely to draw purchasers into a revelation of their own ideas of the value of the timber, and use the information thus obtained in some other direction. After making a more or less careful valuation, which probably involves time, trouble, and expense, it is an unsatisfactory termination of the matter to the tenderer to find that no tender is accepted, or, if one is accepted, no statement made as to its amount. When the tenders are opened in the presence of all parties concerned, this suspicion is doubtless removed; but there may be good reasons for not adopting this course in all cases, especially when the highest bidder happens to be a doubtful individual.

One advantage of selling standing timber by tender is

the option it gives the owner of allowing it to stand should no suitable offer be made. When the timber is already cut, the owner has no alternative but to dispose of it in some way. Apart from the fact that it deteriorates more or less rapidly according to species, the nuisance of felled timber lying about in woods, fields, or parks is considerable, and is a constant source of annoyance to proprietors. Unless the owner is fully prepared to take the market price for the time being, therefore, it is better policy to offer it standing; and if he knows his buyer and his buyer knows him, it is a very simple matter to arrange for the price being fixed in such a way that both parties get fair play. It is often more satisfactory to offer it to one man and accept his bid if at all near the mark, than to go to several, who may, for all one knows, be in league with each other, and agree not to give more than a certain sum for the lot.

On the other hand, the price offered for standing timber is rarely so high as for the same timber felled. It is not the actual cost of felling, as this is always allowed for in the top and lop, and can be easily estimated, but rather to the uncertainty which exists as to the quality of the standing timber and the damage which may be done to it in felling. Oak may turn out shaky, elm unsound, ash black-hearted, or be split in felling, while holes and defects in the upper part of the trunk are not so easily seen, and the extent of the damage gauged, as when the timber is down. Then, again, large timber usually looks bigger when down than when standing, although a practised valuer of standing timber may not be misled on this point. The estate owner, again, can usually fell timber at less expense than the timber merchant, for the former has usually his staff of woodmen on the spot, while the latter is frequently unable to get local men to undertake the work, but must employ men from a distance and pay their travelling expenses, lodgings, etc., in addition to higher wages. Where a regular staff of woodmen is kept, therefore, it usually pays best to let them cut the timber, even if the merchant buys it standing, as the removal of what is sometimes one of his worst difficulties will often lead him to offer an additional price for the timber which will more than cover the cost of felling, although the latter has been allowed for.

On small estates, or in outlying districts, it may be more advantageous for the owner to sell the timber as it is and be done with it. To employ hands specially for the job often proves unsatisfactory, for they are either unskilled in the work, or demand wages out of all proportion to the value of the timber, and, before the work is over, the owner begins to think it would have paid him better to have kept the timber as it was. The comparative advantage of selling timber standing or felled therefore depends a good deal upon the necessity or otherwise for selling it. When ground must be cleared, or money is wanted and sale is inevitable, the chances are that the timber will sell better when cut than standing, as the price offered for standing timber is usually lower, to allow for risks in falling and for defects which cannot be detected until the trees are down. But when the timber is only offered in order to take advantage of a possible rise in the market, or to clear off a certain quantity of mature or superfluous stock, it is probably as well to offer it to some respectable timber merchant as it stands, and to accept a fair offer if such is forthcoming.

SALES BY AUCTION.

The method of selling timber by auction is probably the most universal of any adopted at the present day, and is a method which primarily commends itself to most people. It is supposed to assure to the proprietor any pecuniary benefit attaching to competition amongst buyers, and enables him to obtain the highest possible market price for the timber offered. It is a method which enables large quantities of timber to be disposed of amongst a large number of buyers in one day, and which by other methods would probably involve a great expenditure of time and labour, unless the timber were offered to one or two large buyers only. It is a means of getting rid of timber or other produce for which there is little demand, at some price or another, and when a lot has to be cleared at any price, it saves the trouble of hunting up unwilling customers, whose only motive of purchasing is the chance of getting it cheap and practically

on their own terms. Many proprietors and their agents doubtless believe that by selling by auction they avoid the risk of dishonest dealings between their employees and timber merchants, either in the shape of bribery or lenient measurement. Timber merchants, in their opinion, are not over-scrupulous in their practices, while foresters and woodmen are easily "got at." Whether this is so or not we may leave an open question, but we think that general experience proves that one cannot guard against fraud by any system, and that servants are generally what their masters make them.

But taking the supposed advantages of selling by auction in the order in which we have named them, it may be worth while inquiring into the extent of their reality or otherwise. The benefit accruing to the timber owner from competition amongst buyers would seem to be a foregone conclusion in any case. When each intending purchaser knows that his only chance of obtaining a particular lot depends upon his bidding higher than anyone else, his means of obtaining that particular lot appear to be obvious. No doubt, with a keen competition existing, either owing to the comparative scarcity of timber just at the time or to its superiority, the chances of obtaining good prices in that particular manner are good, and competition does result in obtaining a higher price than would be obtained in other ways. But with ordinary timber, and at ordinary times, the fact that more than one man is bidding for a particular lot is by no means an indication that the respective bidders are competing against one another. In all probability a quiet meeting of the majority of the buyers took place a little earlier than the sale, and amicable arrangements were made whereby each participant in that arrangement was guaranteed the requisite quantity of timber at the lowest possible price. If persons outside that arrangement want lots included in it, they must be prepared to fight this combination of buyers on the latter's terms, and, if the former happen to be select but limited purchasers (and this is generally common knowledge), they may be able to get their timber on reasonable terms or the reverse, according to the estimation in which they happen to be held by the "ring." They may be run up to exorbitant figures (in which

case the seller benefits), or they may be allowed to have it at their own price after a little weak bidding for the sake of appearances. Generally speaking, however, running up prices in order to spite an opponent is dangerous work on a large scale, for it may end in the biter being bit when the hammer falls to the runner-up, and the presence of two or three good outsiders is usually sufficient to break up an average ring.

But the fact remains that with little or no competition, as when trade is bad or indifferent timber is offered, auction sales usually result in lower prices being obtained than by private treaty. When timber is put up for sale, no alternative exists but to take what is offered or refuse it. Where a price is offered much below its fair market value, no doubt it is perfectly justifiable to reserve it, and more especially if the sale is only held occasionally and at long intervals. No intending purchaser has a right to complain of a lot being withdrawn when no offer is made which is at all approximate to its market value. The same rule is applied to all sales by auction, unless expressly held on the condition, "without reserve." But it is, nevertheless, a fact that the discovery or admission that a reserve is placed on timber sold in small and numerous lots, tends to check free bidding more than anything else. There is an impression that an auction sale should be conducted on a give-and-take principle, and that the buyer should have the same chance of securing a cheap lot when competition is bad, as the seller has of securing a good price when it is good. There is probably a good deal of sound reasoning in this argument, and the timber proprietor who sells annually by auction, without any reserve, has usually better reasons for being satisfied with the results than one who places a reserve on every lot and insists upon the bidding reaching it before a sale is effected. The explanation of this is not far to seek. In the one case, men come with the intention of purchasing or attempting to purchase; in the other, they usually take their cue from one another, and in many cases attempt to spoil the sale in order to get cheaper bargains later on. The owner who wants to get a definite price for his timber should offer it standing, by tender or by private treaty, and, when his expectations are not realised, the timber can be left until prices improve.

When cut, he is at the mercy of the buyers if a sale is compulsory, and to offer it by auction, and then not sell, practically amounts to the non-fulfilment of a bargain. Of course, where the auctioneer is met by a large and determined ring, he should both have the power and the nerve to reserve the timber if necessary, but not so long as *bona fide* bids are made, and the timber sold according to the state of the trade and its quality.

The fondness for auction sales is greatly favoured by the glowing reports which are often inserted in the local newspapers by auctioneers themselves. Such reports are absolutely useless for enabling one to judge of the prices made, owing to the measurements given being so often inaccurate, and as much as 20 per cent. below the actual contents of the lots, while the average price for the whole sale is rarely given. Most timber merchants and foresters know enough about such reports to prevent any delusions being entertained on that score, but it is to be feared that proprietors and agents form erroneous opinions as to the current value of timber upon perusing them. If measurements are given at all in catalogues or when putting up the lots, they ought to be genuine and as accurate as circumstances will permit, otherwise no good purpose is served by giving them at all. Apart from their tendency to mislead the owner, they also tend to reduce the amount actually bid for the lots by those who base their biddings on catalogue measurements alone, owing to want of time to measure the timber personally. In such cases, instead of the owner obtaining the fancy prices reported, he really gets less than its fair value, for only those knowing the exact cubic contents of each lot will bid up to its real value. Of course it is only auctioneers that profit by such misstatements, and there is rarely much fault to find when the timber is measured by the estate staff and not by the auctioneers themselves.

But, from a forestry point of view, the chief objection to annual auction sales is the temptation the forester has to "make them up." Good timber always fetches a good price and creates spirited bidding. Inferior stuff, on the other hand, meets with a dragging sale, and timber merchants are apt to complain when the quality is not up to the average. Most

foresters, therefore, or agents who mark the timber themselves, generally attempt to get as much good timber into their sales as possible, and feel tempted to leave out a good deal of rough and indifferent stuff which they know will sell badly. From the auctioneer's and timber merchant's points of view this is all right, and is also a good thing for the current year's accounts of the estate. But it often means that the woods are gradually ruined by over-cutting, and the constant thinning out of the best trees, in order that the one year's sales may be as good as its predecessor's. Such a course can only have one ending; and it is a well-known fact that, on all estates on which an annual sale has been held for many years, the quality of the standing timber gradually deteriorates. Old ornamental timber and young woods may not be much affected, but the quantity of marketable timber gradually decreases at a faster rate than it matures, and the woods eventually consist of either young trees or stunted and decrepit individuals which ought to have been taken out years before. In the case of woods properly and systematically worked, this of course need not be the case, as then each season would bring its annual quota of mature timber to the axe. But how many estate woodlands are properly worked may be seen by referring to Chapter II.

Where the rubbish can be worked up on the estate or sold privately to advantage, the sale of the best timber by auction might be a judicious proceeding. But when the proportion of good to bad or indifferent is about one of the former to three of the latter, as is usually the case, this is not an easy matter. Auction sales depend for their success upon keen competition, and keen competition depends upon the quality and quantity offered and the state of the trade. Small sales mean local buyers, who do not as a rule cut one another's throats, although it occasionally happens that a small man on the spot will give a price for one or two lots which ordinary buyers do not attempt to reach. But the fact remains, that high averages at auction sales can only be reached by good quality offered, and few proprietors are able, after all is over, to say that they have received more for their timber than it is worth, although they may have received, as

already said, a higher price for one or two lots than they might have obtained by selling privately.

Auction sales are probably best adapted for medium-sized estates, which only cut for sales about once in five or ten years, and which contain a quantity of large park or hedgerow timber likely to attract buyers for twenty or thirty miles round, and which can be cut at any time. Brisk trade and high markets can then be taken advantage of as the opportunity arises, and without disorganising the working of the estate, as would probably be the case if plantation timber or coppice were cut to suit the market instead of the woods. Such sales can often be made up of little besides prime timber, and, if held at the right time, usually go off well. It is, however, an important matter to select a suitable time for holding them. A few weeks may make all the difference between good prices and bad, and it will generally be found that better prices are obtained at the beginning than at the end of the year. At the end of the year all trade is usually dull, and especially the trades with which the timber merchant is usually concerned; while, with bills to pay and meet, and others outstanding, there is a general disinclination to launch into fresh buying until a new year has commenced and the result of the old year's working is known.

Of course, where material has to be cleared at any price, as in the case of under-wood, an auction sale may be the best way of disposing of it; but, even in such cases, private bargains may often turn out more advantageous than auction sales, for most merchants are more inclined to bid well in secret than in public.

Where an estate owner has a fall of timber to dispose of annually or periodically, and which varies in quality and quantity from year to year, no better method of selling it exists than that of coming to an informal understanding with a good local timber merchant, and letting him take the lot at so much per foot, according to quality and state of market. Such men do not offer extravagant prices for timber as a rule, but they are generally willing to pay an average price, which equals, if it does not exceed, that which would be obtained by auction, taking one year with another.

All the expenses of auction sales are avoided, and also the temptation to obtain high prices by over-cutting, or undue selection of the best timber. The top prices of the saleroom may not be reached, but, on the other hand, the low prices of inferior lots (which auctioneers are careful not to mention) are rarely if ever touched, and the owner knows beforehand what he is getting for his timber. As already hinted, the success of this method of selling depends a good deal upon the honesty of both the timber merchant and forester, or whoever measures for the owner. A certain amount of dishonesty may be practised by a certain class of men; but if proprietors generally paid more attention to the status and reputation of the timber merchant they dealt with and the forester they employed, and were less tempted by high prices without any obvious reason for their being given, and cheap but incompetent men, dishonesty on either side would soon be a thing of the past. In these days of keen competition timber merchants cannot afford to buy rashly where they pay promptly, and a rash purchaser is often a slow payer, or otherwise he gets an advantage in some way or another which does not appear on the surface. On the other hand, it often happens that a merchant will pay the outside value for timber sold to him privately in order to make sure of getting it, and save the bother of buying in small lots or at a greater distance.

As a general principle of successful timber selling, it may be said that the encouragement of good local and regular buyers, as far as possible, is sound policy. It is upon them that the stability and steadiness of the market depends, and they can make use of inferior material which a man from a distance would not trouble about. To deprive these buyers of their regular supply for a slightly higher price from an outsider and temporary purchaser, does more than anything else to spoil the timber sales on an estate; and the quicker this principle is recognised the better for both the timber grower and merchant.

VALUING.

The attempt to ascertain the value of timber is an undertaking which all men connected with the growing of it are called upon to undertake at some time or another in their career. Whenever an estate or part of an estate changes hands, the timber standing upon it is invariably taken over at a valuation, and in such cases the valuation is usually made by a professional valuer who has no direct interest in either the seller or buyer. The methods of valuing adopted in such cases we do not propose to discuss. Each valuer has his own particular method of doing his work, the merits of which invariably depend upon one factor, namely, experience. Without experience no man can be called an expert valuer, for the irregular shapes which certain kinds of trees take on, and to which no set rule of measuring will apply, render judgment as important a feature of the work as careful measurement.

But coming to those cases in which the forester is often employed, namely, the valuing of either standing or fallen timber for immediate sale, a few words may be said. Apart from the actual measurement of the timber, which will be dealt with presently, the question of its value depends principally upon three factors—*1st*, its size; *2nd*, its quality; and *3rd*, its situation as regards the nearest road or railway station. The size of timber affects its value in varying degrees, according to species and local demand and manufactures. Small, but long and clean larch, for instance, will prove as valuable as larger but coarser timber in most districts. Pit-wood of moderate dimensions, again, will often make more money per cubic foot than heavy timber, which is more difficult to handle, and which means more weight without any compensating quality. Beech in a chair-making district is also another instance of small or moderate-sized timber making as much per foot as large, especially if the latter happens to be coarse and branchy. On the other hand, oak, elm, or ash, if sound and clean, are worth considerably more when large than when small, for certain purposes if not for others. As a general rule, however, a size is reached in the

case of all timber which is accompanied by no increase in value, and a quarter girth of 17 to 24 inches is large enough for anything. Very heavy timber is not only more difficult to handle and convert, but its purchase is also a more risky speculation, as none can say what defects lie within its bark, or, if standing, what damage it will sustain in falling.

But the most important factor in the value of all timber is its quality. What quality means in all cases is not very easy to define, so much depending upon the particular purpose for which the timber is wanted. The most important points in timber are generally the length of the trunk and freedom from coarse knots in the bole, and absence of all decay in the heart or sap-wood. In the case of oak, freedom from cup, ring, or heart-shake is the usual criterion of good quality, and shaky oak is always looked upon as an unprofitable article. In ash the colour of the heart-wood is the principal feature upon which its value depends. If white throughout, it can rank as first-class, but, if black or discoloured by premature or normal decay, it has lost its toughness, and will only make an indifferent price. With beech, cleanness and length of stem is the quality most esteemed, and the same may be said of elm, although in the latter a few branches are always looked for.

With conifers in general, length and cleanness of bole are the most desirable features, and the more so the greater the tendency of the species to produce side branches—spruce and silver fir, for instance, if branched to the ground, being almost unsaleable. With larch, soundness at the heart is probably the most desirable quality, but one which is very rare in most soils after a certain age. It is evident, therefore, that the value of different species does not always depend upon the same factors of quality, and that a factor which is all important for one species has no influence upon the value of another.

The third point upon which the market value of timber depends, namely, the position in which it happens to be standing or lying, is an important one, but one which is frequently overlooked by those with little experience in handling it. In the case of a bulky article, like timber, growing in many cases on soft or broken ground, and at a considerable distance

from a hard road, the cost of transport is an important item in the expense of its conversion. In the case of large timber, several tons have to be moved in one piece, and on bad ground the motive power required to effect this is about double of that wanted on a hard road.

In places where ten or a dozen horses are necessary to get out an average load, none but the big timber merchant possesses the necessary teams and tackle, and this means that the competition for such timber is confined to one or two men, who have things practically in their own hands as regards price. Such men are, of course, entitled to make due allowance for the difficulties of removal, but the fact that they are the only persons, perhaps, within a radius of twenty miles in possession of the necessary tackle and motive power is not lost sight of, and the price is regulated by them accordingly. In the case of smaller stuff its position may not affect its value to such an extent, but it still has a considerable influence upon it. Deep hollows or ravines, out of which no proper road exists, and swampy and rotten ground, such as peat or wet sticky clay, always tend to depress the market value of timber lying in or on them, for the cost of labour in such cases is often doubled, and the wear and tear of horse-flesh and harness, etc., greatly increased.

While such considerations on the part of the purchaser have to be allowed for, however, it is impossible to predict the exact effect they will have upon the price obtained for the timber. Individual purchasers are apt to regard such matters differently; and, while one may lay great importance upon the existence or absence of convenient roads, and upon the facility with which the timber can be moved, another will treat the whole matter as a secondary consideration, and as one of those details inseparable from the home timber trade.

The only reliable valuation which can be made of timber, either standing or lying on the spot where felled, is one based on general and local experience. The valuer must not only know the characteristics of good quality timber and the use to which different species are put in the trade, but he must also have some knowledge of the conditions of the local timber trade to which the stuff will be offered. Every

locality has its special features in this respect, and these often make a difference of as much as 6d. per foot in the value of those species which are of minor importance, and which may be in demand in one locality and not in another. The staple timbers of the home trade, such as oak, ash, elm, beech, larch, etc., vary comparatively little, and such variations are chiefly due to the position of the timber and its distance from a consuming centre. When lying in a favourable place for removal, and within five miles of the purchaser's sawmills, the cost of delivery ought not to exceed 3d. per cubic foot, and this sum may be fairly allowed off the maximum or delivered price for sound timber. But when badly situated, and at a considerable distance from the consuming centre, the cost of delivery may be doubled or trebled, and may even reduce the selling price to a nominal figure. All this is a matter of judgment for the valuer when fixing what is considered a fair price, and if he can get within 2d. per foot or so of the sum actually obtained he does not do badly.

But in the case of less common species, such as Scots fir in a hardwood country, beech in a fir country, or such species as alder, sycamore, horse-chestnut, etc., his valuation may be a long way out of the price actually obtained. In such cases everything depends upon the right class of purchaser being forthcoming, for the man who has an immediate use for such species can afford to give double the price for them as another who buys on speculation only. Herein lies the importance, as stated elsewhere, of growing any kind of timber in fairly large quantities. A lot of 10,000 feet of any timber which is used at all is sufficient to bring the user of that timber from a distance, for the quantity offered is sufficient to pay him for the trouble of looking at it. But a small lot of 200 or 300 feet, in the absence of any local demand, will only be bought up at a nominal price, and on the chance of being resold at some time or another. The valuer of such lots, therefore, must trust a good deal to chance, for he has little upon which to base his estimate.

A mistake often made by proprietors and agents is that of valuing their own timber on the strength of reports of

sales of timber on neighbouring estates, as already referred to. For these to be of any value at all, the timber concerned must be personally inspected and its quality compared with that to be valued, otherwise the mere statement of price per foot is valueless. But, over and above this, the fact must be recognised that auction prices by no means necessarily vary with the quality of the timber for which they are given. The tactics of the auctioneer, the possibility of "rings," and the personal feeling which may underlie the bidding for particular lots, tend to render auction prices anything but safe criterions of the local value of timber, and the owner or agent who sells or expects to sell at a similar rate is likely to be badly taken in, or grievously disappointed, as the case may be.

MEASURING STANDING TIMBER.

To the uninitiated there is always something mysterious about the measuring of standing timber. It is a difficult matter to understand how the height, girth, and cubic contents of a standing tree can be ascertained accurately enough for sale purposes, without going to the trouble of employing a ladder and other implements, which necessitate several assistants and a considerable expenditure of time. Yet practical timber growers no more think of employing a ladder to ascertain the height or girth of a tree, than an old horse-dealer thinks of employing a vet to certify the soundness of every horse he buys. In both cases instinct and the law of averages are depended upon for satisfactory results; and if a tree is occasionally reckoned at more or less than its true contents, or a screw is taken for a sound horse, it is considered better to run the risk than to go to the extra expense which continual verification would involve. No doubt, if a valuer had only one tree to measure, or a dealer had only one horse to buy, common sense would dictate the exercise of a little extra trouble and care in preventing mistakes. But when large numbers have to be dealt with, necessity knows no law, and absolute accuracy is neither expected nor obtained. We have heard, it is true,

some experts assert their ability to estimate the contents of a standing tree to a foot. Such statements may be taken for what they are worth, and be at once put down as idle brag. By mere chance anyone can guess the contents of a tree, and the guess may turn out identical with the result of subsequent measurement. But we never heard of a timber valuer of any experience pretend that mere ocular measurement was superior to that effected by string or tape and rule. Everyone knows, as a matter of fact, that the measuring of standing timber is not adopted in cases where accuracy is of paramount importance, nor is it ever adopted as a final estimate when the seller has the opportunity of measuring it after being felled. Of course, much depends upon the class of timber to be measured. For all practical purposes some trees can be measured as well standing as felled, especially if the fall in girth allowed can be verified by one or two felled trees. But with large-headed and heavy hardwood timber, such as that found in parks or hedgerows, and which contains as much timber in the tops as in the stems, the measuring of the trees standing is quite a different thing to that of measuring them down, and the former can only be considered approximately correct at the best.

But supposing that a quantity of timber must be measured while still standing, whatever the reasons may be, the usual method of doing it may be described as follows:—The measurer has usually two assistants, one with a girthing tape, and the other with a rod 20 or 25 feet in height. The measurer takes his stand about 50 feet from the tree, the assistant with the rod places the latter upright against the stem, while the other man runs the strap round the bole about 5 feet from the ground. The measurer judges the total height of the measurable stem, by estimating with the eye the distance between the top of the pole and the point at which the bole ceases, and adds that to the height of the rod. The mean quarter girth is estimated by deducting so many inches from the quarter girth obtained at 5 feet. The number of inches deducted depends upon the height of the bole and its taper, and varies from 2 to 6 inches. Short stems and mature timber fall

off less than long and tapering boles, but with ordinary plantation trees a drop of 3 inches on a bole of 20 feet in length is usually sufficient, allowing an extra inch for every additional 10 feet of bole. With cylindrical boles, such as those of mature trees, which have been drawn up closely in their youth and have laid on wood fairly evenly for some years, 3 or 4 inches is usually the maximum that should be allowed, and may even be as low as 2 inches in some cases; while, on the other hand, large park or hedgerow timber, with buttress-like projections reaching well up the bole, should have a wide margin allowed for the drop in girth—sometimes as much as 12 inches. It is apparent that a slight error in judgment, in the case of a large quarter girth, may make a considerable error in the cubic contents. For instance, the difference in the cubic contents of a tree 40 feet long by 24 inches quarter girth, and another of the same length but 25 inches quarter girth, is 20 feet. Yet such an error may be easily made in allowing for the drop or in estimating the quarter girth with the eye, and the boast that a tree can be ocularly measured to a foot is obviously absurd.

If the measurer of big standing timber can get within 10 per cent. of its true contents, after allowance has been made for defects and damage in falling, etc., he does not do badly, although many may not admit their liability to such an error. Of course, one frequent source of disparity between the estimated contents of standing and the actual contents of felled timber lies in the absence of any clear definition of measurable timber. It may be said that nothing is timber with a diameter less than 6 inches. But this rule could hardly be applied to small larch or ash, with which perhaps half the entire length of the bole falls below this size. Large and rough tops, on the other hand, often have a considerable diameter, and yet are of no value as timber, while in another case smaller but cleaner tops may possess almost as much value as the bole. The prevailing practice is to ignore tops altogether in valuing standing timber, but in the case of large trees this always seems to us to allow the buyer too wide a margin for the cost of felling. The tops of a large oak, ash, or elm often contain from 50

to 100 feet, and are worth at least £3 or £4. To leave such tops out of account altogether is rather too generous a proceeding on the part of the seller or valuer, and we think that at least half the quantity of timber in the tops might fairly be reckoned in with the butts, and still allow the buyer sufficient to fell the trees. On the other hand, it must be borne in mind that heavy tops are invariably broken and splintered a good deal in throwing, and this renders a liberal allowance desirable, if not imperative, if purchasers' views are to be met.

CHAPTER VIII

THE HOME NURSERY

ON the majority of wooded estates throughout the country a home nursery either exists, or has existed in some form or another for many years. It may take the rough-and-ready shape of a patch of ground in a corner of a wood enclosed by a bit of wire netting, and used for three or four years at the longest, or it may consist of the more elaborate kind characterised by intersecting hedges and gravel walks, in which nursery stock has been raised and grown for many years. In the one case we have what is called a temporary nursery, which is generally used to bed out young trees which have been bought in from a public nursery for immediate planting, but for which time was insufficient or weather interfered with the original plan. Such nurseries, of course, are simply a means of keeping alive plants which would otherwise perish, or become useless in the course of the summer, and any ground which can be protected from ground game, and on which rank rubbish can be kept in check, will answer for this purpose.

But the formation and management of a permanent nursery is a more complicated business, and requires a little more consideration. In the first place, it is necessary to glance at the advantages which are derived from it in the shape of acclimatised or cheaper trees and shrubs, and, in the next, at the trouble and expense of raising seedlings and young plants on a small scale.

The advantages of a home nursery were probably much greater a hundred years ago than they are to-day. At the former period the number of public nurseries in the country was comparatively small, and those that existed carried on the raising of ordinary forest seedlings on a much

smaller scale than is usual to-day. Planting operations were not conducted on a large scale, and the sowing of acorns was more often the rule than the planting of seedling oak, this tree being the most important species at that time. Facilities for the rapid conveyance of trees to all parts of the country were not then so numerous, and estate owners were thrown more upon their own resources in the way of providing young trees for their parks and woods. The "seminary" occupied an important place in the older system of woodland economy, and a considerable part of the works of all the older writers on forestry is taken up with a description of collecting and sowing seeds and the propagation of plants.

But at the present day all this has been changed to a great extent. The development of public nurseries, the increase in the number and use of species which only ripen their seeds in large numbers abroad, and which rarely pay to procure and raise on a small scale, and the means of rapid transit from one end of the country to the other, have all tended to minimise the importance of the home nursery, and to make the average estate more and more independent of it. Still, good reasons yet exist for the maintenance of home nurseries on a moderate scale, and we will endeavour to see what they are.

It is a well-known fact that the chances of successful transplanting are largely increased by the speedy transfer of the plants from their old site to their new. The root hairs and fibres are easily destroyed by exposure to sun, wind, or dry air, and this is especially the case in spring, when the air is drier and the sun increasing in power, and the roots of most trees or seedlings are covered with young root hairs, or are beginning to make their new roots. When plants are raised in a distant nursery, packed or tied into bundles, and conveyed by rail or waggon for long distances, the chances of injury from this cause are greatly increased. Careful handling and the absence of all delays on the road do much to reduce these chances to a minimum, but still they do exist to a greater or less extent, and their effect is seen in the percentage of deaths which follow or accompany ordinary planting operations.

These deaths or failures are of course much more common with some species than with others. Larch and deciduous hardwoods generally bear root exposure with much greater impunity than the majority of conifers. It is a well-known fact that several of the pines, such as Austrian or Corsican, are often destroyed by transplanting under ordinary conditions; and this we are perfectly convinced is greatly the result of root exposure, although their mutilation in the process of lifting may also have something to do with it. But in the case of all species it is a well-known fact that careful avoidance of root exposure is the best means of securing successful transplanting, and this is rendered much more easy and simple when a mile or two separates the nursery from the planting ground, instead of a hundred miles or so. It is in this respect that the existence of a home nursery proves so useful. Trees can be lifted to-day and planted out to-morrow, and no unforeseen risks of delay need be encountered, and with delicate species this may mean the saving of from 20 to 50 per cent. in respect of losses during the first season.

The general idea which prevails in connection with a home nursery is that a great deal of expense is saved by buying in two-year seedlings and growing them on for two years, instead of buying trees old enough to plant out at once. The difference in the cost of "two-year seedlings" and "two-year seedlings two-year transplanted" stuff varies from £1 to £3 per thousand. On an estate where from fifty to a hundred thousand trees are planted out annually, this means a difference of probably £150 in the nurserymen's bills, and at first sight this looks like a considerable saving. But it must be remembered that this is not a nett saving. The cost of cleaning the ground, bedding out the seedlings, keeping them clean for two years, replacing deaths and damaged plants, and the general upkeep of the nursery ground, have to be deducted from this difference in the cost of small and large plants. The cost of cleaning the ground is often considerable, especially after a wet season, and, although alternate cropping with potatoes, roots, etc., may do much to assist, it is often necessary to fork over the ground before plants are bedded out. The cost of

bedding out should not exceed 1s. per thousand, but with unskilled labour it is often more. Cleaning during the summer months is a considerable item, and may run to 5s. or 6s. per thousand, while from 5 to 20 per cent. may be lost through drought, frost, cockchafer grubs, and so forth, which may add to the cost of the survivors considerably. The upkeep of a permanent nursery has also to be allowed for, and consists in cutting hedges, cleaning or repairing walks or paths, rates and taxes on the land, and so forth, while the plants have to be lifted before planting out. In fact, it is doubtful if two-year seedlings can be grown on in a home nursery for two or three years at a lower cost than £1 per thousand on a large scale, and on a small scale it is more. In the latter case, therefore, it is doubtful if a home nursery pays, so far as ordinary forest stock is concerned, although its advantages in other respects may be considerable, as in growing on extra large plants or ornamental trees, which cannot be purchased under a high price.

A great deal depends, of course, upon the class of nursery stuff grown. It may be said at the outset that no advantage is derived from attempting to grow a comprehensive list of plants which would be appropriate to a public nursery. A few of the more generally used species, and those which present no great difficulty in growing from seed or cuttings, should always be kept in stock, and outside these it is probably better to buy direct from the public nursery for ordinary planting purposes. The class of soil upon which the nursery is formed must also be considered. Ash should not be grown on poor soil or gravel, nor beech on strong clay, and neither in spots at all liable to spring frosts; Douglas fir and Spanish chestnut should not be grown on chalk; conifers on strong loams, nor hardwoods on dry poor soils, although there may be exceptions in both the latter two cases. Given suitable soils and situations, the species best adapted for growing in home nurseries from seed are oak, beech, ash, Spanish chestnut, sycamore, etc. The seeds of these are easily collected, easily stored, and easily raised, and with an inexhaustible supply of seed on the spot in good seasons, it is little short of extravagance

to purchase them in the form of seedlings or transplants, unless the local crops have failed, as of course they often do. In growing on from two-year seedlings, larch, pine, Douglas fir, etc., often pay, especially Douglas fir, which is an expensive tree to buy in at a large size. Experience will soon teach what can be most easily raised or grown, and what not, and when a species has failed more than once, it is better to give it up, unless the cause of failure is exceptional.

AREA OF A HOME NURSERY.

The exact area which is required for nursery stock on any estate is easily ascertained by experience. As a general rule, however, it may be said that when all seedlings are bought in at two-year, and planted out at four years, one acre of ground is required for every thirty thousand plants planted out annually. This enables half the ground to be stocked with potatoes or roots for one season after a crop of trees has been cleared off. Where the plants stand for three years in the home nursery or are raised from seed, more space will be required, and one-fourth may usually be added for walks, hedges, fences, etc., round and between the cropped area. Allowing three thousand plants to the acre, it follows that one-tenth of the area annually planted should be allowed for a home nursery, where nothing but ordinary forest trees are grown, and where all planted are grown on for the time allowed. In the case of avenue, park, or ornamental trees being grown, or a certain proportion of the trees bought in ready for planting out, the area may be more or less, as the case may be, but, as already said, experience will soon settle this point.

ASPECT, SOIL, AND SITUATION.

The aspect of a home nursery may be of almost any kind, except perhaps due east. An eastern aspect is always exposed to the rays of the rising sun, and when these fall directly on plants which have just experienced the effects of a sharp spring or May frost the result may be disastrous. It is a

well-known fact that active vegetation will withstand several degrees of frost without injury if they are protected from a sudden thaw; and this fact can be taken advantage of on a small scale by syringing the frozen plants, or lighting fires which will fill the atmosphere for the time being with thick smoke. The safest plan to adopt, however, so far as nurseries are concerned, is to choose an aspect which will keep off the rays of the sun until the temperature has risen well above freezing point, so that frosted plants may have an opportunity of thawing out as gradually as possible. This, in our opinion, is the most important point to look at when selecting a site for a home nursery. On a dry, warm soil a northern aspect answers best, as the plants are less exposed to the direct rays of the sun, and evaporation is less rapid. On the other hand, cold and wet soils, if such must be chosen, should be given a south aspect for the opposite reason.

The soil of a home nursery is probably the most important point about it. As a general rule, it may be said that the nursery should stand on the same class of soil as the bulk of that on which replanting is to proceed. This, we believe, is generally recognised, and it only remains to mention the most suitable soils for the production of stout healthy plants, such as were specified in the chapter on Planting.

In a dry climate probably the best class of soil for root production is a moderately strong and deep loam on a porous sub-soil. Such a soil stands drought well, and supplies all the elements of plant food which are requisite for well-ripened wood, without the assistance of artificial manuring. An occasional dose of lime from time to time will keep it sweet and open, and unlock further supplies of plant food as required. It produces stout well-nourished plants of almost any species, and which have every prospect of making a good start when transplanted. Its effect on the root system is also good, tending to produce plenty of fibre and strong, well-developed secondary roots, which are the best foundations of a permanent root system.

The next best is probably what is called a hazel loam, and in a wet climate such a soil is preferable to the one first named, and usually gives as good results. For conifers alone, such as pines, sandy loams are probably best, and for seed-beds of all kinds lightness and friability are essential.

The worst kinds of soil, in a general way, are probably peat, dry sand, thin gravel, and wet, stiff clay. All these should be carefully avoided, unless the object is to grow a particular class of plant, such as rhododendrons, Scots fir, oak, or hornbeam. It must be recollected, of course, that all soils can be modified to a great extent by the addition of composts, leaf-mould, road edgings, etc., and, when no chance is left but to select an unsuitable soil, these means of improvement may be adopted. Well-rotted leaf-mould is an excellent dressing for both light and heavy soils, and if liquid manure is plentiful, and can be applied to a large heap of it now and again when rotting, nothing better could be applied to poor hungry soils, and either dug in or used as a top dressing after the trees are bedded out.

The situation of a home nursery is, to some extent, a matter of necessity. It should of course always be near the forester's house, for the sake of constant and convenient supervision, and it is also desirable to have it in as central a position as possible. It should occupy gently sloping, rather than flat ground, and should never be placed in hollows or low bottoms, on account of late and early frosts. A situation well sheltered from east winds by rising ground or belts of trees is also desirable for reasons already stated.

LAYING OUT A HOME NURSERY.

The shape which a nursery should be given, when no restrictions exist, should be that of an oblong, with its longer sides in the direction of the most favourable aspects. When of this shape the beds can be arranged so that horse labour can be employed in ploughing, cleaning, and cultivating the root or other crops grown for rotation purposes; and this is a great advantage when the expense of that work is considered. A hard road or drive should run through the centre, on either side of which ornamental or specimen trees may be grown if desired, while round the edges a broad grass margin may be maintained for turning horses when at plough, and thus avoiding headlands. The width of the beds may be from 20 to 40 yards, as these limits enable the line to be conven-

iently used when bedding out, and hoeing can be more economically done. Their length may run the whole of the distance from top to bottom of the nursery, and the fewer cross paths there are the better.

The advantages of shelter hedges in a nursery are very doubtful. They add, no doubt, to its appearance, and also shelter the ground from drying winds, but, beyond that, it is questionable whether they pay for the expense of maintaining and the ground they take up. Where shelter is necessary, it is more easily secured by rows of poplars, limes, etc., which can be pollarded from time to time at a height of 10 to 20 feet, and one row of these will shelter as much ground as two or three hedges of the ordinary kind. As boundary fences, neat hedges are of course most appropriate, and give more shelter than a dead fence, but inside these they are probably expensive luxuries, and interfere with the economical working of the ground.

MANAGEMENT.

The successful management of a home nursery depends a great deal upon the personal attention and interest bestowed upon it by the forester. Delicate seedlings need constant supervision in order to protect them from weeds, insects, grubs, etc., and this is especially the case when they are raised from seed on the spot. The best way to ensure success is by putting an intelligent man in charge, and inducing him to take an interest in the work. Such a man should be able to supervise the bedding out, hoeing, lifting, etc., and to make cuttings, prune trees, collect and clean seed, and so on, and there is always something of this kind to do in a nursery of two or three acres.

Apart from the details of the work, the most important points to be considered are the rotations adopted on the various breaks or beds, and the manures applied to them. Conifers should follow hardwoods, ground recently manured should be stocked with more exacting species, such as ash or oak, and beds infested with cockchafer grubs should be cleared, and a liberal dose of pig manure applied before cropping with potatoes, roots, vetches, etc. The manures

applied to the latter crops should consist of well-rotted farm-yard manure, artificials, and lime at suitable periods. Where the ground is in good condition, the tree crops should not require manuring at the time of planting; but during the second year, if the ground be naturally poor, it often happens that the colour of the leaves becomes sickly, and growth falls off. When such is the case, it is often advisable to dress with artificials, for such plants are very liable to become attacked by aphides, leaf diseases, etc. We have found the following mixture, which was prepared for us by Messrs. Dickson of Chester, a valuable manure for crops in this condition:—

8 cwt. kainit,
8 cwt. bone superphosphate,
4 cwt. sulphate of Ammonia.

The principal item of importance in this mixture is the kainit, which supplies an adequate quantity of potash for the proper development and ripening of the young shoots, which we consider to be an essential condition for all trees intended for transplanting.

Applied to larch, ash, etc., during the summer months at the rate of 5 cwt. per acre, the effect upon the colour of the leaves and growth of the plants was remarkable, and the plants thus dressed developed into stout, well-rooted, and well-ripened plants, and the cost per ton was not more than £7. The great advantage of using artificials in the nursery is the prevention of all weed seeds (which are invariably present in farmyard manure, unless thoroughly well rotted) being introduced.

COLLECTING, STORING, AND SOWING TREE SEEDS.

It is rarely advisable for the forester to attempt to save the seed of any but the commoner trees of the country, unless they are conveniently in his way. Seed collecting on a small scale is an expensive business, seed-beds of delicate species are troublesome to protect and keep clean, and late frost may destroy the whole season's work in one night. Such seeds, however, as oak, ash, beech, Spanish chestnut, sycamore, Scots fir, etc., present no difficulties, and oak and

Spanish chestnut especially can be raised much more cheaply than they can be purchased as seedlings.

The collection and storing of the above seeds is not a difficult matter, and, whenever a good seed year occurs, the cost of securing a good supply of one or the other of the seeds of these species is not great. The collection of oak and beech seed is very simple, as it only requires picking up from the ground as soon as it falls in the autumn. As a general rule, acorns are best sown as soon as they are collected, as they germinate at once, and are thus fully established by the following spring. Their greatest enemies, however, are mice and pheasants, and if sown where these animals or birds are numerous, they must be protected in some way or another during the winter. The cheapest and most effective method of doing this is probably that of mixing the acorns with some vile-smelling composition, such as Stockholm tar mixed with cow manure, *Renardine*, assafoetida, red-lead, or any other material which is distasteful to these creatures. Acorns are best sown in drills, about 12 inches apart, and should be covered to a depth of 2 to 3 inches. When so sown they can be allowed to remain at least two years in the seed-beds, and, if necessary, even longer. If any fear is entertained that the tap roots are developing at the expense of fibre, they can be root-pruned by inserting a spade on either side, and cutting the tap roots about 6 inches below the surface.

Beech seed should be collected when dry and stored on the floor of a dry cool cellar, being occasionally turned to keep it from heating. In the following April it may be sown in the same way as recommended for acorns, and its subsequent treatment is much the same.

Spanish chestnut seed must be collected in the same way as the above species, and may either be sown at once, after being dressed as recommended for acorns, or stored in a similar manner to beech. The great point about storing these nuts is the prevention of their becoming too dry, as their vitality is quickly destroyed by over-dryness.

Ash seed is most easily collected by cutting off the twigs bearing the bunches of keys in autumn, placing them in heaps, and collecting them with a cart for conveyance to the

nursery. The keys can then be pulled off the twigs at any time within the next month or two, and this work can be done in an open shed when outside work is prevented by wet or snow. As these seeds do not germinate until the second year after ripening, they must be stored in a rot-heap in the open, and are best mixed with sand or leaf-mould.

Sycamore seed may be collected in the same way as ash, or picked up beneath the trees by boys. It germinates the first season, and may either be sown at once, or laid up in a heap until the following spring. In all the above cases the ground selected for sowing should be carefully cleaned of couch, or other perennial growth which will tend to foul the seed-beds, and, if sown in drills, they can be kept clean much easier than when sown broadcast. The seed-beds should have a width of about 4 feet, or may even be dispensed with altogether, provided sufficient space is left between the drills to enable the hoe to be used freely between.

The collection of Scots fir seed is a more complicated matter. The cones must be pulled or cut off the standing trees, or from those felled in winter. In the following spring they must be opened either by artificial heat, or by spreading them out on sheets of corrugated iron exposed to the sun. When the cones are well opened, any seed which has not fallen out must be shaken out of the open cones by stirring the latter about with a broom or rake. The separated seed should then be cleaned from chaff and dust, and is then ready for sowing. The usual method is to mix the seed with red-lead before sowing, in order to prevent it being destroyed by mice or birds. The seed is first damped in a small heap, the red-lead placed on top, and the whole mixed together until each seed has received a good coating of the lead. This seed must be sown in beds, so that careful weeding and protection may be afforded the seedlings. The greatest enemies to the seedlings are small birds, such as linnets and finches, which will destroy the seedlings wholesale unless guarded against. The only effectual method is that of protecting the seed-beds with a net such as that used for fruit trees or strawberries. Slugs are also troublesome foes to these delicate seedlings, and a dressing of soot and lime should be applied from time to time when the seed is

appearing above ground. Where the sowing of this seed is an annual operation, it is probably better economy in the long-run to sow in a wooden frame formed of slabs or boards let into the ground to a depth of 6 or 8 inches. The soil inside these frames can then be removed before sowing, and a layer of soot, lime, or any other material which will keep out grubs and worms be placed in the bottom. The natural soil can then be returned, and the seed sown on top. These frames are also useful for protecting seeds against late frosts, as thin canvas or mats can be placed over the seed-beds at night.

As a general rule, raising plants from seed in the home nursery should not be carried on to any great extent with delicate seedlings. The dangers and accidents to which seedlings are exposed, the many enemies which have to be fought against, and the large percentage of losses which are almost sure to occur during the first two years, render home-raised plants a more expensive item than those inexperienced on the subject would suppose. In the large majority of cases it pays as well, if not better, to buy in two-year seedlings from a public nursery, and grow them on until fit to transplant in the woods. This method is almost invariably adopted with larch and conifers generally, and with moderate care the losses attending the process are very small. But great care should be taken to prevent the seedlings becoming dry at the roots before they are bedded out. In many cases the plants are received from the public nursery several months before they are bedded, and, the custom being to tie them up in bundles of a hundred or so in each bundle, it is naturally most convenient to lay them in by the heels without untying them. Yet this practice is responsible for more deaths amongst seedling plants than many imagine. The plants in the middle of these bundles are totally isolated from the surrounding soil, and in the course of a week or two they become almost as dry as if spread out on the floor of a shed. Fully 50 per cent. of the plants so treated either perish or become so weakened that their growth is affected throughout the whole of the following season. A rule should always be made, and

steadily adhered to, that all bundles of seedlings should be untied the moment they are unpacked, and laid in thin layers until wanted for planting out. It is to be feared that private purchasers of seedlings are not the only offenders in this respect. It is no uncommon sight in a public nursery to come across thousands of seedlings tied up and laid in by the heels in the manner complained of, and, although they may arrive at their ultimate destination *looking* none the worse for this treatment, we have no hesitation in saying that this is the cause of numerous deaths during the following spring and summer.

CHAPTER IX

WOODLAND WORK AND WORKING PLANS

✓ FEW branches of estate work are more interesting, either to the man engaged in it or to the general observer, than wood-work. From the raising of the seedling in the nursery to the felling of the mature tree in the wood, and its subsequent removal, there is always something of interest to note and some interesting problem to solve. Even though the sound of the axe may be associated with unpleasant emotions for the true lover of arboreal life, there is also something cheery about it as well, reminiscent of sturdy energy and freedom. Life in the woods has always proved attractive to those fond of country pursuits, and it is especially attractive in winter, when other parts of the country are barren and lifeless. Almost every month brings its characteristic changes, denoting the advance of the season and the development and cessation of growth.

Although the average woodman may not possess that artistic eye which sees beauty in every twig and leaf, and which is able to appreciate the various forms and groupings of woodland trees, yet there is little doubt that the effect of woodland scenery makes its impression upon him also, although he may be unable to put his impressions into words. In spite of the arduous labour peculiar to his calling—for most wood-work is exceptionally severe on the labourer—there is a fascination in it which binds him more closely to it the longer he lives, and he seldom leaves it for any other sphere of work, so long as health and strength remain. No doubt, the higher wages which woodmen receive in return for the greater skill required in their labour, do something to retain good workmen in the wood; but it is also certain that the freer and

more attractive conditions under which they work, and the degree of mental exercise demanded by the work itself, are of equal influence in securing their allegiance to the calling.

The most familiar, though not necessarily the most important, branch of English wood-work is that of timber-felling. It was certainly this branch of work which employed the earliest generations of woodmen; for, when forests more or less covered the surface of the country, the first problem which confronted semi-civilised man was the clearing away of the forest growth, to make way for cultivated fields or pasturage for cattle and sheep. Probably the man of the Bronze or Iron Age was the first to use the axe, for it is only of that metal that implements capable of cutting timber could have been made. But the earliest reference to timber-cutting in history dates from the Roman period. In A.D. 84 the Roman general Agricola defeated Galgacus, the British chief, and before the battle Tacitus relates that he harangued his followers in the words: "Our limbs and our bodies are worn out in cutting wood and draining marshes." The hard lessons learnt by the British as slaves to the Romans probably proved useful to them after the conquerors had retired, and from that period onward timber-cutting would be more or less common as a rural occupation. Canoes of British workmanship have been unearthed from time to time bearing axe or chisel marks, and formed of the hollowed-out trunks of large trees, and other remains of timbered structures tell the same tale.

At a much later period (the thirteenth century) the Duke of Lancaster marched an army into Scotland and set twenty-four thousand axes to work to destroy the Scottish forests, the squad employed being one which any timber merchant might envy. We thus find the English woodcutter has a fairly ancient origin, and to have figured to some extent in the history of his country.

The English woodman of the present day differs little in appearance or methods of working from his predecessors in the past centuries. Cutting timber is one of those operations which has not been greatly altered by invention or science, and even the American lumberman still continues to use the axe as the handiest tool for individual workmen.

It is an interesting sight to watch a skilful axeman "lay in" a large oak or elm, and note the accuracy and judgment with which each blow is made. Commencing at the side towards which the tree will fall, the bark is lightly cut through in a downward direction, and, the second stroke being made horizontally, the first chip is detached from the tree. Succeeding strokes from the axe remove large chips, and the process goes on until an almost right-angled step or niche is removed all round the base of the tree and in a practically horizontal line. The side on which the tree is required to fall is then cut in obliquely for about a quarter of the diameter of the tree and slightly hollowed out below. The saw is then applied to the opposite side, and the bole sawn through until within a few inches of the falling face, when the weight of the tree ought to break away the remaining portion and bring about its fall. If it does not do this, but is inclined to "sit back," as woodmen term it, a wedge should be driven in behind the saw, and the tree forced over in that way. In windy weather, or with trees with well-balanced tops, it sometimes happens that the tree falls back over the saw-cut, instead of away from it, and such an accident may prove dangerous to the workmen, or to buildings which happen to stand in the way. Trees standing near buildings, unless they have a decided lean away from them, should always be lined or roped for safety, and the tree pulled over by means of pulleys after the butt has been cut through to the necessary extent. Ropes used for such a purpose should be carefully kept, and tested from time to time, as, in the event of a rope breaking at the critical moment, a serious accident might result. Another method of inducing a tree to fall in the right direction is that of removing branches from the opposite side, and thus altering its centre of gravity. Men employed for such work require plenty of nerve and judgment, for it often happens that parts of the trunks have to be scaled which no available ladder will reach, and in big trees both hand and foot hold are not easily obtained, and the only way for a man to ascend is with a rope thrown over a branch above his head. Another case in which the removal of branches is sometimes necessary, is in the case of large-headed ash or oak on which a branch

projects at an angle of about 45 degrees on the falling side. In such a case, the weight of the whole tree coming suddenly upon this branch will often split a slice off the trunk when the tree falls, and spoil a great deal of valuable timber.

The above instances prove that men engaged in felling timber should be possessed of considerable skill and intelligence, as well as sober habits of living. Careless workmen not only endanger their own lives, but may easily spoil a quantity of valuable timber by unskilful felling or lack of judgment, and it is highly important that the woodmen on an estate should be the cream of the labouring staff. To be an expert axeman, a man must start fairly early in life, and for the lighter kinds of wood-work a lad of seventeen or eighteen should get into the way of handling the tools and acquiring the necessary skill.

If strong healthy lads of this age could be induced by suitable wages and prospects of advancement to take up the work in earnest, any estate should have little difficulty in possessing a squad of suitable workmen. Unfortunately, in common with all classes of skilled rural labour nowadays, very few lads seem inclined to take the work up seriously, but get away into towns or more crowded centres after a year or two. The system which prevails on most estates, however, of treating all labourers as if they were of equal value, and rewarding them all with the same wage, is fatal to a great deal of the encouragement which ought to be extended towards suitable men.

Timber-felling is usually done by piecework at so much per foot, load, or 100 feet. Oak is paid for at a higher price than other timber, on account of its hardness. Ash, beech, and elm come next, while coniferous woods are paid for at the lowest rates.

The average prices paid for felling oak per 100 feet are from 2s. 6d. to 3s.; ash, beech, and elm, 2s. to 2s. 3d.; and soft woods, 1s. to 1s. 6d. This includes lopping and knotting up the timber, and at this rate experienced workmen should earn from 20s. to 25s. per week, without trouble, in good weather and with fairly clean timber.

A feature of felling oak in many districts is the work of peeling or stripping off the bark for tanning purposes. This

can only be done in the spring, when the new growth or wood-ring is just about to form by the activity of the cambium layer. In most districts the tree is first felled, but in parts of Devonshire and elsewhere a limited practice prevails of barking the trees standing, and allowing them to remain until the following winter. This is done to improve the quality of the timber, as the sap still retained in the tree and renewed by the roots during the summer prevents any cracking or warping of the timber. But in the great majority of cases oak is cut and barked in one operation.

Fifty years ago, when foreign tannin, barks, and chemicals were unknown in the tanneries, the demand for oak bark was keen, and the price ran high, from £8 to £12 per ton being average prices in those days, and tanners took all they could get with thanks. Now the price of bark has sunk to £3 or so per ton, and many tanners are not eager to take it at that. Indeed there is little doubt that the price would be lower still if proprietors could be induced to take it off for lower rates, but experience proves that most estate owners prefer to cut their oak in winter, and avoid the trouble of barking and collecting, when the price falls below £3 per ton delivered. The cost of barking and delivery runs to at least £2 per ton when the woods are not more than five or six miles from the tanyard, and when put on rail this cost is increased. It is evident, therefore, that the wood owner gets very little for his trouble after all outgoings are paid, and the inducement to bark is not great. One advantage in barking is the fact that the operation pays for the felling of the timber, and a further advantage may be gained when the latter has to be forwarded by rail, as the carriage of bark has to be paid for. But, taking it all round, the advantages and disadvantages are fairly evenly matched; for amongst the latter must be reckoned the greater difficulties of cutting and working up timber through the summer months, the trouble and risk of taking up bark in wet weather, and the greater damage done to the under-wood shoots when the timber is cut amongst it and not removed until the end of the summer. Still, a nett return of £1 per ton, together with the saving of something like $\frac{1}{2}$ d. per foot on the throwing of the timber, is an inducement which appeals

to most estate owners within a reasonable distance of a tanyard.

But, however doubtful the financial aspect of bark-stripping may be, there is little doubt that it is one of the most attractive and interesting operations that fall to the lot of the woodman, when things go smoothly. The smell of the freshly stripped bark, the satisfaction of seeing it tear off freely under the outward pressure of the barking iron, and the sights and sounds of the surrounding woodland, with its bursting foliage, full-throated songsters, and carpet of anemone and bluebell, invest bark-stripping with associations which can never be forgotten by those taking part in it. The work itself, though heavy enough in some respects, is, on the whole, less laborious than ordinary wood-felling, the combination of barking and felling forming a blend which no genuine workman would complain about. The only drawback to which it is often subjected is the pernicious effect of cold drying winds or frosty nights, which prevent bark from running with that freedom which is desirable both in the interests of workman and tanner. Bark which clings to the wood must be beaten or forced off in such a manner that it is not only bruised and damaged, but the best part of it—that which is richest in tannin—is often left on the tree, and its weight and value reduced. Under such conditions barking becomes irksome and trying to the patience, and unsatisfactory from everyone's point of view. But every genuine forester will regret the day, if the day should ever come, when the familiar sight of a gang of bark-strippers can be no longer seen in the month of May, for so long as bark-stripping flourishes, so will the oak that produces it, and English forestry without the British oak is an asset of doubtful value.

UNDER-WOOD CUTTING.

The cutting and working up of under-wood is one of the oldest branches of English forestry—as old, if not older, than timber-felling itself.

A hundred years back or more, when the produce of one acre of coppice with standards was about four times of what

it is to-day, the cutting and working up of coppice-wood kept several small industries in existence. The barking of poles, the splitting or rending of laths, and the fagoting up of the brush-wood and otherwise useless produce, had each its particular expert, whose work kept him employed the greater part of the year. Many small articles, such as rakes, clothes-pegs, skewers, etc., were made by this class of labour during odd times, and when other work was at a standstill, and in this way forms of village industries were maintained which added largely to the prosperity and contentment of the community. In the heavily coppiced parts of Sussex and Hants, labour of this kind has been inherited from father to son even to the present day, although it is painfully evident that most successions of this kind have now terminated, and that the growing generation is turning its attention to less rural pursuits.

Whether under-wood cutting is performed by the wood owner before sale, or by the purchaser afterwards, the operation of cutting is much the same in either case. The wood is divided into drifts or narrow strips, and as the standing shoots or poles fall before the axe or bill-hook, they are piled up in the centre of each drift. The smaller shoots of hazel, etc., which are grown on short rotations, are usually cut with a bill-hook, but the axe has to be brought into use for larger poles, or "lugs" as they are termed in the south-west of England. Text-books on forestry lay special stress on the importance of cutting under-wood shoots in the proper way, so that no jagged or splintered wood is left on the stool. Unfortunately, few foresters or proprietors are able to profit from advice of this kind to any great extent beyond what is practicable by employing the best woodmen of the district. An expert axeman will cut under-wood with little damage to the stools, but the majority of men at the present day pay no attention to this point, and hack off the shoots in the way which gives them the least trouble. Compared with other injuries to which under-wood is subjected, this question of skilful cutting becomes of secondary importance, and, in the case of hazel at any rate, it is doubtful if the manner of cutting it affects its vitality in any way.

After the cutting of under-wood is completed, the sorting

TIMBER CUTTING.

UNDERWOOD CUTTING.

and dressing of its various components must be undertaken. Long, fairly straight rods are trimmed and stacked up for hurdles, short but stouter lengths are cut out and tied into bundles as stakes for setting them, and the stoutest ash set aside for stems, or handles of spades, brooms, and agricultural tools. Long and straight rods from ash or willow go for rake handles, and the larger poles are piled up for the turner, bobbin, or clog-maker, etc, while alder poles must be partly peeled or stripped of their rind. In the Sussex coppes-woods large quantities of chestnut are worked into barrel hoops, and in pit-wood districts under-wood is largely used for the smaller class of pitprop. Compared with ordinary plantation produce, the conversion of the coppice-wood is a much more complicated business for the forester to superintend, and, although he is rarely called upon to do it on a large scale, the successful disposal of the wood depends a great deal upon his knowledge of local demands and customs.

As a general rule, however, the purchaser of under-wood is a small merchant who has risen from the rank of woodman, or has inherited the business from his father. For that class of man a considerable amount of capital is required to carry on the work successfully. In the first place, it is necessary for him to own and maintain a stout nag for delivering his fagots and other articles of sale. He must employ men to assist in cutting and working up his wood, and whose wages he must pay probably many months before he gets any considerable return from his produce. He must find customers from amongst two or three different classes, and upon whose stability and solvency his ultimate reward must depend. Neighbouring farmers buy his hurdles, turners take his poles and handle-wood, whilst cottagers are his principal customers for fagots.

We know as a fact that long credit has to be given by such dealers in the case of all these classes, and although the price paid per acre for the under-wood that they buy seems small compared with past prices, there is little doubt that the risks attending their business is much greater than was formerly the case.

Observation proves that most of the men engaged in this

business are old, and that few younger men are coming on to take their place. Every now and again we meet with one of those cases where a woodman has saved a little capital and gone into a business of this kind on his own account. But such cases are too few to seriously affect the truth of the statement that this class of man is dying out in company with those engaged in most rural industries, and that the country generally is the poorer for the want of him. Yet, with the price of every commodity he sells going down, while that of the labour he is bound to employ going up, it is difficult to see how such men can exist with any prospect of success. They work harder than ordinary labourers, and, so long as their independence is maintained and they can turn two shillings into half a crown, do not object to it. But when it is a case of turning half a crown into two shillings, as must be when prices fall too low, it would be madness on the part of a man to invest his savings in any such undertaking as under-wood dealing.

It is a fact that the returns from English coppice-woods depend almost entirely upon the existence of these small dealers, who alone possess the knowledge and the patience to turn the wood to account and to wait long periods for small returns. One cannot but come to the conclusion that the day of ordinary under-wood is past, and that the only sound policy for the coppice owner to adopt is that of converting it into ordinary plantation, or to grow large poles which may meet a demand in certain districts.

HURDLE-MAKING.

Closely associated with the under-wood dealer is the hurdle-maker, probably one of the oldest types of wood-worker that still exist in England. A skilful hurdle-maker is as much entitled to be called a mechanic as any skilled labourer in the country, and being paid almost entirely by piecework, his wages are higher than those of the average labourer. Hurdles may be said to be the cream of the out-turn of coppice woods, and with wood suitable for this work and a ready sale for the hurdles, it only requires a really

good hurdle-maker to make the merchants' purchase a profitable one.

The life of the average hurdle-maker through the summer months is almost an entirely open-air one. He often works many miles from home, and possibly several miles from civilised habitations, and in such cases he finds it more convenient to camp out in the woods, and on the site of his work, than to take lodgings and tramp to and fro morning and night. In such cases he rigs up a hut in some sheltered corner, or lies rough in some convenient shed or stable, and dispenses with the usual accessories to the toilet and wardrobe of a gentleman of fashion. If his aspirations run in the direction of a substantial style of residence, he takes a leaf out of the book of his remote ancestors, and erects a hut, which, according to the highest authorities, is an exact counterpart of those used by the Britons before the Roman invasion. A few poles are placed, end up, on the ground, brought together at the top, and the inter-spaces bridged over with rods or split stakes. An old tarpaulin, turf, or fern is then thrown over the whole, and the floor made warm and dry with straw or fern. In a hut of this kind an average hurdle-maker will cheerfully spend a month or two, making frequent excursions to the nearest village for provisions, and calls at the public-house for refreshment and recreation. A thrifty man, living in this fashion, and working long hours and earning from 25s. to 30s. per week, can, in the course of a few years, accumulate a nice little sum. But, as often as not, a hard-worked summer is succeeded by a more or less idle winter, and, at the return of spring, little if any of the previous year's earnings are left.

The hurdle-maker's equipment is not an expensive one, and his mode of working is as follows:—A block of wood, bored with auger holes about 8 inches apart, rests on the ground. Into these holes are stuck the pointed uprights between and round which the rods are twisted, and which the hurdler has sorted and split down to the required size and pliancy. Placing the end of a rod between two of the centre uprights, and as near the ground as possible, the rod is plaited in and out until the outside upright is reached. It has then to be twisted sharply round as in making a

withe, so that a turn can be taken round the end without breaking it, and the plaiting proceed in the opposite direction. Rod after rod is plaited in, one above the other, in this way until the hurdle has reached its full height of 3 feet or so. The uprights are then trimmed off at one height, and the hurdle placed on the accumulating pile at his side. A good hurdle-maker should make about a dozen hurdles per day, and at the price of 5s. per dozen, his weekly earnings total up to a respectable sum.

The hurdle referred to above is known as a "wattled" hurdle, and is the common sort in use throughout the south and west of England, but in other parts what are known as "flake" hurdles are preferred. These are made out of split ash or other poles, and are of a more substantial nature than the wattled type. The heads of these hurdles are mortised, and resemble a rail fence more than the basket-work structure of the other, and are made more often in the yard or workshop of the hurdle-maker than in the woods. Their manufacture is frequently combined with that of crate-making, feeding-troughs for sheep, etc., and hardly comes within the province of woodland work.

CHARCOAL BURNING.

Charcoal burning is another ancient practice in English woodlands. It was a charcoal burner's cart on which the body of William Rufus is supposed to have reached Winchester, and it is fairly certain that the profession was a more numerous one in those days than it is now. It is hardly conceivable, in these days of gas and steam, that the entire heat production of the old days depended upon wood and charcoal; but so it was. The charcoal burner's fires have been credited with the destruction of most of our old forest tracts, for the smelting of iron was done entirely with charcoal at one time, and until sea-coal came into general use. Its use in the domestic life of the Middle Ages is well known, for it took the place of the modern fireplace to a great extent, and was used wherever warmth was required. Later on, charcoal was an important

ingredient of the old black powder which fought our battles by sea and land in the days of Nelson and Marlborough, and with which the old-fashioned sportsman of a century back did his day's shooting. In fact, charcoal was as indispensable in domestic circles and for manufacturing purposes up to two or three hundred years ago as coal is to-day and electricity will be to-morrow.

The modern use of charcoal is now, however, extremely limited, hot-water pipes and gas stoves having taken its place in most of the country houses in which its use lingered until quite recently. In the manufacture of steel, it is, however, still used to supply the carbon which is an essential element in the process, and most of the charcoal burnt in the Midlands goes for this purpose.

The charcoal burner is one of the least common of the woodland artisans at the present day. In most districts he has died out altogether, and where he still remains his services are required in various parts of the country more or less distant from his native spot. Charcoal burners are born rather than made. To live for several months on end within a few feet of a heap of dry, black, powdery dust, which penetrates through every thread of clothing, to snatch a few hours' fitful sleep in an extemporised hovel, without a change of clothes, much less linen, and to remain day after day enveloped in a dusty coating, perfect enough for the equipment of a nigger minstrel, are not ideal conditions of life for even low-paid rural labourers.

But, apart from the dirty nature of the work, it requires an apprenticeship of considerable length before a man can call himself an expert. He may study the arrangement of the blocks in the oven or hearth with the greatest care, watch the operation day after day, and note the smallest detail, yet, when he comes to perform the work unaided by the old master, there is usually something lacking in his methods. His fire either burns too fast in one place or too slow in another, or the wood bursts into flame when the fire is "drawn," or something else happens to prevent the quantity of properly burnt charcoal being made from the wood supplied. Yet an expert charcoal burner will turn out thirty-six bushels of charcoal from one cord of any

hardwood, such as oak, beech, ash, etc., and at 2d. per bushel will earn, together with his assistant, from £3 to £5 per week. Such charcoal, which is made with a minimum of waste, will have a sharp metallic ring when struck, and show absolutely no trace of combustion beyond its colour. We have specimens of charcoal in our possession which show the bark and moss intact on the wood, and even the larval dust of the workings of *Hylesinus fraxini*, together with the beetles themselves, are as perfect as when the former were fresh and the latter still alive. Charcoal of this description is a good test of the burner's ability and skill, and is a proof that combustion has not proceeded beyond that point necessary to drive off the volatile gas, moisture, etc., and that the heating power is still retained in the wood.

But while the use of charcoal may linger in country places for a time, there seems little prospect of its ever regaining its old degree of importance, or of retaining its present one. Hundreds of estates on which charcoal burning was a more or less annual operation fifty years ago, now see the smoke of the charcoal burner's hearth no more, and the name only lingers to indicate the locality associated with it. Yet it cannot be denied that it was a highly profitable method of using up the odd wood of tops and branches, which was fit for nothing but firewood, and which now has to be practically given away, or allowed to rot in the wood.

WORKING PLANS.

A working plan for a woodland estate may be described as an organised attempt to convert the real into the ideal. It aims at obtaining the greatest sustained return in timber, combined with the greatest economy in working expenses, or, in other words, of obtaining the highest rent from the soil in perpetuity. In ordinary practice, all land under timber, and which is treated as a rent-yielding area, is subjected to an annual or periodical demand on the growing stock. In small woods these demands may only occur once in ten, twenty, or thirty years, as the case may be; in large woods they may be made annually. They may either take the form

of clearing off the entire crop of timber from a limited area, or may consist in weeding out the oldest and largest trees over a large extent of ground; but, whatever the method adopted, it is evident that the quantity obtained must bear a more or less definite proportion to that produced by each season's growth. On a properly stocked area, it is easily seen that the proper proportion which each periodical cutting should bear to the periodical increase should be as 1 is to 1, and that the annual increase should be equivalent to the annual fall. If less than this quantity is cut, then the accumulating stock, apart from its possible deterioration in value, is occupying ground which ought to be carrying younger wood; while, if more is cut, then the capital value of the stock will be reduced, and ultimately the annual yield. It is in attempting to regulate the periodic falls in accordance with this principle that the value of a working plan lies, for it is impossible to obtain the highest returns without it.

The most frequent difficulty experienced in executing a working plan is the fact that the area to which it applies is scarcely ever normally stocked, that is to say, the various age classes, which on a normally stocked area would range from 1 to 100, or whatever the age of the oldest wood may be, are rarely fully represented. The stock is often found to consist of very young or very old plantations, and a big gap exists which it is very difficult to fill up. Or it may consist entirely of middle-aged or old woods, which ought, from a strictly economic point of view, to be cleared off in the course of a few years. Another, but rarer case may occur, in which practically the whole of the plantations are young and immature, and in which no final fellings can be expected for an indefinite period. In any of these cases a working plan can only be drawn up on very elastic principles, for the various features upon which its success depends are more or less matters of speculation and uncertainty. With young plantations the period of maturity can only be fixed in advance within very wide limits, except in the case of an indigenous species growing upon ground which has already borne similar crops. The clearing of large areas of mature wood depends upon the condition of the

market and the demand for the particular species, which cannot be accurately predicted six months in advance. Storms may create gaps in all age classes, which may completely disorganise the regular plan of operations and glut the timber market for two or three seasons. All these contingencies cannot be foreseen by the forest organiser, although his experience of forestry in general may render him cognisant of their possibility. But the particular manner in which they will affect his plan neither he nor anyone else can anticipate, and its successful execution depends more upon a combination of fortunate developments, than upon any apparently exact calculations he may take the trouble to make.

It is evident, therefore, that the task of private forest organisation, if based upon the recognition of all the innumerable factors which influence the profitable marketing of timber, is no light one, and is largely a matter of speculation. The more one looks at the question, in fact, the more difficult it appears to formulate any scheme which will meet the various exigencies which are always arising on private estates, and over which the owner or his forester has little or no control. In large Government forests, consisting principally of one or two species of tree, and which have given rise to certain industries, such as pulp-making, which use immense quantities of raw material, the drawing up of a suitable working plan is a necessary and comparatively easy undertaking. The class of material most in demand, and which will bring the highest price in the market, is known within certain limits, and arrangements can be made accordingly for growing that class in the quickest possible time. Or it is possible to ignore the most profitable felling age to a great extent, and work the forests on the principle of obtaining the maximum quantity of mature timber annually, which would work out fairly well where big timber was most in demand. In either case, both the annual timber supply and working expenses can be regulated in such a way as to ensure an annual nett yield, according to the productive capabilities of the soil. The forest area being always fully stocked, or as nearly so as practicable, is not subject to those long and spasmodic breaks in the process

of clearing and replanting which are often so conspicuous in English wood management, and which incurs such a loss upon the owner who first attempts to avoid them.

The individual estate proprietor is at a disadvantage with respect to working plans, owing to the fact that he usually stands practically alone in his particular district. If the woodland proprietors of a certain district could agree to work their woods as a whole instead of as distinct units on each estate, they could command the market to a much greater extent than is the case now. The timber cut in each district would be regulated to meet the local demand, instead of any rise in the market being met by a simultaneous fall of timber over the whole district, and resulting in the market becoming glutted in the course of a couple of months.

Such agreements present many difficulties, and are only a form of that co-operation which seems incapable of being organised in country districts. Hardly a sale takes place at which some agreement amongst the buyers is not arrived at, by which one is prevented from bidding against another. But one rarely hears of any counter agreement amongst timber sellers which prevents the local market being overstocked. We have no faith in any attempt to fix the price of any class of timber, for this must always depend upon quality and the locality in which it is grown; but we certainly believe that the sales in a particular district might be so arranged as to prevent one from clashing or reacting against another. That a number of sales in one particular district, and at one time, do react against one another and tend to lower prices, is obvious if one takes the trouble to look into the matter. With the exception of first-class timber, for which manufacturing buyers often go long distances to obtain, the bulk of the timber is used in the same district as it is grown in, or is at any rate converted in that district. If one watches the buyers and prices given at most auction sales, it will be generally found that the highest prices are given by small buyers, who buy for their own use or for a particular purpose. Large buyers, on the other hand, either buy comparatively cheaply, or belong to the immediate neighbourhood. Why is this? Because the man who buys on a small scale has already found a use for the timber,

and has selected his particular lot or lots with that end in view. He is prepared, and can afford, to give more for it than a man who buys on speculation only, and who runs the risk of having his purchase depreciated in value by a fall in the market, or by having to hold it in stock for an indefinite period. The large buyer only buys dearly when his stock is low, and he is unable to meet his present demands, or when the timber lies close to his hand. In the former case he buys on exactly the same principle as the small buyer, and in the latter, the short carriage of the timber enables him to buy dear. It is clear that when a large number of sales are held simultaneously in one district the local market is in danger of being glutted, and buyers must either be obtained from a distance, or the timber pass into the hands of one or two big buyers who buy on speculation, and consequently cheaply.

On the other hand, there is little doubt but that a steady and constant supply of timber tends to create a demand for it. So long as the supply is erratic and uncertain, local trade always exists in a disorganised condition, for a business cannot be properly developed unless the raw material upon which its existence depends is easily procurable. A timber consumer who has to obtain his material in small parcels from points at wide distances apart is always at a disadvantage, for both time and expense are incurred in finding and collecting to a common centre, which might well be saved if larger quantities of one class of timber were grown in one spot. The mixed character of English woods is often a cause of their unprofitable condition, especially when they contain conifers, such as spruce or pine. In small lots these species are often practically unsaleable, but, when grown clean and in large masses, an enterprising timber merchant will often find a use for them in a special line of some kind.

If, therefore, a satisfactory working plan could be drawn up for the whole or greater part of the woods of a district, we believe it would benefit both the timber grower and timber consumer in the long-run. In the case of under-wood, of course, a working plan is imperative, but, when confined to one isolated estate here and there, it can do little good

unless the estate happens to be a large one, and with a large area of woodland upon it which is able to feed a few industries in the immediate neighbourhood. Even on such estates, however, such a plan, as already stated, must be of an accommodating nature. For the average woods of an average estate, our ideal of a working plan is that which enables the entire woodland area to become stocked in the least time, and without obliging the owner to spend a greater sum than the income from the woods will cover. As already stated, wholesale clearing of old woodland is not advisable as a rule, but, on the other hand, the process should not be prolonged beyond a certain point, otherwise the loss, in the shape of deterioration of timber and land lying idle, is greater than any gain arising from the annual expenditure being kept down.

Any scheme, however rough and ready, which entails the clearing and replanting of old woodland, is a step in the right direction, and a step in advance of the average estate wood management of to-day. Every estate forester who is a forester in reality, and not in name only, keeps this object steadily in view, and uses every means in his power to stock his ground with young and profitable crops of timber. But he finds from experience that his powers are usually limited to a degree which prevent him from working up to his ideal, and that these powers are not always increased by stating the necessity or desirability for them on paper. It is often easier to get a piece of work carried out when the powers that be know little about it beforehand, than when the whole of the details and the expense thereof are laid bare at the outset. A comprehensive working plan on paper appears to the average owner or agent too big a thing to be taken in hand by the forester's staff, and it probably looks like signing a death warrant for all the sentimental or historical associations of the woods. Let it be done bit by bit, and in such a way that the mark of each footstep is covered before the next is made, and it is possible for a satisfactory working plan to be executed, more or less according to the spirit, if not to the letter, of the law in which it was designed.

For the woods of an average estate, a working plan which answers all practical requirements could be drawn up

on the following lines:—A general survey should be made of the soils and situations of the woodland area, and the suitability or otherwise of the existing crops and sylvicultural systems for these situations noted. If changes are desirable on sylvicultural grounds, the effect of such changes should be considered with regard to the local timber market, as influenced by the demand for a particular class of timber. This having been done, the formation of one or more working circles can then be decided upon, according to the most important variations of the ground. Each working circle can then be dealt with separately, and a policy decided upon with respect to it. If of considerable extent, an endeavour should be made to divide it into units or compartments of a convenient size for clearing and replanting when the time comes. Should the working circle be of small area, it may be treated as a unit in itself, or divided into two or three as convenient. The great thing, in our opinion, is to make these compartments as compact and convenient in size as possible for replanting, and avoid strips and areas with too many points and projections, and arrange for one or two of their sides to follow a necessary ride or road. The importance of this can be seen when the use of wire netting is imperative, for the same principle holds good in this as in ordinary fencing of ground, and the larger and more compact the area the smaller the expense per acre. No unit should be less than five acres, or more than twenty in extent, however small or large the area of the working circle, or the expense of netting becomes a serious item in the cost of replanting, or it will prove ineffectual.

These units or compartments having been laid out in the most convenient manner, the working circle can then be dealt with according to the condition of the existing crops and the state of the timber market. If the greater part of the ground is stocked with thin and over-mature timber, it is a question for the owner to decide approximately how many years shall be occupied in clearing it; and this point being settled, the number of compartments or fractions of them to be cut annually or periodically can be fixed accordingly. If annual fellings are desirable and the number of years over which clearing is to extend exceeds the number of compartments,

then one of the latter must be divided into two or more annual falls, or cleared in two or three years, as the case may be. Or, if clearing is to proceed more rapidly, it may be necessary to clear more than one compartment annually, those most in need of clearing being selected first. When, on the other hand, young or middle-aged plantations form the bulk of the working circle, clearing must be delayed, or proceeded with on a small scale until they approach maturity, when it may be gradually increased according to the crop and market. Any attempt to arrange the felling in any particular order is rarely possible; neither is it necessary, unless on shallow soils or in a wind-swept locality. Local surroundings, differences of soil, condition of crop, and in most cases landscape effect, will all exert their influence upon the process of clearing, and these influences will probably vary with each compartment. When both young and old woods exist in the same compartment, the predominant class of timber should decide the period of its fall.

In the same way, any attempt to regulate the amount of yield in timber or money within narrow limits is also unnecessary, and is rarely possible without complicating the plan of operations to an undesirable extent. On large estates, where an annual sale of timber is held, the returns may vary little from year to year, but too often the last year's returns are only made to correspond with those of the preceding by drawing upon the capital stock. To see a steady income from the woods of an estate looks well on paper, but to an owner who has the interests of his woods at heart, it must be more satisfactory to know that their capital value is increasing steadily, than that the annual income gained from them is only got at the expense of his successors.

A rough-and-ready allotment of the woodland area into working circles having been done, the division of each working circle into series of age classes should next be carried out. For this purpose all ages may be conveniently divided into five periods of twenty-five years each, calling all ages between one and twenty the fifth period, twenty-one to forty the fourth, and so on until all ages over eighty years of age are reached, which will be Period 1. In this classification larch and Spanish chestnut should be considered

mature between sixty and eighty years of age, and when they occur at those ages should be entered in Period 1. Ash is also a species which might be classified in the same way on some soils, but its existence as a pure crop may not extend over a large area.

The first aim of the woodland organiser should be that of ascertaining all portions of the ground which carry crops falling into Period 1. Where young plantations predominate, the total area to be thus classified will be small. On the other hand, in woods which have been neglected for many years, the greater part of the ground will probably carry crops already mature. In either of these cases a large number of age classes will not be represented, and the area allotted to each period will be very irregular: but, whether large or small, it is necessary to regard Period 1 as being most in need of immediate attention, whenever any scheme of replanting is introduced. The whole of the woods having been classified in the above manner, the next point to note is the composition and bulk of the crops on the area entered under Period 1. The approximate number of trees of each species and their contents must be found by counting and ocular measurement, and, their value being found in this way, a general idea of what stock of timber is available for cutting until the next series of age classes will reach maturity is obtained.

The next step to decide is the extent of cutting on the matured area. Financial considerations occupy an important place here, for, when the area to be dealt with is large, and the crop on it thin, the value of the cleared crop may not even cover the cost of replanting. If the proprietor is willing to incur a little self-sacrifice, however, the clearing of the ground should be determined as much as possible by the condition of the old crop. If consisting largely of old stunted trees, which are adding practically nothing to their bulk or value, the sooner they are cleared off the ground the better, and the larger the area which should be dealt with annually, provided market conditions will allow it; but, if fairly good crops are present, which are not deteriorating in value to any great extent, the aim should be that of prolonging the clearing of this area until the oldest wood in the next period is likely

to become mature, or, if the area belonging to that period be small, the clearing of Period 1 may be extended into it for several years, and thus absolutely barren years avoided.

The main object to be obtained is the arranging of the clearing and replanting in such a way that a uniform amount of income and expenditure will be assured in the future, and the organisation of the work itself be simplified. Where the total area of woodland is very small, this point is of less importance, and may be ignored altogether; but, with an area of anything over 500 acres, a steady progression of both clearing and replanting should be kept in view. It is not of course necessary that a piece of ground should be cleared and replanted annually, as this might involve work on too small a scale for economy, but the work of two or three years may often be concentrated into one, according to convenience, and this need not interfere with the general scheme of organisation.

The precise order of cutting adopted in Period 1 of any working circle must be determined by local conditions. Wind must not be let suddenly into young or middle-aged plantations, the timber must be cleared so that it can be conveniently got away, and the ground afterwards replanted in compact blocks of 10 to 20 acres. Individual areas should be bounded by, or touch the more important rides, where possible, so as to facilitate the removal of the timber. On hillsides the felling should be arranged in oblong strips, running up and down the hill or obliquely across its face, as wind is thus much less likely to affect the growth of adjoining plots, and the timber can be pulled down hill with the least labour. Local conditions and the contour of the ground must, however, decide all these points, and a great deal must be left to those in immediate charge of the work, as modifications may be necessary at the last moment, as the work goes on.

Such a simple working plan as we have sketched above will be sufficient to meet the expectations of the majority of estate owners, and will exceed the requirements of most. The great points to be borne in mind, in any case, are simplicity and the economical clearing and replanting of the ground. Small units often mean neglected ones, while it is

impossible to plant and protect them from ground game without going to greater expense than would be the case with larger areas. With fairly large areas, again, rides and roads can be kept in much better condition than when the entire woodland area is continually being hauled over and cut up in removing small lots of timber.

But, after all is said and done, the question remains: Will a working plan prevent that constant pilfering which goes on from all age classes, and especially the younger ones, to meet estate requirements? Can estate owners, agents, and foresters resist the temptation to swell current returns by anticipating the future yield of each unit or series of age classes? If these hindrances to profitable forestry could be removed, whether by working plans or otherwise, then the success of most English woods as producers of timber and yielders of rent would be assured. But, so long as it exists in its present form, English forestry will probably show little if any improvement from a financial point of view, for a reduction of capital or growing stock will sooner or later end in a reduced income.

CHAPTER X

LANDSCAPE FORESTRY

LANDSCAPE EFFECT OF TREES IN GENERAL.

ALTHOUGH landscape gardening has long been regarded as the proper art for dealing with the ornamental distribution of woods and trees over the face of the country, it is, in reality, the forester alone who renders that distribution a source of enjoyment to the cultured eye and taste. However carefully woods, clumps, and single trees may be laid down in the plans of the landscape gardener, and however faithfully the execution of such plans may be carried out, their successful development depends almost entirely upon the skill and judgment with which they are thinned out, and dealt with from time to time as their development proceeds. It is apparent to everyone in possession of a true sense of arboreal beauty and landscape effect, that very few of the original designs of the landscape gardener are brought to a successful issue, owing to the imperfect or injudicious treatment masses or groups of trees receive at various stages of their growth. Even at the time of planting, many errors are committed which may be traced to a lack of forestry or arboricultural knowledge and experience. Clumps, for instance, are planted on the same principles as would be observed in planting a wood or forest, heavy-foliaged trees are used where lightness is desirable, and *vice versa*, and a general observance of rule-of-thumb practices takes the place of artistic grouping and arrangement.

No doubt, much detail is left to the workman or foreman which ought to be superintended by the artist himself. It is hardly conceivable that any genuine lover of nature would

plant either trees or shrubs with that mathematical regularity, and monotonous repetition of the same arrangement of different species, which characterise so much of the landscape work of the present day, and which differs as much from true art as geometry differs from freehand drawing. It is obvious that the effect produced by trees in a landscape depends as much upon the details of the component parts as upon the precise arrangement of the latter on the ground. The plans of the landscape gardener only show the latter; the former change or develop with each stage of growth, and with the treatment they receive at the hands of the forester. Pruning can alter the appearance of the individual tree, and thinning that of the clump, and also affect the survival or suppression of certain species; and these artificial conditions of growth must be regulated by the forester, and their effect has a material influence upon the ultimate results.

No doubt, the precise arrangement of trees, groups, and larger masses is of importance when the landscape is viewed from one particular point only. But the ordinary beholder cannot walk blindfolded to one or two important points of observation, and see only what is best. In most landscapes fresh points of view are continually cropping up as one walks or rides about, and a perfect landscape is one which has varied but equally attractive details at all points, and yet possesses a character which is in keeping with the locality and the physical features of the neighbourhood. Round most country seats, perhaps, the most important views to be studied are those obtained from the windows of the mansion house. But however attractive these may be rendered by nature or art, it cannot be denied that those seats which give most pleasure to the owner or his friends are such as possess constantly changing views as one walks or rides about. An extensive view is far more attractive when it is hidden or confined at various points than when it is perpetually before the eye without the slightest variation, and variety and contrast are almost, if not quite, as essential in producing pleasant emotions as beauty. Trees enable greater changes and variations to be made in natural scenery than any other details the latter possesses, for their different

stages of growth can be taken advantage of to open or shut out views from time to time as desired, and thus constantly create fresh or alter existing effects.

EFFECT OF TREES ON THE PRINCIPAL TYPES OF NATURAL SCENERY.

A perfect landscape is usually supposed to consist of land, wood, and water; the first named being the exclusive product of natural causes, and the two last being either the result of artificial or natural agency. But in the three distinct types of landscape entirely produced by natural causes which are represented by a forest, a moor or open plain, and a tract of mountainous country untouched by human agency, the influence of trees varies to a considerable extent. In a forest of natural growth trees practically constitute whatever scenery there is, and the view is usually of an extremely limited nature, according to the undulations of the ground and the existence of glades or clearings here and there. On a moor or open plain whatever trees exist are prominent objects for a considerable distance, and they are capable in themselves of rendering such a landscape picturesque, monotonous, or absolutely ugly, according to the way in which they are distributed over the surface. In a mountainous or hilly country land is presented to the eye on a large scale, and such details as trees or water are dwarfed in proportion to the extent of the view and the height of the hills. Grandeur and wildness are here strongly in evidence, and such objects as trees merely furnish detail, which is only apparent at a comparatively short distance.

When the extent is considered to which the forester, or his especial charges—woods or trees—are able to make, alter, or modify a landscape, it is necessary to confine one's attention to one or the other of these distinct types of scenery. To compare the effect of trees on a flat plain to that of such objects amidst a range of lofty mountains is obviously absurd. In the one case they are bold and prominent objects in themselves, in the other they are more or less minute details which do not materially affect the bolder

outlines of the landscape or its general effect upon the observer.

Bearing the above facts in mind, therefore, an endeavour will be made to see how the defects peculiar to all natural types of landscape can be altered or modified to add to whatever beauty and picturesqueness they already possess. Take, first of all, the case of a flat open heath, down, or agricultural country, where the variations in the surface of the ground are too small and trivial to break the monotony and dreariness of the view. Here trees have very real and important duties to perform, and not the least of these is their ability to block out and obstruct the view in various directions, and give it a definite back-ground. Probably most people have a high opinion of any view which can be called extensive. To be able to see over so many miles of country appears to them to justify the expression, "a fine view." But in reality there is little or nothing to please the artistic sense in looking over a dead level from higher ground, unless that ground is sufficiently high to allow what is called a "bird's-eye view" to be taken, and thus give detail as well as extent to the scene. Whatever pleasure is derived from a flat view is chiefly due to the presence of a rising or setting sun, and the cloud banks and forms which invariably accompany these phenomena, and at such times the character of the country below is of little importance. A really fine view must possess a back-ground of some kind, and this can only be afforded by ground lying at equal or higher levels than that on which the observer stands. Without a back-ground the eye naturally ranges away to the farthest point on the horizon at the first glance, and the intervening detail is either overlooked, or has to be picked out bit by bit. But when trees are plentiful they break the view in many directions, and, by giving relief to the flat horizon in some directions and blocking it out altogether in others, provide an amount of variety to the view which no other objects are capable of doing. The difference between a flat and treeless country and one equally flat but well stocked with park and hedgerow trees is well known to everyone. The one is monotonous in the extreme, while the other is continually presenting fresh groups, combinations, and masses of foliage

to the eye. In neither case can the scenery be called grand, and possibly it may not even deserve the name of "picturesque"; but the one is as superior to the other, from a scenic point of view, as is a broken mass of towering rock to a flat sandbank.

In a hill country the precise effect of trees depends upon the height and nature of the hills and the slopes of their sides. With low flat-topped hills with gently sloping sides and wide shallow valleys, forming what is usually known as an undulating country, their presence is as great an acquisition to the landscape as in a flat country, provided they are properly placed. In an undulating but treeless country the surface is more broken, and alternate hill and vale relieve the monotony of a flat plain, it is true, but the variations are, as a rule, too slight to give the landscape that boldness and character which prevail in mountainous districts. The hills and vales resemble each other so closely in form and outline that one square mile of the district usually contains all the features that may be found throughout the whole, and the scenery becomes tame and insipid, and almost as monotonous in its way as a dead level. But with the presence of trees it is possible to change all this. By the existence of clumps and groups of trees on the summits and upper slopes of the hills, their height and the depth of the intervening valleys are apparently increased, while their rounded outlines are broken and varied. The valleys and hollows, when left fairly open, and simply dotted over with single trees or hedgerow timber, lead the eye from hill to hill without any disagreeable break or abrupt boundary line between the wood and open ground. The effect of a wooded undulating country is heightened or decreased in proportion to the judicious or fortuitous distribution of the trees, and the broken character of the heavier masses, while the distribution, proportion, and arrangement of the different species is also of importance.

When a hilly district possesses a more mountainous character, the effect of tree-growth is chiefly in the direction of detail and ground colouring. In such districts the observer looks on rather than over the hills, and the slopes of the latter are usually sufficiently steep and irregular, and

the valleys between sufficiently narrow, to prevent the eye looking over a regularly level plain for any great length. The difference trees make in such a landscape, therefore, is not so great as on level or undulating ground, unless they exist in sufficiently large masses to confine the view to a few openings in the leaf canopy, which could only occur in a regular forest. But in mountainous districts the amount of detail in the near distance provided by trees is very great, more especially if they happen to be distributed naturally and irregularly along the sides of ravines, or on the slopes. They help to clothe the nakedness of rocky slopes and precipices, and in both cases they give a greater depth and variety to the country, which take off that bleakness and wildness which bare mountain districts invariably exhibit; and, in their various shades and tints of spring, summer, and autumn, they add colour and life to the foreground, where they are almost as essential to the creation of a pleasing scene as on flat or undulating ground.

As regards a forest, the fact is self-evident that trees are the chief features present, and it is therefore superfluous to discuss their desirability or the reverse.

It is obvious, therefore, that without trees, either as individuals or in the form of clumps or woods, a really attractive landscape cannot be obtained. But the degree of its attractiveness depends a great deal, if not entirely, upon the species of trees, and their arrangement, grouping, and general distribution over the face of the country, rather than upon their numbers or the size of individual masses. A few shapely and well-placed trees have far more effect than perhaps ten times the number mixed indiscriminately, or badly placed. In fact, the desired effect in all cases is a matter of judgment, skill, and design, rather than accident and chance, although the latter may occasionally produce results which, if detail is ignored, the former may fail in achieving with every care. But, if every constituent of attractive landscape effect derived from trees be carefully analysed, it may be possible to see the causes of success or failure, although it may not be possible for any one individual to secure the former, or avoid the latter in the course of a lifetime. The landscape artist who is compelled to plant

trees to attain his desired results is in the unfortunate position of every planter—he can only lay the foundation upon which his successors may build. If the latter happen to be merely jerry-builders instead of masters in the art, the work of the designer is often spoilt, and a very different result attained to that which was intended.

TREES IN THE FORE-GROUND.

In discussing the various effects which trees produce upon a landscape of any kind, it is necessary to divide them into two classes, namely, those which stand singly or in small groups, and owe their effect to their isolation as individuals, and those which stand so closely together as to form more or less compact masses in which individual trees cannot be recognised at a distance from their fellows. In the former class the position of every tree, as well as its size, shape, and character, are of importance, for it forms a distinct detail in the landscape, which is either necessary to its completeness, or forms a superfluous element which would be better away. Such trees, of course, are of more importance in the fore-ground of a landscape, because the nearer they stand to the eye, the greater the space they occupy in the picture, and the greater their ability to block out what is behind. Generally speaking, the great beauty of a wooded landscape is its intricacy and depth. A solid mass of wood has no depth unless the fore-ground possesses trees or small groups which shorten the view here and there, obscuring the back-ground in some places, and rendering it visible at others. At a distance of a mile, a wood of 10 acres appears as a low bank, and the details of stem and foliage, as well as the actual height above the ground level (which is apparent at close range), are entirely lost. But when a back-ground of foliage is extended forward in gradually decreasing quantities, the component parts of which are apparently increasing in breadth and height, it ceases to form a detached and distant feature of the landscape, but appears as a gradually receding continuation of the middle-ground, which latter, again, is blended with the various objects of the fore-

ground, so that the different parts of the view run insensibly one into the other.

The most desirable characteristics of fore-ground trees are lightness, grace, and symmetry. Such trees not only act as reflectors of light and absorbers of shade, but are, or should be, in themselves objects of interest. Their outlines should be graceful, their limbs should possess easy sweeps and curves, and their foliage should exhibit sufficient variation in its density, and beauty in its detail, to render them at all times attractive objects to a critical eye. Ugly trees or clumsy groups should therefore never be allowed to stand close to a country mansion, residence, or principal point of view, nor should heavy-foliaged trees stand in such situations on a large scale. Grace, elegance, and lightness are the qualities most desired in such places, although an occasional exception to this rule may sometimes have a good effect where screens or contrasts are desired. Such trees, for instance, as birch, aspen, acacia, ash, etc., are more appropriate to the fore-ground of a view than beech, hornbeam, sycamore, or many evergreen conifers, although the contour of the ground generally and the character of the back-ground may make all the difference to the effect produced by any of these trees.

With clumps, again, dense solid masses rarely produce good effects. Clumps or groups in the fore-ground should either be beautiful or picturesque, according to the particular character of the trees which form them. As a general rule, picturesqueness is more often a feature of desirable clumps than beauty, so far as trees are concerned. Occasionally a clump of symmetrical conifers, or ornamental foliaged or flowering trees may deserve the term "beautiful," but with ordinary forest trees a clump that is not picturesque as well is seldom worth having. It is difficult, for instance, to see much beauty in a group of oaks or Scots firs, but they may often be extremely picturesque. The gnarled and twisted outlines of the branches, and the massive lichen-stained stems of the former, or the tall red columns of the latter, surmounted by dark, glaucous, dome-shaped crowns and pendent plumes, resembling a Highland bonnet, are features upon which the eye never tires of gazing; but it is seldom that

MARGIN OF WOOD WITH TREES STANDING FORWARD.

MARGIN OF WOOD BROKEN UP BY THINNING.

such results are produced until the clumps have had full time to develop. Neither the oak nor the Scots fir can be called picturesque in youth, and they must, therefore, be kept as much as possible in the back-ground at the time of planting. Beauty, on the other hand, may be said to be represented in a graceful clump of ash or birch trees, for both trees exhibit that lightness and elegance upon which beauty depends. The branches of an ash which have not been confined by other trees often exhibit curves and lines of the most beautiful nature, which completely relieves that tendency to stiffness on the part of the spray which is objectionable in young trees. A weeping birch, again, is one of the most charming objects in nature, not only as regards the habit of the tree, but also in respect to its silvery, variegated, and rugged bark.

In fact, while beauty and picturesqueness may be detected in all trees to a greater or less extent, it may be stated as a general fact that the former depends upon the individual, and the latter more upon its age and relation to its surroundings. We can often find beauty at a very early age in such trees as silver firs, spruces, cedars, etc., in which it is represented by their symmetry, habit, or foliage. But it requires a great stretch of the imagination to see beauty in a twenty-year-old ash or Scots fir. With age, on the other hand, the latter may often be as beautiful, and are usually more picturesque, than those trees mentioned above, in which outline, habit, or foliage never alters, or, if so, only for the worse.

These differences in the habits and characteristics of trees illustrate the different points of view from which they may be regarded by the layer out of the place, and those who follow and watch its ultimate development. Trees which are appropriate and ornamental in the fore-ground of a view during the first fifty years after planting, may be out of place and disagreeable later on; and it is therefore as necessary to revise and modify the work of the original designer from time to time, as it was necessary for the latter to study immediate and early effect at the outset.

THE MIDDLE- AND BACK-GROUND.

Compared with the fore-ground, the smaller details of the middle- and back-ground of a wooded view are comparatively unimportant. At anything beyond a distance of a mile or so, trees simply become masses of light or shade, according to their foliage, or the light which is reflected from them. It is therefore the size of such masses, and their relation to one another, that render them picturesque or the reverse. Their effect is also considerably modified by the shape and contour of the ground, and is very different on a flat surface to what it is on a hillside, or undulating ground. In either case, however, the function of a back-ground is to increase the depth of a view, and so remove that flatness which is peculiar to all objects which are *apparently* at about the same distance from the eye of the observer. Depth and flatness may be well illustrated by the appearance of the scenery presented by a theatrical stage, and the drop curtain hanging in front of it. Although both are within a few yards of the audience, the latter appears nearer, and the former farther away, than either really are; the true distances being concealed by the absence of familiar standards by which the eye can judge them. In a landscape, depth is obtained by constantly varying the distance across which the eye can roam uninterrupted, so as to necessitate a constant change of focus, and giving the view a succession of fore- and back-grounds without leaving perceptible gaps in between. Back- and middle-grounds are, therefore, part and parcel of one another; for the one cannot exist without the other, nor should there be any perceptible division between them. While the fore-ground is chiefly composed of single trees or small groups, the back-ground is only effective on flat ground, when the groups or clumps are of large size, and able to block out the view beyond when such is desired.

At what distance a back-ground of trees ceases to produce an effect on flat ground is a doubtful point. An English landscape is invariably sufficiently varied, and dotted over with trees of some kind or another, to render a view with a

perfectly flat horizon very rare. But probably few objects under 100 feet in height, such as trees in general, have any definite effect at a greater distance than a mile. At that distance the angle formed by the height of such objects, and the point of observation, is so small, that the difference between their outline and the horizon lies in the former being broken and irregular to a greater extent than the latter. Even this distinction disappears when a large block of unbroken woodland forms the back-ground; for the tops of the trees being on practically the same level, the line they form at a distance has much the same effect as a flat ground surface. Trees or woods at such a distance, therefore, should be sufficiently broken and varied in height, to render a dead or uniform level impossible. In many cases narrow belts of tall trees have been planted to form back-grounds to park scenery, the result being that not only are their tops on a more or less dead level, but the gradual loss of their lower branches has rendered visible a narrow streak of sky between the crowns of the trees and the ground level. Such an effect, which is more or less characteristic of many of Brown's inevitable circular belts, is a great deal worse than that produced by absolutely open country, and no hesitation should be felt about breaking up such belts whenever they occur.

But on hilly or undulating ground the effect produced by trees or woods is seen at a much greater distance than on flat ground, although it still diminishes and disappears as the distance increases. The best effect is probably produced on a hillside or bank from a quarter to a half mile away, on which the outline and character of every tree can be seen at a glance, and where the effects of sunlight and shade vary with the season and time of day. Here again, however, density and uniformity destroy a great many of the finer effects by producing a flat surface, on which nothing but the smaller twigs are visible as a homogeneous mass, varied only by those differences in the height and shape of the crowns which occur with individuals or different species. But to obtain really fine effects the trees must stand singly or in small groups between the larger masses, which ought to crown the summit and blot out the sky-line to a greater or less extent.

The trees ought, in a general way, to increase in numbers and density as they ascend the bank, leaving all ravines or depressions in the sky-line comparatively bare, and massing the trees on the hillocks and high ground. So placed, the heights and hollows of the surface are increased, and the general view presented to the eye rendered more intricate and broken, and the variations of shade and sunlight increased. With the masses composed of dense-foliaged trees, such as beech, horse-chestnut, Scots fir, elm, lime, etc., and the smaller groups and individuals of oak, ash, birch, acacia, larch, etc., both the summer and winter effect of such a view should be good, and, with grass and bracken below, the rich browns of the buds and twigs, the greys of the stems and branches, and the bleached or russet tints of the grass or bracken during winter and early spring, will produce almost as fine a picture as the deep shadows and rich masses of foliage in summer, or the varied tints of autumn.

The great point in planting or producing such scenes is, of course, to prevent sharp outlines appearing at the edges of clumps. It should, as a general rule, be impossible to note any definite distinction between the clump, the group, and the single tree, so far as their closeness or density is concerned. The one should pass imperceptibly into the other, the trees gradually thickening as the centre of a clump is approached, and thinning out again as the more open ground appears. A familiar example of the neglect of this rule is often met with on the chalk downs of the south of England, where small circular clumps of beech or Scots fir are seen on the extreme summits of the hills. Ugly as they are, they were doubtless intended by their planters as ornaments to the landscape, but have entirely failed in their object owing to their complete isolation, and violent contrast to the condition of the surrounding ground. If the latter were wooded to any extent, their presence might add to the general effect which trees produce in such places. But, rising abruptly in the midst of perhaps a thousand acres of bare down, they are simply objects of an unattractive nature, although they may serve as landmarks, if such are needed, over a wide area.

Another point which deserves attention in forming

clumps is the character of the trees which compose them. When formed entirely of heavy-foliaged trees, such as beech, Scots fir, etc., it is impossible to give them that lightness and open character at the margins which they ought to possess. Although a certain proportion of such trees should be present in every group, in order to afford a fair amount of contrast and increase the effect where large tree masses are required, their heaviness should always be relieved by a few light-foliaged trees, such as ash, oak, etc. The absence of such trees, together with the formal outlines of the clumps formed by Brown in the eighteenth century, have a great deal to do with the disfigurement of many parks throughout the country at the present day. To see huge, solid, circular masses of beech standing at regular distances on an expanse of bare turf is not a picturesque scene, by any means, although it is one which is far too familiar, and is occasionally copied with painful fidelity even now.

The treatment of wooded back-grounds in mountainous districts is usually determined as much by opportunity as choice. Hills which rise above the normal tree-line, *i.e.* to a height of 2000 feet or upwards, can rarely be wooded to their tops, and it is only those woods which lie on their slopes that have much effect on the back-ground of the landscape. At a distance of two or three miles, woods of average size rarely appear more than patches of colour—black, green, or brown, according to their being formed of conifers or hardwoods, or according to the season of the year. When on the sky-line, or projecting from a shoulder of the hill, they may be more conspicuous, but, as a general rule, it is rarely possible to judge the height or size of any individual trees on the face of the hill at that distance, and their effect is little, if at all greater than that produced by gorse, broom, or even bracken or heather. Where plantations can be formed for profit as well as effect, the two objects might, therefore, well be combined, but, where the altitude is too great, or the soil too poor for a profitable growth of timber, it is well worth considering whether these humbler forms of plant-life might not serve the same purpose at a trifling cost as expensive plantations which will never produce anything useful. Cheap forms of tree-growth, such as birch, juniper, mountain pine, etc., are

also useful for such places ; but the great point, of course, is to avoid the expense of fencing if possible, and broom or gorse can be usually raised on thinly grazed ground without it.

THE INTERIOR OF WOODS.

So far, the general effect of trees in the open, or when viewed from a distance, has been studied. A few words may now be devoted to the landscape effect of trees when grown in large masses, such as woods or forests, and when viewed from within or at a short distance away. Many might suppose that woods have no landscape effect when seen from their interiors, and, in the general sense of the term, perhaps they have not. But as the interior of woods may be equally a source of enjoyment to the admirer of natural scenery, as an extensive prospect, this chapter would not be complete without a reference to it.

The most important elements of woodland scenery may be said to be the general distribution of trees, and the character and variety they exhibit. So far as arrangement goes, a desirable feature of woodland scenery are glades and small openings, which enable the eye to catch the effects of light and shade on stem or foliage. In such spots the seclusion of the forest is combined with the green sward and rich masses of foliage associated with the park, and the contrast existing between the two heightens the effect of each. Such glades and openings are also rendered more attractive by the invariable existence in them of the smaller trees and shrubs, such as thorns, brambles, briers, etc., which add variety to the scene and give nearer detail than is afforded by trees alone. In a natural forest its glades often occupy the sites of swamps or marshy patches, through the centre of which a small stream often runs, and they then owe their open character to their unfitness for the growth of ordinary forest trees, as much as to anything else. But even more picturesque still are those glades which follow the line of, or are formed by a wide ride or rough green road running down a hollow or trough, and which is frequently bordered by bracken and other low growth of that kind. The sloping banks on either side enable a wider view of tree

tops and foliage to be obtained than would be the case on flat ground, and also add to the apparent height of the trees standing on their tops. Such glades are easily formed, if they do not already exist, on undulating ground, and, in addition to their picturesque character, they are admirably adapted for shooting purposes, although it must be admitted that they take up a good deal of the best soils and situations for timber production, as the richer or deeper soils, and more sheltered situations of valleys, usually produce the tallest and finest trees.

The character of a wood or forest is determined by the class or species of tree which predominates in it, and it is often the case that this character varies with the soil and situation in different parts of the same wood. A piece of ground stocked with oak or beech, for instance, has a different character from another piece in which pine or spruce prevails. Young plantations, again, differ in character from that of old and mature woodland, although in a purely natural forest old and young are usually mixed up together. But, whatever the origin of character may be, its existence is absolutely essential if a picturesque scene is to be provided, for otherwise the harmonious blending of the various details cannot be secured. This quality of character in a wood probably needs a certain amount of education in order to appreciate it properly. To many persons, perhaps, two woods of the same age would appear to differ very little, although composed of different species. The difference in habit, leaf, density of crown, shades of stem and branch, and what may be termed the architectural plan of the two woods, which is dependent upon the habits of the trees, would not be observable unless specially pointed out, and the more subtle differences due to character would be undetected. Character may be defined as the harmonious blending of the different features which belong exclusively to a particular type, and the absence of one or two of these features or the addition of others effectually destroys it. In a too mixed wood the character of one species is neutralised by that of another, and, as excessive variety destroys the effect of it, so the multiplication of different characters entirely does away with the effect of any one. Pure woods never lack character,

although they may prove monotonous from a lack of variety; but the latter is far more easily supplied than the former, and is supplied with less trouble.

The variety or æsthetic effect of a mixture of trees may be said to be of two kinds—that which is due to the varied effects of their foliage, density, form, etc., and that dependent upon their character generally, such as height, fulness of crown, straightness and cleanliness of stem, and capacity for growing in dense or open masses. The former of these effects is of most importance on the margins of plantations, or in small clumps which have been planted or are maintained to produce masses of foliage. In such cases the judicious mixture of different species of hardwoods has a fine effect when light- and heavy-foliaged trees are introduced in small groups at or near the outside, and in such a manner as to present alternate masses of light and shade. Oak and beech stand out with a full heavy front, while lighter-foliaged trees, such as ash or birch, cause breaks in the wall of foliage which make a pleasing contrast, and have much the same effect as a broken margin, such as that described above. In spring and autumn especially, the different tints belonging to each species make a wonderful show of colour, while an occasional larch or Scots fir still further adds to the effect. The great point here, however, as in the interior of woods, is to avoid too regular an alternation of species, but to plant good big masses of one variety here and there, so that the light and shade effects may possess sufficient breadth to produce the desired effect. When the boundary line winds in and out, the use of light-foliaged trees in the recesses, and trees with dense foliage at the projecting points, will add considerably to the depth of the plantation margins, especially if the light-foliaged species consist of such smaller-sized trees as birch, false acacia, English maple, mountain ash, etc. The effect of most plantation margins is rarely so good as it might be if more attention were paid to this point, as it matters little what shape the outline may be, so long as a hard and unbroken front of foliage presents itself all along the line, with little or no variety in the heights of the trees. This defect is often present in plantations which have been planted primarily for landscape effect, such as belts, park

clumps, and small woods planted on the crests of hills, as has been, or will be dealt with later on.

Another frequent cause of lack of variety in woods is the removal of all but normally shaped trees in thinnings. In a natural forest trees of all ages and sizes will be found, and this is a constant source of variety; but in an even-aged plantation the only difference in the size of the trees is due to different conditions of growth, such as extra space or overcrowding, or to accidental agencies, such as wind or snow. The natural instinct of the forester is to remove all these broken or partly suppressed trees, and, from a forestry point of view, that is the correct thing to do. But it is just such trees as these that give that touch of nature to artificially formed plantations, without which they are mere crops of poles, and too formal to please the picturesque eye. A stunted or deformed tree in its youth may not be particularly attractive to anyone, and to leave large masses of such trees behind when thinning is neither necessary nor advisable. But a tree or two here and there along the margins of rides, or at odd corners do no harm, and often become, when they have attained a venerable age, exceedingly picturesque. The leaning, forked, or crooked stem, the irregularly shaped crown, or the partly suppressed trees surrounding a well-developed specimen, all add a pleasing amount of variety to a middle-aged plantation, which would otherwise be tame and uninteresting to all but the professional forester or timber merchant. The retention of a thick group here and there, allowing the trees in them to settle matters for themselves, is also another source of variety which can easily be taken advantage of. The tall, clean stems in the centre of such groups, with the varying heights and sizes of the crowns of those round the margins, afford a great deal of variety which even-aged plantations would otherwise lack, while the greater or smaller inclination of the smaller trees from the perpendicular gives the plantation a more natural appearance than it would otherwise possess when thinned in the ordinary way.

The preservation of a few open spaces or wastes is also another means of giving variety to large woods. Occasionally patches of soil exist which are quite unsuited for timber

production, or which would require expensive preparation to render them so. Boggy places, or patches of rocky or extremely thin soils, are often useless for timber growing, and, when planted, only give rise to a sickly and stunted growth. Left alone, they cover themselves with their characteristic surface growth, and give a certain forest character to the wood, whatever it may be. Occasionally such places are adapted for growing dwarf shrubs, semi-aquatic or bog plants, and others which, at little expense, will add to the attractions of the wood, if not to its market value, and provide the occasional open space which keepers like for shooting corners. Much of the natural beauty of woods must undoubtedly arise from nature herself; but there are many ways in which artificial assistance may be given, and such are a few of them.

ORNAMENTAL WOODS.

The landscape effects of woods hitherto mentioned only refer to those due to the ordinary growing of common forest trees for purposes of utility or sport, and to mixtures due to occasional changes of soil. But the interior of woods, from a landscape point of view, is of far more importance in those plantations, or parts of plantations, which are often set apart to serve the purpose of rough pleasure grounds, through which the owner or his friends can ride or walk, "when," as Mrs. Gamp would observe, "they be so disposed."

At the outset it must be mentioned that the term "ornamental" is only used to distinguish such plantations from those managed entirely for sport or profit, and does not necessarily indicate that they consist of ornamental trees alone, such as the newer conifers or flowering trees or shrubs. A wood or plantation may be, and often is, far more ornamental when composed entirely of indigenous forest trees or shrubs than when crowded up with ornamental conifers planted with little or no judgment or taste. The principal features which render a plantation picturesque or the reverse have already been dealt with, and of course these features are equally as important and

as indispensable in an ornamental plantation, as in a wood formed for utility alone, but which it is desired to make picturesque at the same time. It is in the matter of smaller details, and in the features which are alone introduced with the object of adding to the attractions of the wood, that the chief difference exists between these two classes of woods. Such details are of almost endless variety, and may be few or many, according to the point of view from which such a wood is regarded. In some cases an ordinary wood may be used for the production of timber or under-wood, and at the same time its picturesque or ornamental character may be studied as regards mixing, grouping, thinning, etc., as already pointed out. In other cases, again, especially in the vicinity of the mansion house, the entire wood is regarded more or less as an ornamental feature, and whatever trees it may contain are valued and treated without reference to their market value or maturity.

Although ornamental woodlands may not form a large proportion of the wooded area of an estate, there is little doubt that their existence adds greatly to the attractions and amenities of a country seat, provided they are managed and treated with correct taste. Too often, however, the sole idea of rendering them ornamental appears to be that of keeping the rides neat and trimmed, and crowding up every available space with the most expensive trees and shrubs that can be found. We have even seen the rides mown with lawn-mowers and their edges broken up and raked smoothly over, and every vestige of dead leaf or twig removed with scrupulous care. Such painstaking efforts at excessive tidiness, however, add no more to the picturesque or ornamental appearance of a wood, than would paint and putty to the beauty of an old ruin, or a silk hat to the picturesqueness of a beggar. The ideal that should be aimed at is that of faithfully copying nature in all her best and most attractive aspects, and preserving all that is best worth keeping, while removing all that is tasteless or incongruous. The natural herbage, weedy growth, and even decaying *débris*, have a certain picturesque value, which can no more be spared from a picturesque woodland than can the lichen and moss from an old building, and nothing

of an artificial nature can adequately take their place. No doubt, such growth as nettles, thistles, and all that savours too much of the rubbish heap of mankind, is better cleared away; but there is a vast difference between doing this and aping the prim tidiness of a pleasure ground, or the painfully correct details of a London park. The ornamental woodland should rather err on the side of the other extreme, if anything, and, by affording a contrast to all that reminds one of art and artificial beauty, provide that true touch of nature which cannot be obtained elsewhere on a small scale.

Woodlands of this kind are usually a continuation of the pleasure grounds, gardens, etc., or occupy certain parts of the park or demesne which lie inside the park boundary fence, or within a short distance of the mansion house. They often constitute a link between the trimmed and dressed portions of the grounds, with their mown lawns and gravel walks, and the ordinary woodland and agricultural country which lies outside, and may be said to stand in the same relation to the shrubbery as the park does to the lawn. To a somewhat similar extent they may be also said to stand midway between the timbered park, with its groves, clumps and single trees, and the ordinary plantation or wood which has been formed and thinned for timber production alone. The main features of such woods are, or ought to be, dry, grass-covered rides or drives leading through their most interesting parts, and the grouping or arrangement of the trees in such a way that their most attractive characters and habits are able to develop, and can be seen to advantage. They should be characterised more by the presence of indigenous trees and shrubs than by a lavish display of exotics, except in spots where the character of the ground is sufficiently well adapted for their growth, to enable a section of the wood to be planted with them more or less entirely. This statement, of course, applies more particularly to conifers and evergreens, and will be dealt with more fully below.

The economic importance of such woods is, of course, small, as, when the trees or groups have attained maturity, their ornamental value standing is, in a general way, greater than when felled and sold as timber. Such woods, therefore,

not only contain a great deal of ripe and possibly decaying timber, but the manner in which the trees are arranged and grown does not always tend to produce timber of high technical value, nor such as the timber buyer has any great liking for. With large woods, of course, it is unnecessary to treat the whole of the ground from the ornamental standpoint, and a greater or smaller extent of the ground may be used for timber-growing pure and simple. But this does not affect the margins of the more important rides, nor those points which have anything of a landscape value, such as the summits of hills or the crests or slopes of ridges. But such matters as these must be left to the taste or discretion of the owner, and individual cases must be treated according to the local surroundings and the main purpose for which the wood is maintained.

An attempt will now be made to supplement the principles already laid down on the subject of landscape effect, by enumerating the various trees and shrubs which may appropriately be used in planting such woods, the position they ought to occupy, and the treatment they ought to receive.

In the first place, it is necessary to divide all trees and shrubs into two classes—one of which is represented by those trees which owe their beauty to their symmetrical outline and formal habit of growth, such as the majority of conifers, and those which are of a more or less irregular habit of growth, unless moulded and influenced by surrounding conditions, such as practically all indigenous trees and the majority of deciduous ones. It may be laid down as a general principle that these two classes rarely harmonise with one another. Take two such extreme types as a birch and an araucaria. The former owes its beauty to its loose and pendulous habit and the entire absence of stiffness and formality, while the latter is nothing if not absolutely regular in outline and symmetrical from base to apex. These two species, planted side by side, therefore, are rarely attractive, the contrast being too great. But, although the araucaria may be too stiff and formal to suit every taste, it can at least be tolerated in a pinetum, where trees more or less of a similar character prevail, and where species of

this nature are more or less natural to the surroundings. Harmony between the various species represented in a piece of woodland, therefore, is absolutely essential if it is to deserve the name of ornamental; otherwise the wood becomes a mere jumble of trees and shrubs, somewhat similar to a mixed plantation.

The position which these two classes ought to occupy in any piece of wood depends, in the first place, upon the soil, and, in the second, upon the contour of the ground and the general character of the scenery. Conifers, as a general rule, are much more in harmony with a heath-clad moor, or a broken and rocky hillside, than a level plain or undulating country. Hardwoods, on the other hand, are more in keeping with the tamer and more fertile parts of the country. There are exceptions, of course, in both classes; but it is usually found that nature respects the principle of adapting the character of the tree to that of the land which produces it, and we seldom see oak associated with heather or rocky hillsides, or Scots fir with rich natural pasture or alluvial plains.

In selecting the species for an ornamental wood, therefore, one must be guided to a great extent by the character of the ground to be planted. On rich loams, clays, and fertile land generally, of a flat or undulating character, oak, ash, beech, etc., should form the backbone, as it were, of the wood, while many of the newer introductions amongst deciduous trees and shrubs may also be used with advantage.

These should be arranged as much as possible in large groups, in which one or the other species predominates. Beech, for instance, is best grown almost pure, and in fairly large and thick masses, so that its most admired feature of long, clean stems may be produced to perfection; oak, on the other hand, may be grown in more open order, and the groups may be scattered and smaller; while ash is most ornamental when on the outside of a group, or standing in twos or threes in the bottoms or on the sides of ravines.

Other species may be dotted about wherever the situation seems adapted for them. Such trees as alder, willow, poplar, etc., may occupy swampy patches of ground, birch may be planted on poor or thin soils, and hornbeam on stiff

clay, and so on. But, while these may give variety, the three most common species, oak, ash, and beech, must be depended upon for character, and planted accordingly.

That slight admixture of evergreens, which is necessary for the sake of variety, is most appropriately furnished by such indigenous species as yew, holly, juniper, box, broom, gorse, etc., with an occasional larger-sized tree, such as Scots fir, which, by developing a more or less flat top in later life, harmonises better with hardwoods than pointed crowned trees, such as spruce or larch. Where the latter type of tree is used, it should be confined to banks, ridges, or hollows, where some alteration in the general character of the surface seems to suggest a corresponding alteration in the vegetation. The hemlock spruce, evergreen oak, laurels, and similar kinds of evergreens, may also be used in moderation, but the point should always be kept in mind that a deciduous wood should have a deciduous character, and that too great a use of evergreens will neutralise this character just as effectually as too great a use of deciduous trees will spoil the character of an evergreen wood. It must also be remembered that evergreens have a much greater effect than deciduous trees. The former can be picked out at a glance as distinct features, while the latter are more uniform, and different species are less easily distinguished when massed together in a wood. The introduction of hardwoods into coniferous woods, therefore, can be carried out with more freedom than the reverse process, although both have their limits.

In coniferous woods much the same remarks will equally apply. Character in these may be given by Scots fir, spruce, Douglas fir, etc., and a much wider choice of species is available. On poor or dry ground it is doubtful, however, if a better tree can be found than the Scots pine, as its growth is practically assured, and its appearance improves with age. Spruce requires fairly moist and sheltered spots if it is to be depended upon for a back-ground, and, as an ornamental tree, is probably inferior to the Douglas fir. On chalk or marl, on which the latter will not grow, the spruce is a useful tree, however, and, if grown in thick masses on banks and slopes, will provide a good effect as long as it remains healthy and vigorous. Much the same may be

said of silver fir, although this tree is rarely ornamental when standing alone in later life, and is best grown in thick clumps.

INDIVIDUAL FEATURES.

The most important features of an ornamental wood are the lines followed by the rides, and the disposition of the trees or shrubs at or near their margins, the grouping or arrangement of species or mixtures, the shape and character of individual trees and clumps, and the amount of variety produced by the above details, combined with the slope and contour of the ground.

The line followed by the roads or rides in a wood, as well as their width and the condition of their margins, have a great deal to do with the picturesque appearance of the latter. The modern methods of laying out rides are invariably based upon the ideas and convenience of the sportsman, the result being that broad rides intersect each other at right angles about every 300 yards or so throughout the entire wood. This system may be all right when formed for shooting purposes alone, but it certainly does not add to the picturesque appearance of the wood, nor in many cases to the utility of the rides for timber removal. On undulating or hilly ground it is often advisable, if not necessary, to lay out shooting rides quite independently of those used for carting, and in such cases the right-angled system may possibly be the best. But where rides are used for both purposes, and the picturesque is worth studying at all, it must be admitted that absolutely straight lines are to be deprecated. Shooting rides are of course made straight for convenience and safety combined. Beating can be done more easily when the distance between the outsides of a beat remain the same throughout, as is the case when the rides are parallel, than it can when the ground is constantly varying in width between circuitous rides. From the safety point of view, again, straight rides enable each gun to see his right- and left-hand neighbours, and the chances of accidents are thereby reduced. But, in spite of the advantages which may be claimed for straight rides,

no reason exists why a slightly curved ride should not possess them to an equal degree, and at the same time conform more closely to the picturesque ideal than those referred to above. It is not asserted that a perpetual curve is necessarily more picturesque than a straight, for, as a matter of fact, both straights and curves are required to give roads and rides a natural and informal appearance. But rides laid out in gentle curves are certainly preferable to those which run entirely in straight lines, and which have all their corners at right angles, and divide the wood into perfect squares. An occasional straight length of 200 or 300 yards has often a good effect, especially on undulating ground, where the rise and fall of the latter provides a certain amount of variety, and breaks long perspective lines in itself. But, otherwise, graceful curves are the best features that rides in general can possess, although their deviation from a straight line need not be great enough to add appreciably to their length, or to make awkward or dangerous corners for the sportsman.

Corners, again, should branch off at slightly obtuse or acute angles, or those joining the main ones may even divide when near a junction, and leave a three-cornered piece of ground, which can be planted up with trees or shrubs of an ornamental nature, or contain a picturesque group of ordinary forest trees. Such corners, if not of too geometrical a nature, may represent the most picturesque features of a large wood, and enable the larger blocks of ground to be worked more economically, without destroying the whole of its ornamental features when clearing takes place.

The width of ordinary rides varies from 10 to 20 feet, but it is not necessary, and it is certainly undesirable, that this width should be absolutely uniform. Nothing, in the writer's opinion, spoils woodland scenery so much as that slavish maintenance of a long ride at one regular width throughout. On wet, heavy ground this is often due to the necessity for open drains on either side, and the raising of the middle of the rides to keep it as dry as possible, but the formal lines which may arise from this may be greatly modified by allowing an occasional tree or group, or a few bushes or shrubs to stand on the ride itself and break its

regularity, without interfering with its utility for riding, carting, or shooting. On dry ground the avoidance of this defect is simple enough, especially when the rides are cut or trimmed annually, as is usually the case. In nine cases out of ten, however, uniform widths are caused by the workmen themselves, who invariably do work of this kind more or less mechanically, cutting back grass, bracken or other growth, to a regular distance in either case, and cutting off the sides or through the centres of projecting bushes on the same principle that they would trim a hedge. This is particularly noticeable in rides running through under-wood, where the stools nearest the ride on either side are invariably trimmed back in a perpendicular line, which gradually assumes the appearance of a wall of shoots, behind which little or nothing can be seen, and which renders one ride as much like another as one stool of under-wood is like its neighbour.

But, whether rides run through under-wood or high-wood, the same principle ought to be observed in either case, namely, that these should vary sufficiently in width and straightness, to avoid sameness and monotony. Whatever shrubby growth is on the margins should be allowed to grow practically unchecked, unless it encroaches on the ride to an undesirable extent, when it is better to remove it altogether or cut it to the ground, than to keep trimming it back until it assumes an unnatural appearance, and rises in the shape of a wall. On the margins of rides, again, trees and shrubs should both be represented. It is not unusual to see broad rides from the edges of which ordinary timber trees have been entirely removed, shrubs and specimen trees alone being represented within a chain or so of them. Such rides may be ornamental and appropriate enough in a pleasure ground, but they are certainly not natural in a wood, where one at least expects to find the shade and shelter, afforded by an overarching canopy of foliage, more or less in existence. In fact, that attempt to keep trees at a distance from the ride, so that the latter may be fully exposed to sun and air, simply results in the conversion of the ride into an unnatural hybrid between a glade and a woodland path, which is too narrow and formal for the one, and too wide and regular for the other. As far as the

STRAIGHT RIDE THROUGH BEECH WOOD.

DRIVE THROUGH MIXED WOOD.

picturesque alone is concerned, nothing can be better than the rough woodland road with its wheel tracks winding in and out between the trees, or the well-trodden path, which is invariably picturesquely crooked without going unduly out of its way. An old oak or ash leaning across a ride, or standing so close to its edge that its gnarled and bulging roots project half-way across it, may be a fault in a mind in which tidiness and formality amount to a disease, but will never be objected to by the true lover of the picturesque.

Another pleasing effect is often produced by rows of trees standing on either side of a straight ride, their tall clean stems standing up like pillars of masonry, and forming a beautiful vista from either end. Such woodland avenues are far too few, although it takes many years before they come to perfection. As examples of trees forming this kind of avenue may be mentioned the beech at Savernake, the cathedral firs at Lord Bathurst's, Cirencester, the lime avenues in the grove at Longleat, the Spanish chestnut avenue at Cowdray Park, Sussex, etc., while numerous double avenues in parks, as well as those bounding many of the green alleys of the formal style of gardening all over the country, exhibit the same class of landscape forestry.

ARRANGEMENT OF SPECIES.

It has already been pointed out that the character of a wood depends almost entirely upon the way in which the different species which compose it are arranged. The æsthetic effect of a mixture of trees may be said to be of two kinds—that which is due to their various tints, and density of form or foliage; and that dependent upon their character generally, such as height, fulness of crown, straightness and cleanliness of stem, and capacity for growing in dense or open masses. The former of these effects is of most importance on the margins of plantations, or in small clumps which have been planted, or are maintained, to produce masses of foliage. In such cases the judicious mixture of different species of hardwoods has a fine effect, when light-

and heavy-foliaged trees are introduced in small groups at or near the outside.

But too much cannot be said against the indiscriminate mixtures often seen in plantations of late years, and which are often referred to as "ornamental." Indiscriminate mixtures invariably produce abrupt contrasts, which do not constitute beauty in any scene; and it is as unnatural to find an isolated patch of a totally distinct species from that constituting the mass of the wood, as it is to see an isolated patch of wood on bare ground or hillside. One species should blend with another in any mixture, and the effect is much better when the general character of a wood, or part of a wood, is present intact, than when it is made up of two or three totally distinct features, without any apparent reason being forthcoming. No native tree, for instance, at all resembles in habit or foliage a *Thuia* or a cypress, let alone an *Araucaria* or *Wellingtonia*; and such trees in a natural bit of indigenous woodland, give it an incongruous aspect, which is quite out of keeping with the truly picturesque. One or two ornamental trees here and there have a far better effect than a larger number standing at regular distances apart, and a plantation planted with common species only is often far more ornamental than one crammed with expensive trees mixed without harmony or taste.

ORNAMENTAL CHARACTER OF TREES, AND TREATMENT REQUIRED.

SCOTS PINE.

In a wood composed chiefly of evergreens the Scots pine has few equals, and probably no superiors, as an indigenous back-ground. Its well-shaped, reddish-brown trunk, its dark green, glaucous foliage, and the beautiful habit which isolated trees or groups exhibit when mature, render this species one of the most ornamental of British trees. Its chief advantage, of course, lies in its ability to grow and develop on soils

which are usually too poor and dry for most trees, while it is equally at home on wet moorland. It thus affords an opportunity of turning poor heathy ground, which is more or less useless for profitable cultivation, into a picturesque bit of forest scenery, and, when the most favourable spots are planted up with a few ornamental conifers, or evergreen shrubs of the American peat plant type, the formation of an ornamental woodland is at once accomplished.

Scots fir appears equally to advantage in thick clumps, or when isolated and standing singly. It is a tree which is well adapted for leaving entirely alone, if properly planted to begin with, and is seldom improved by thinning or artificial assistance. On heaths and poor ground it usually reproduces itself freely if given the necessary space, and in such cases it arranges itself in groups and small clumps and single trees, which have a very picturesque effect when they have had time to mature. In fact, trees which have lost their leaders, or have grown into crooked stems early in life, often develop, when isolated, a fine spreading head, the lower branches of which take on that beautiful drooping habit which renders this tree so much admired. Half a dozen such trees scattered irregularly over an open spot in a thick wood, mixed with a beech or two here and there, form some of the most picturesque objects that can be found in woodland scenery, and, with a carpet of heather or bracken below, an ideal landscape is produced. This drooping habit of the branches, which old Scots firs exhibit, and which has gained for such trees the title of "bonnet" fir, has often been attributed to the weight of snow on the branches. But in reality it is due to the slowness of growth in the wood of the branches, which renders the latter more slender and pliable, in relation to the amount of spray they have to bear, as age increases. No doubt, snow assists in giving the branch a certain droop, especially at its junction with the main stem; but, as this type of Scots fir is almost as common in the south as in the north, it is obvious that the effect of snow has been greatly exaggerated. A special feature of the crowns of mature Scots firs, and which distinguishes them from the majority of conifers, is their round-headed character, in contrast to the more pointed crowns of most conifers. This feature is one

reason for their harmonising better with most hardwoods than such trees as have the habit of the spruce or larch, and possess a spiry top. Beech and Scots fir make a fine combination, especially in autumn and spring, when the rich tints of the former tree in autumn, and the warm purplish-brown buds and twigs in spring, blend well with the dark glaucous green of the Scots fir needles, and in sunlight produce a rich mass of colour in isolated clumps, or on the margins of woods. Birch and Scots fir, of course, is a mixture which one almost looks for under any natural conditions, and there are few trees which fail to mix with Scots fir successfully.

THE BIRCH.

Another deciduous tree, which is naturally associated with most types of woodland, is the birch. Being of lower stature than most trees, it should not be mixed regularly with them, but the two should stand more or less in distinct groups—the Scots pine, spruce, etc., forming the larger and thicker masses, and the birch scattered along their edges, or standing thinly on the more open ground. The birch makes a beautiful contrast to the pine. Its silvery, variegated bark, and pendulous spray of purple twigs and buds in winter, its delicate green in spring, its feathery plumes in summer, or its pale yellow tint in autumn, relieve the dark and unchanging hues of the Scots pine at the different seasons of the year, while its more or less crooked and leaning stems intensify the effect of the perpendicular columns of the pines, and take away that somewhat monotonous and depressing effect which large and unmixed pine woods are apt to produce. Birch probably produces the best effect when planted, and allowed to stand unthinned, in thick but small clumps, with an occasional single tree or two in between. These clumps throw out leaning stems in all directions, some almost crawling along the ground for a short distance, and then rising in graceful curves; others growing into tall slender poles, surmounted by a weeping head of delicate spray. In fact, the birch is a tree which has many friends

and no enemies as an ornamental tree, and no coniferous wood can be said to be complete without it.

THE SPRUCE.

The spruce tribe have a good effect in ornamental woodlands, when planted on steep slopes, or the sides or bottoms of ravines, where the conical and regularly shaped crowns rise one above the other in serried ranks, On flat ground they are probably most ornamental when young, well clothed with branches to the ground, and symmetrical in shape; and a few spruce amongst or under Scots fir have often a good effect. When old and mature, spruce can only be termed ornamental when in perfect health, and clothed with branches to the ground, or standing close enough together for its tall clean stems to produce an effect in themselves. Good specimens in the former condition are often beautiful examples of the more symmetrical type of conifer, and, when standing in the bottom of a valley where their entire length can be seen from above, and properly appreciated, they are probably as ornamental as any conifer that can be grown in Great Britain.

When once the spruce begins to lose its health and vigour, all its attractions disappear, for it is seldom a picturesque tree, or one which age and decay render more worthy of admiration. Occasionally, however, a spruce may be seen which has lost its leader early in life, or been overturned by the wind and allowed to remain. Such a tree will often develop a group of leaders instead of the ordinary single one, and, although of little use as timber, affords a pleasing variety to the normal type, and a picturesque detail in the wood.

As a general rule, the spruce should be confined to small groups, or be scattered about singly in exceptionally suitable spots, such as old quarries, damp hollows, or beneath the shade of old Scots fir or other trees, where a little youth and vigour afford variety, and where it can be removed when the ornamental stage is passed, which is usually by the thirtieth year. Few trees are more ugly than an isolated middle-aged

spruce, with the lower branches dead or dying, and forming a thick, bristly, brown mass, which remains on for many years, for few trees retain their dead branches so persistently as the spruce. This tree should therefore either stand in close masses, or singly as specimen trees, and, when the latter have lost their lower branches, it is better to take them away altogether.

THE LARCH.

Although the larch occupies such an important place in woods intended for profit, it cannot be said that it is a great acquisition in ornamental woodlands, except when used in much the same way as recommended for spruce. In old age, however, the larch is, as a rule, much more picturesque than spruce, and, when standing singly or in a small group, is well adapted for giving that amount of deciduous character to evergreen woods which is necessary for the sake of variety. When young, single trees or scattered groups are often ornamental when healthy and free from disease, for the crown of an isolated larch develops a pendulous or weeping habit, which gives it a lightness and elegance which the majority of conifers lack; while its open crown in winter, and delicate green foliage and red catkins in spring, afford a pleasing contrast to the heavier and more uniform shades of Scots fir or spruce.

It is scarcely necessary to add that larch should never be used in ornamental woods in the same way as in mixed or ordinary plantations. By so doing, it not only loses its ornamental character, but destroys that of the surrounding trees, although it may be a source of profit to some extent.

THE OAK.

The oak is undoubtedly the tree which invests an English woodland with its most characteristic features, for, while all other species are either introduced, or more or less peculiar to different localities, the oak is practically ubiquitous, and is an invariable constituent of all natural forests. While there

are few grander sights than a clump or grove of old and well-proportioned oaks, it is the most difficult of all species to produce in perfection, and requires a period of time of which the life of a man constitutes but a fraction. For this reason, if no other, the planting of oak is not work which appeals strongly to self-interest, or to those who study immediate effect above ultimate success. Yet, when once established under suitable conditions, and left practically alone, it requires little or no skill to produce, by slow degrees, one of those picturesque old groups of oaks which are the pride and glory of all those who happen to possess them. To leave oak out of a plantation altogether, when the soil is suitable for its growth, therefore, is an omission which does not seem justified on patriotic grounds; for, however low the value of its timber may fall, it will long be regarded as an emblem of British strength and character, and in that capacity must appeal to every genuine Englishman.

The best method of raising oak in an ornamental wood is probably that of growing it more or less pure in groups or clumps, in which the trees can fight it out amongst themselves, and gradually develop into those picturesque groups and single trees which are so characteristic of a natural British forest. The ground need not, of course, be entirely occupied by the oaks. When once the latter are thoroughly established and have attained a height of 10 to 20 feet, many lower forms of forest vegetation may be allowed to grow up beneath them, such as brambles, bracken, gorse, broom, etc., while yew and holly are specially suited for growing amongst oak, and improve its appearance during the winter months immensely. A few beech or ash in a group of oaks also afford variety at all seasons of the year, but the practice of mixing too many, or unsuitable, species with oak cannot be too strongly condemned when a good effect is desired.

Many fine and promising clumps of oak have undoubtedly been spoilt by thinning as much as anything. While this operation may be beneficial when skilfully applied to oak woods grown simply for timber, it is doubtful if it can do any good, and can certainly do a great deal of harm, when practised on groups of oak grown in parks or woods for

ornament. An oak clump in which the trees have grown up together from infancy as a more or less solid mass of foliage, usually exhibits every form of stem and crown. Some have taken the lead from the start, and have developed tall stout boles and massive crowns; others have been more or less overshadowed by their stronger brethren, and have only been able to push up a thin tuft of foliage to the sky on an attenuated and more or less crooked stem. Others again, towards the outside, have thrown out a few horizontal branches to the light from short and leaning stems, and are little more than bushes in height, or gate-posts in diameter. Yet, whatever their form or development has been, they are all more or less essential to the completion of the group; and to take out the smaller and weaker individuals at any time after middle age not only destroys the general effect, but may even stunt or affect the growth of the larger trees. While the crown of an oak may require a good deal of light and air for its healthy development, its stem should always be as closely shaded as possible, unless fully exposed from the first. To expose it late in life invariably leads to the breaking out of water branches, or epicormic shoots, up the whole length of the bole, and these in their turn check and stunt the growth of the tree during the remainder of its life, in addition to disfiguring it as an ornamental object. The only satisfactory method of thinning an oak clump is to clear it away altogether, unless one tree or so happens to exist which, from its comparative isolation previously, is adapted for standing alone.

THE BEECH.

While many trees look almost equally as well when grown in the open as in close woods, there is little doubt that the beech only looks its best when grown in thick masses or in the recesses of a dense wood. The reason of this is not far to seek. The beech is a tree which can dispense with a great deal of the air and light which are necessary for the development of many trees, and its natural tendency is to take full advantage of those elements whenever they are available. Grown in the open, therefore, it forms one of the

fullest and best developed crowns possessed by any tree; and this often gives it a heavy and clumsy appearance, which few lovers of the picturesque can find pleasure in contemplating. This unpicturesque appearance is not so much due to the full, round, and semi-globular shape of the crown, but to the close and regular mass of foliage of which it is formed. In all full-crowned trees which can be termed ornamental, this character depends a great deal upon the openings or gaps in the crown, due to the unequal length and size of the branches, which does not necessarily affect their symmetry, but gives light and shade effects, or depth, to the foliage. In fact, the effect produced is much the same as that by the broken and indented margin of a wood, or by single trees or groups standing outside the margin.

But, in the case of a beech crown, depth is invariably absent, as the branches terminate in a mass of stiff twigs, which present a regular surface of foliage or buds to the eye, while the outline is equally regular, unbroken, and monotonous. These were the features of beech trees which offended the eye of Gilpin so greatly, and which led to his describing the "massy, full-grown, luxuriant beech" as "rather a displeasing tree." "It is made up of littlenesses, seldom exhibiting those tufted cups or hollow dark recesses which dispart the several grand branches of the more beautiful kinds of trees." "In full leaf it is equally unpleasing: it has the appearance of an overgrown bush," etc. etc.

But in a grove or wood the above objectionable characters are replaced by far more attractive ones. The round, globular, bushy crown gives way to a tall column of bare stem, or, when allowed more space, by a bole clothed more or less with gracefully drooping, frond-like branches, which overlap each other like the folds of a curtain. The leaves and spray assume a more delicate texture, and that dinginess which beech leaves put on in late summer, when exposed to a hot sun, is rarely seen in the recesses of a wood.

On a hillside the crowns of beech trees, when viewed from a distance, exhibit a smoky purplish tint, which is very beautiful in March and April, but the effect disappears when approached. But to see a beech grove or wood breaking into leaf in spring, or putting on its tints in autumn, is to see one of

the finest sights to be obtained in English woodlands, and one which should be provided in all ornamental woods on a larger or smaller scale ; the more so, as there are very few soils or situations on which beech will not grow. As with many other trees of this kind, however, it does best and looks best when massed, and kept as a more or less pure group, single trees being scattered about here and there amongst oak or other trees, where their tendency to branch out too strongly will be more or less counteracted by side shade. Such groups, if rabbits are kept in check, will reproduce themselves naturally when gaps occur through wind or decay, and a wood composed of different-aged clumps which have sprung up naturally from seed, and been left more or less to themselves, is far more attractive than one regenerated artificially. The centres of such clumps invariably grow into tall, fine clean stems, while the more or less suppressed trees which are able to survive give the required amount of variety and contrast. A few hollies or yews, the only species able to live with beech, will give the evergreen sprinkling which is desirable for this type of woodland. A ride or road running through a thick beech-wood, bounded by the tall clean stems, and overarched by the topmost branches, has a wonderfully fine effect, especially if the ride runs east and west, so that the rays of a rising or setting sun happen to flood or illuminate its entire length at certain times of the day. The grey or olive tints of beech bark are also very fine, and assume a silvery tint under the influence of sunlight. But it is probably in April and May, when just breaking into leaf, that the beech assumes its most beautiful character. The delicate green of the young foliage, and the manner in which individual twigs and shoots break suddenly into leaf, while those round about are still bare, produce an effect which has few equals and no superiors in woodland scenery ; while the changing foliage in autumn is equally attractive from the same individuality exhibited by different parts of the same tree.

THE ASH.

The ash is generally considered to be one of the most beautiful of trees, and it owes its reputation more to its lightness and elegance when standing singly and unconfined, than when crowded up in a thick wood. When young, and consisting practically of a single stem, the ash is not particularly ornamental; but as the side branches gradually develop and clothe the stem with light feathery foliage, or with spray which gradually acquires a drooping habit, the ash fully deserves all that can be said in praise of it. In a crowded wood the branches are entirely confined to the top of the tree, and therefore its most ornamental character cannot be seen under such conditions. To obtain picturesque trees, space is necessary after the first twenty or thirty years, and the best specimens are invariably found in the open, or on the margins of plantations or groups. Few situations suit this tree better than the sides of ravines, or the banks of streams, where at least one side of the tree has unlimited space, and the stem and branches can acquire those graceful curves which are seen to perfection in few other species, and give it a totally different character to that possessed by an oak or beech. These lines of beauty are well described by Gilpin, who writes of this tree: "But its chief beauty consists in the lightness of its whole appearance. Its branches at first keep close to the trunk, and form acute angles with it; but as they begin to lengthen they generally take an easy sweep, and, the looseness of the leaves corresponding with the lightness of the spray, the whole forms an elegant depending foliage. Nothing can have a better effect than an old ash leaning from the corner of a wood, and bringing off the heaviness of the other foliage with its loose pendant branches."

A more modern writer, and one who did not make trees such a speciality as Gilpin did, thus refers to the ash in woodland scenery: "If you put mercury into a solution of nitrate of silver, and leave them for a few days to combine, the result will be a precipitation of silver in a lovely arborescent form, the *arbor Dianæ*, beautiful beyond

description. Such are my favourite ash trees when the summer sunshine sparkles on them. It is their bare silvered trunks that give the special charm to these hanging woods."

Although the best features of the ash are only brought out when the tree approaches maturity, yet, in the form of saplings or coppice, it adds greatly to the beauty of any wood or copse during the summer months. The straight slender rods, with their pairs of pinnate leaves, give a lightness to the under-wood which is absent from other species, and in old oak woods especially this effect is produced to a greater extent by the massive trunks of the old trees, and the flecks of sunlight which penetrate their crowns.

Probably the ash is seen at its best during the summer months, when its foliage is fully developed, and has acquired that open, perforated leaf surface which gives the tree such a beautiful appearance when seen at a distance of 100 yards or so, or even farther, and which resembles a lace-work screen more than anything else. For this reason, the ash is particularly adapted for clothing the face of banks and slopes, where depth must be obtained by the open order of the trees, but where the crowns of beech or oak would become too heavy and rounded. The leaves of the ash, or rather its leaflets—for the leaf is a compound one—have just that amount of healthy vigour which saves them from becoming gross and rank. The autumn tints are not striking, and in certain seasons are entirely absent, the leaflets falling off the stalk while still green in late October. Not the least of the attractions of this tree are the lichens and liverworts, which mottle its trunk with browns, olives, greys, and scarlets.

ORNAMENTAL TREES AND SHRUBS IN WOODLANDS.

So far, only the characters of the common forest trees of English woodlands have been dealt with. A few remarks may now be devoted to those trees and shrubs which are usually regarded as being of little or no economic value, but which are planted for their ornamental effect alone. Reference has already been made to the practice of planting

many of these in such a way that they only become eyesores in themselves, and destroy the character of other trees around them. This practice is probably more prevalent at the present day than it has ever been, and is due to several causes.

In the first place, the number of species which are at the disposal of the ornamental planter to-day are innumerable, and as their propagation increased, the cost of producing them has gradually decreased. This has led to their being much more freely used in all planting operations than when the cost was more or less prohibitive, and when custom and necessity compelled the planter to depend more upon indigenous species.

Another cause is the entire lack of taste exhibited in a great deal of modern planting-work. The forester or his substitute, who happens to have a large number of such plants to get rid of, is naturally less particular where he places them than when they were scarce; and as the principle observed, in ninety-nine cases of mixed planting out of a hundred, is that of distributing the various species over the ground with mathematical precision, and filling up the intervals with nurses, instead of confining the former to the most suitable spots, it is not surprising to find a very large proportion of what ought to be ornamental trees and shrubs existing under conditions which not only prevent them from being seen by the ordinary visitor, but also effectually destroy all that is of an ornamental or useful character about them. There is nothing, for instance, ornamental about a Douglas fir, *Wellingtonia*, or any other conifer planted alone in the midst of a mass of larch, spruce, or Scots pine, which results into its growing into neither a good timber tree nor a satisfactory specimen. If of faster growth than the trees around it, it develops a gross top-heavy crown, while the lower branches are not killed off clean and effectually, as they would be in a thick wood, but are stifled and crippled in a manner which is ugly in the extreme. If of slower growth than the nurses, again, it is quickly crushed out, and its place might just as well have been filled at the outset by an ordinary timber tree at one-twentieth the expense.

Another tasteless style of planting ornamental trees is that of planting them at regular intervals along the edges of rides. When one species only is used, and planted close enough to form an avenue in course of time, this plan sometimes leads to good results; but when perhaps half a dozen different conifers are used, and planted in regular succession like sentinels from so many regiments, the general effect is anything but good, for the constant repetition becomes monotonous, and is, further, out of character with the surroundings. One does not expect or look for a collection of ornamental trees, or a display of specimens at every step of a woodland walk, and which are continually reminding one of the artificial origin of the wood. When other than indigenous trees are used, they should appear as if they had come there by accident as much as design, or at least their artificial arrangement should be disguised as much as possible.

A far more appropriate form of planting artificial trees is that which arranges them here and there in groups throughout the wood. Arranged in this way, their true character is able to develop, and they form distinct features in the scenery, instead of being lost or disfigured by unsuitable neighbours. Even this style, however, is liable to be abused in one or two ways. In some cases too many species are employed in planting them, instead of one or two only. In such cases character is lost, and the clump becomes a jumble of different colours and foliage, which cannot be called really ornamental. In other cases the trees are planted at too wide intervals to grow up in close order, and yet not far enough apart to enable them to develop as specimens. The result is that the lower parts of the crown are cramped and confined, while the stems are sufficiently coarse and knotty to prevent the trees ever becoming of use or ornament as timber specimens. Sometimes, again, the clumps form too great a contrast to the surrounding wood. This is often the case when the clump is composed entirely of a species which is not represented amongst the adjoining trees, thus rendering it too prominent and distinct to appear quite natural. This defect can, and should be, avoided, by gradually leading up to, or toning off, any distinctive clump

of trees by mixing the same species more or less with the prevailing type for a short distance round about. A clump, the boundaries of which can be followed in a square or circle by keeping to the outside trees, is not a desirable type by any means, especially if the species can be recognised at a distance. Take, for instance, a clump of *Thuia gigantea* or redwood, standing amongst Scots fir or larch. The habit and foliage of the two former are quite distinct from those of the two latter, and a pure compact clump of either of them appears as a round island in the midst of a lake. But by thinning out the margins of the clump, or projecting its trees into the surrounding wood, the compactness is taken off, the boundary line obscured, and the clump has a more natural appearance.

Situations for ornamental clumps are also badly chosen at times. The most prominent situations, such as the end or corner of a ride, or high hillock, are not always the best for placing the most distinct species. Soil and situation must of course be studied from an arboricultural point of view, in the first place, and the species planted where it is most likely to thrive and develop properly. But, apart from this, the clumps should be placed in such a way that they do not bring themselves into notice in an unnatural manner, or do not stand at set distances from the ride. Although it may be a fault to plant too near the latter, it is equally a fault to place all of them too far back, reminding one of auctioneers' notice-boards on building plots. No harm is done by planting an occasional clump on both sides of a ride, and so near that the latter appears to run through it; and in the same way a small group planted so that the branches overhang, and the stems stand on the margins of the ride, affords variety, and does not interfere with its use. In short, it is of little importance what style is adopted for the planting of ornamental trees, so long as they can develop their true character, harmonise with those round about them, and appear as natural instead of artificial objects in the wood.

The planting of rarer kinds of trees, which are too scarce to be planted in groups, calls for few remarks. Their scarcity prevents them from affecting the character of the wood in any way, and the only important principle to be borne in mind is

that of giving them every opportunity, by means of suitable soil and situation, of developing into interesting specimens. Such situations may often be found in those gaps and open spaces between the commoner species, and which exist within sight of the ride, but not necessarily on its margins.

The planting of shrubs in a wood is, in our opinion, often carried to excess, although their ornamental nature is usually made the excuse for it. While a certain amount of undergrowth is desirable, both from a sporting as well as an ornamental point of view, the bulk of this undergrowth should consist of bracken, brambles, and other indigenous growth of that nature. Deciduous shrubs are also more admissible in a wood than evergreens, such as laurels, rhododendrons, etc., as they not only blend better with the trees, but are not so dense and heavy. In coniferous woods, generally, evergreens have a fairly good effect if not overdone, as they harmonise better with the foliage and shades of the trees, and the contrast is not so violent. But the objection to evergreen undergrowth lies in its blocking out, more or less completely, all those vistas of tree trunks which are the chief charm of woodland scenery, and their unnatural bushiness goes badly with ordinary forest trees; while their compact and heavy character, and uniform appearance throughout the year, does away with a great many of the finer features of an English woodland.

Unless repeatedly cut down, great masses of laurels or rhododendrons not only confine the view beneath the trees, but, by rising to a height of 15 to 20 feet, give the trees above them a dwarfed and unnatural appearance, and hide up many of those features upon which their attractive appearance depends. This applies as much to conifers as to deciduous woods, and shrubs of that nature should stand more or less alone, or be mixed with those of a similar habit, and not planted extensively under tall trees. There is little doubt that a large number of woods, and even shrubberies and pleasure grounds, are spoilt to a great extent by the excess of rank evergreen growth they contain. In mid-winter, perhaps, they give such spots a warm and snug

appearance, but they are far too heavy and dull for beauty or tasteful effect. When consisting of the dwarfer and choicer specimens, such as *kalmias*, *berberis*, *cotoneaster*, etc., the above objections do not apply to the same extent, as when planted in twos and threes they do not spread in the same way as *rhododendrons*, or rise to the height of the *laurels*.

An objectionable feature of *rhododendrons* on sandy or peaty soils is the freedom with which they spread along the surface of the ground, or spring up from seed. In such cases they will, if unchecked, cover acres of ground with a dense and impenetrable growth, through which nothing can force its way. When this occurs, energetic cutting and grubbing must be proceeded with, if the wood is to be saved from becoming entirely blocked up, while all seedlings should be pulled up before getting a firm hold of the ground. Cutting during the summer months is also a good means of weakening their growth, although they are difficult to kill outright, and their stumps are troublesome things to get rid of, even when grubbed.

One extremely tasteless method of planting shrubs is that of confining them to a strip along each side of a broad ride, and in front of ordinary forest trees. Planted in this way, they tend to dwarf the trees behind them, shut out the view between the trees, and in the course of time acquire the form of an overgrown hedge, which shuts in the ride on both sides and deprives it of all variety and interest.

The safest plan to adopt, when planting shrubs for ornament, is that of using them sparingly, except where thick growth is wanted for shooting purposes, when compact and close-growing deciduous shrubs, such as *spiræa*, *dogwood*, and so on, with an occasional patch of *privet*, *berberis*, etc., to give colour during the winter, might be put in at corners and other spots, where they will be effective, without being sombre and heavy, as are *laurels* and *rhododendrons*. In planting such corners, however, it is not necessary to crowd everything into one small patch of ground, as is often done. By means of a few outlying clumps, and grouping the different species, these corners may be made as ornamental as they are useful,

instead of being a dense lumpy mass, through which beaters can hardly break their way, and out of which pheasants rise in a flock at the finish of a beat.

TREATMENT OF ORNAMENTAL WOODS.

After an ornamental wood has been once planted, little requires doing beyond taking such steps as are necessary for the proper development of the trees. Nurses, or temporary groups, planted to fill up or for immediate effect, may have to be removed from time to time, but, as a general rule, trees of this class should not be put in more than is possible. Where something of a temporary nature is needed, gorse, broom, or such growth, is most suitable, as the small size of the trees when first planted gives the ground more the character of a common or waste than a wood. As time goes on, the cutting back of overgrown shrubs, or the removal of dead or dying trees, is work which invariably requires attending to. In this, mere "rule of thumb" should be avoided as much as possible, as cutting back shrubs to a set distance from a ride, or the trimming and cutting of the latter in too methodical a manner, often forms an unpleasant artificial line, and spoils the picturesque effect of the wood to a great extent.

If rabbits are kept well down, woods containing a good number of indigenous trees rarely need replanting, as seedlings will always be coming up from time to time. When an old clump has been gradually thinned out until little remains, or is so shattered that its removal is necessary, self-sown groups may often be allowed to take its place, and are best left more or less alone. Any attempt to encourage their growth, or improve their appearance by artificial thinning, usually makes matters worse instead of better, for it tends to produce a monotonous type of tree throughout the wood, and destroys its most picturesque elements. In replanting, an opportunity is often presented of introducing a little more variety in heights and ages, and filling up clumps with trees of the same species, so as to resemble natural regeneration as much as possible. Nothing looks better than to see a few young trees growing

up naturally round the bole of an old veteran, and partly screening its stem with spray and foliage. Planted midway between the old trees, as is often done, the effect is rarely good, and gives the wood a heavy and unnatural appearance.

CHAPTER XI

PARK TIMBER

HOWEVER weak the majority of English estates may be as regards examples of economic forestry, there is little question about their ability to show picturesque park scenery, and the finest effects which the art of the landscape gardener can produce. Originally, no doubt, parks were formed and maintained for the purpose of fencing in the beasts of the chase, such as deer, and thus rendering it possible for the Norman baron or bishop to enjoy, on a small scale, the sport afforded by the more extensive forests of the king. They were also used as a kind of paddock for breeding and feeding the deer destined for the venison pasties so esteemed at the tables of the great, and in the *Anglo-Saxon Chronicle* frequent mention is made of the "deer-fold"—usually that of a bishop, as that of Peterboro'. A few parks are supposed to have existed in Saxon times, and amongst these have been maintained Eridge, Eastwell, Blenheim, and Knowsley. Enclosures for wild animals are frequently mentioned in *Domesday*, and although no precise description of them exists, the natural inference is that they were simply tracts of the waste or forest fenced round to keep in the larger game. But before the Conquest it is not probable that parks existed on a large scale, or in great numbers. The Saxon Thanes, fond as they were of sport, preferred to take it under natural conditions, and that conversion of the "fole land" into "lords demesne" had not proceeded to any great extent under their rule. It is rather to the Normans and Plantagenets that we must attribute the chief extension of parks, and which laid the foundation for their general distribution over the face of England. That this is so, is proved by the

constant grants for their enclosure during the twelfth and thirteenth centuries, which are found in the State Rolls and Charters of those periods. In Scotland no such process went on, as that country was not under feudal tenure; and to this fact may be attributed the absence of parks in that part of the country.

So far as size went, these ancient parks were probably no larger than those of the present day, although the area over which the deer now roam may have been gradually restricted by the fencing in of ordinary grazing ground, and the planting of woods or pleasure grounds. During the Wars of the Roses it is probable that many parks were devastated, and the ground they occupied subsequently put to other uses, as a result of the destruction and decay of the castles round which they had been formed.

During the reign of Elizabeth there were said to be seven or eight hundred parks in England. But this was a utilitarian age, and the enormous development of sheep-breeding probably brought the devotion of large areas of good land for the feeding of deer out of fashion. This was the day of the yeomen of England, and the multiplication of manor houses throughout the land, and very few of these manors possessed parks; nor was there any inclination on the part of their owners to form them. But the parks of the great nobles and prelates still remained, and, although many of the latter passed into private hands at the Reformation, it is not probable that any great decrease in their number took place after that period. During the Civil War a great number of parks were considerably damaged. The deer were killed, the timber cut down, and the park palings burned. This may have resulted in a few being abandoned when peace was restored, and it also did away with the deer of a great many; but the fact remains that the majority of the parks of the seventeenth century still remain, in addition to a large number of smaller ones which have been formed in modern times.

Although the term "park" is now applied to any tract of permanent pasture adjoining a mansion house, and outside the limits of an ordinary field, the word is only used here in connection with those stretches of timbered grazing ground

which have some resemblance to the natural forest or wooded waste of olden times, in so far that there is no sharp distinction between the land occupied by pasture and that by timber. They may vary in extent from a hundred to a thousand or more acres in extent, but in either case their attraction depends upon the distribution and character of the trees they contain, and the fitness of the latter for the positions they occupy.

The character of park timber may vary from the specimen tree grown in the open, and perfectly symmetrical in outline and form, to the bare stems and small suppressed crowns of the type of tree peculiar to close plantations. The one class of tree is as essential as the other, and all of the intermediate forms should be well represented in a perfect park. This variety, of course, can only be obtained after a sufficient time has elapsed for all specimens to develop and mature. The shapely lime or the full-headed horse-chestnut may be obtained in twenty or thirty years; the gnarled and shattered oak may require five hundred. The one type can be obtained within the lifetime of a man; the other is more the result of accident and neglect, and the effect of a long period of time, than to any definite forethought or design. Yet we are accustomed to look for both classes in a park of any extent, and something appears to be lacking when one or the other is absent. Fortunately, most of our parks have been in existence long enough to enable most trees to develop, and many of them to decay and disappear. Others, again, have been formed from parts of ancient forests, the tree-growth of which, in the form of oak or ash pollards, still lingers on, and gives that touch of hoary antiquity to ground which has otherwise been "laid out" centuries after the first enclosure was made.

A great difference of opinion still prevails on the subject of park treatment. Some appear to entertain the idea that a park should be a pleasure ground or arboretum on a large scale, roads taking the place of walks, and the teeth of deer, sheep, and cattle that of the gardener's mowing machine. We often find parks planted with specimen coniferous trees, fenced round with scrupulous care, and occasionally surrounded by a "trimmed" hedge or "ha-ha." The trees

MIXED GROUP.

GROUP OF ASH AND THORN.

PARK GROUPS.

are planted in regular figures and at set distances, and all minor growth, such as long grass, brambles, briars, etc., carefully removed, and the trees pruned from time to time to give them a regular shape. Near the mansion house, perhaps, a certain amount of tidiness is appropriate and looked for, but the greater part of a park of any size should be kept in as natural a condition as possible, consistent with the ideas of modern civilisation.

On broken ground or marshy bottoms it is useless, of course, to aim at trimness; and here nothing should be done to interfere in any way with the natural condition of the surface, unless it be to plant it with trees which will be appropriate to the surroundings. Willows and alders will grow in such places if nothing else will, and a few clumps or scattered groups of these will give all the variety that is needed. On the drier or flatter parts deer or cattle will usually do all that is needful in the way of keeping down rubbish, unless it be thistles and nettles, and these of course should be kept in check as much as possible. But thorns, both black and white, crabs, hazels, and such-like low forms of growth, should rather be encouraged than otherwise, for they give more variety in height and shape, and do more to break the browsing line here and there than ordinary forest trees. Lawns in front of the windows of the mansion house should be kept as clean and tidy as may be done without undue labour, but, when once a proper turf is formed, constant grazing will usually do the rest.

The species suitable for park planting include all the ordinary deciduous forest trees, and a few conifers. Ornamental trees, such as evergreens, symmetrical conifers, and such-like, should, in our opinion, be excluded. Oak, ash, elm, beech, birch, chestnut, lime, sycamore, plane, maple, with a few Scots firs or larch in suitable spots, should form the bulk of the trees represented, with willows, alders, and poplars in wet places. Thorns are, of course, a standing constituent of park vegetation, and these, and English maples, are particularly suitable where great height is not desirable. In the early stages of park-planting, quick-growing trees may be introduced for rapid and temporary effect, such as black Italian poplars, abeles, aspen, and so on, and a few of these

may be retained with advantage when the first object has been achieved. The beech has a fine effect in spring, and the aspen is a most beautiful tree through the summer months. Other trees of the same nature might be introduced, but character should be aimed at rather than too great a variety. A few groups of English elm, with their massive boles and branches, and their rich masses of tufted foliage, form grander features than a great variety of less conspicuous trees.

The distribution of park timber is affected by much the same principles as those already referred to in connection with the landscape effect of trees in general, and it will be sufficient to deal here with the character of park timber in the form of masses, such as groves or clumps, belts, groups, and single trees of different species, and the positions which are best adapted to show them to advantage.

THE CLUMP.

Of all forms of park timber, the clump is the one most potent for good or evil. Properly placed, and skilfully planted or thinned, it constitutes one of the most conspicuous as well as one of the most pleasing objects that can be found. In small parks clumps can only exist in small numbers and on a small scale, or they will block up the ground and obscure the view in every direction. But in large parks, clumps are absolutely necessary if adequate variety is to be secured, and the space become something better than a plain sprinkled with single trees, and every acre of which is a more or less exact copy of its fellows. The function of clumps is that of furnishing a number of small back-grounds which shorten the view in various directions, and produce masses of shade which will contrast with the more open portion of the ground. They also serve in hiding the skyline of bold or bare hills or hillocks, and give a depth and variety to the scenery generally, which would be impossible with single trees alone. Considerable skill and judgment are required, however, in placing clumps so that the end in view shall be obtained, and yet too great an interference

with the prospect be avoided. Where the hills or elevations are few in number, it is usually possible to clothe them all more or less with clumps, and leave at the same time abundance of open ground between and around them. But in very undulating or broken ground the most prominent elevations must be chosen only, or breadth will be sacrificed to an undesirable extent, and the view obstructed in too many directions. This must be especially guarded against in the fore- and middle-grounds, where the function of clumps is rather to break up the view into two or three parts than to form back-grounds or hide the sky-line; and in such situations this may be obtained by small groups. The farther back the ground lies from the principal point of view, the larger the clumps may be, until they merge into a belt or screen which forms the chief object on the horizon.

It is obvious that the proper effect of clumps can only be seen when viewed from the correct point, and therefore it is hardly possible to lay down more than very general rules for their formation. But it may be taken for granted that all prominent points, such as the summits of hills, the crests of ridges, and the edges of valley slopes, should be more or less clothed with clumps of one form or another, while the lower ground, valleys, etc., should be kept fairly open. On the face of steep slopes, on which the ground is broken, it is often difficult to decide where the clumps should stand and what should be left fairly open. The best effect is usually produced when the top of the slope is practically entirely covered with trees which gradually thin out as the hill is descended, and isolated clumps are only needed towards the base, as already pointed out in a previous chapter.

But it is rather the form and character of clumps that require consideration here. In nine cases out of ten, park clumps are given the most tasteless form that it is possible to select, namely, that of the circle. It is only natural that ground which requires fencing, as that occupied by all clumps must be when first planted, should be fenced in the most economical manner, and for that reason circular patches of ground are usually enclosed for the purpose. There can be little or no objection to this in theory, as the fence is merely

a temporary erection, and, when removed at the end of a few years, it matters little what its shape has been; but, in almost all cases in which this form of fence is adopted, the clump within is given the same shape. This is not only unnecessary, but is positively a disfigurement to the landscape; for nothing is more unnatural than to see a round compact mass of trees standing on a patch of bare ground. The cause of such unsightly patches is, of course, the method adopted when such clumps are planted. Instead of looking forward and anticipating the growth and development of the trees, the sole idea of the planter is to give his work a finished appearance at the outset. He considers that leaving a few patches of ground bare, or keeping the trees at anything but a set distance from the boundary fence, is an indication of bad workmanship, and certainly inferior to the method of putting in the trees at regular distances apart, and on exactly the same principle as would be followed when forming a plantation. If more than one species are used, the mixing is carefully regulated so that no two individuals of the same species are planted side by side, and to plant thicker in one place than in another is considered evidence of carelessness. The effect of such methodical methods of planting park clumps is the development of a solid mass of stem, branch, and foliage, which presents an unbroken front on all sides, except when gaps are formed by wind or old age.

When the trees consist of oak, elm, or ash, a certain amount of variety and depth may be present, as these trees naturally possess more broken and irregular crowns than those of beech or hornbeam. But with the latter trees no such relief is possible, and the clump has much the same appearance as a large overgrown bush, or one of those clipped box bushes or yews which the gardener with no taste, but a yearning after the formal style, delights to produce. It is many years since the absurdity of these circular clumps was exposed by Sir Vvedale Price, in his *Essays on the Picturesque*, published in 1810. At that period, the effect of Brown's style of landscape gardening could be seen in a general way, and, while his ideas had not had time to fully mature, they were sufficiently advanced to allow their results to be seen. So far as position went, the majority of Brown's clumps were

admirably placed, and, had the details of his work been as skilfully carried out as the main idea, little could have been said against them. But whether from lack of opportunity, or too close an observance of a fixed but narrow idea, these clumps were made in such a formal manner, and composed so largely of beech (a tree which aggravated their formality rather than modified it), that they soon acquired, amongst persons with true taste, an unenviable notoriety.

Price's *Essays* fully exposed the tasteless character of these clumps, and pointed out the anomaly of replacing the formal style of landscape gardening, with its stately avenues and tree-shaded canals, by one which was in reality just as formal, but lacking the beauties which characterised its predecessor. He ridiculed the invariable formation of a belt round every park, and the planting of bald and circular clumps at regular intervals in a detached and semi-disconnected manner; the successive use of tame and uninteresting curves on the banks of lakes and the edges of woods; and deprecated applying the same treatment or method of laying out to all sorts and conditions of landscape and varieties of ground. Whether Price's remarks were fully appreciated at the time or not it is hard to say, but, judging from the numerous examples of Brown's work, which are still retained in their entirety, it is probable that true taste was not a more common attribute of the average individual a hundred years ago than it is to-day. Had they been taken in hand in good time and judiciously thinned, these clumps would have lost a good deal of their formality; but whatever thinning was done, was done in exactly the same style as would have been appropriate for a plantation, namely, simply a methodical process of regulating the distance from tree to tree, so as to produce a regular distribution and uniform size. Had they been boldly cut into here and there, leaving small thick clumps to stand at the margins and develop untouched, that depth and irregularity in height and density would have been produced which is so desirable in all park clumps. But, so far as one can judge now, they were allowed to grow untouched for a number of years, and then thinned out with a view to develop individual trees, rather than with the idea of giving the entire clump those

features which would render it a means of improving the landscape.

The formation of a picturesque clump must be begun at the time of planting. Let the fence be round, square, or any other shape it may, the grouping and arrangement of the trees should be done independently of it. The most economical shapes are probably the circle or the hexagon, as they look better when the trees are small, and while the fence is a prominent object on the ground. But the trees within should be arranged on other than geometrical lines. Clumps in the shape of an irregular letter Y are probably most ornamental, as they form recesses and projecting points on all sides, and thus acquire depth and irregularity. Star-shaped clumps are also good for the same reasons, but any shape which does away with formality is better than nothing. The recesses formed by such figures can be utilised for planting thorns and other small trees, which will fill up the space for the time being, and afterwards exist in the form of undergrowth, or a single tree or two may be planted in them. Species which vary in height and density of foliage should also be represented in a clump of any size, as that will prevent the regular rounded outline which is so objectionable when constantly repeated over a wide area, and which results when pure clumps of any species are present. As a general rule, hardwoods and conifers are better not mixed, but the Scots fir is rarely out of place in any clump, if not overdone. Oak, of course, is a standing constituent of all forms of park timber, while ash, Spanish chestnut, birch, etc., are also suitable. English elm, lime, horse-chestnut, etc., look better in small groups by themselves or as single trees, and beech should be confined to the larger masses to which its heavy nature is more appropriate.

The formation of clumps on hillocks requires especial care, if they are to possess a natural appearance. Too often a round clump is perched on the extreme summit without any surrounding trees to break the outline, and in such cases it can never assume a natural appearance. When the area it covers is too large to fence in any ground beyond its base, a small detached group or two must be planted a few yards from its boundary here and there, while the clump proper

should be planted as irregularly and openly as possible. By such means the boundaries or outlines of the clump are effectually obscured, and the opportunity is taken of obtaining the variety due to the alteration of ground level, and at the same time obscuring the ugliness of a tame sky-line.

As regards the thinning of clumps, it may be said that a clump properly planted is better left unthinned. The chief fault in most clumps is the want of natural grouping, which is more or less prevented by thinning. Leaning stems, several trees springing from the same point, and that formation of composite crowns which results when two or three trees have stood close together from the first, are the most attractive features to be found in park or forest scenery, but which too careful thinning invariably prevents. When planted too thickly or formally at the outset, however, thinning may do much to correct or modify faults in these directions. The object to be aimed at in such work should be that of breaking up the margins where these are too regular in outline or too flat in surface, and by cutting a hole or two here and there, and isolating a marginal group of two or three trees in such a way that they will eventually acquire an easy and natural shape of stem and crown, and disguise the fact as much as possible that artificial thinning has been done. In any case regular thinning should be carefully avoided, and an attempt made to imitate that natural arrangement of self-sown clumps which never proves distasteful or formal.

THE GROVE.

The grove is a feature of park scenery which is especially appropriate to large parks which require splitting up into two or three portions. It is often the means of separating the more polished and tidy portions of a park near the mansion from the wilder and more forest-like tracts farther away, and represents the denser parts, which are popularly but erroneously considered to be the only typical portions of a natural forest. This feature of park scenery is more neglected than ought to be the case; for it undoubtedly affords a pleasant relief to the ordinary tree-dotted turf, which

is too often considered of paramount importance, to the neglect of the wilder but often more natural types of scenery. In small parks, groves are usually confined to the outskirts, where they can take the place of belts or screens, which may hide the boundaries and disguise the true extent of the ground.

In larger parks they may occupy long ridges, or stretches of high and broken ground which afford facilities for breaking them up into glades, and small openings which destroy their monotony and produce the necessary irregularity in the level of the tree tops. On flat ground, again, groves may be used for the formation of short avenues or straight green rides, at the end of which, vistas of the surrounding park or country will appear. Their shape and extent will vary, of course, with the situation; but irregular oblongs, which dwindle in some parts to the narrowness of belts, and in others widen out to a quarter of a mile or so, are probably the best. The margins should be well broken up into clumps and single trees, and no sharp lines of division exist between them and the open ground. Planted and maintained in this manner, groves may constitute never-ending sources of variety and contrast, and are far preferable to a flat unbroken expanse of turf, which is a bleak plain in winter or a sun-scorched desert in summer.

The trees represented in groves should be of the ordinary forest character—oak, beech, ash, etc., grouped more or less according to their kind; while thorns, hollies, or any other lower growth which can be got to grow in a park, may be scattered about the more open parts.

Beech is particularly adapted for forming those picturesque groups and combinations, in which it appears at its best, and in groves it rarely develops that thick bushy head which often makes it so ugly as a single tree, and long clean trunks of beech, oak, and ash are invariably produced in groves in which thick groups have been allowed to grow up untouched by artificial thinning. The general arrangement of the trees should resemble a number of connected clumps rather than a continuous wood, or a wood in which a number of smaller or larger openings are continually letting in sun and air, and allowing the trees round their margins to develop

PARK GROVE.

PARK GROVE.

their side branches, in that one-sided and leaning fashion which is the most fertile source of picturesque variety. The surface of groves is always improved by a carpet of bracken, coarse grass, briars, etc., for grazed parks are seldom inclined to become too weedy in this respect. Nettles and thistles should be excluded as much as possible by cutting and spudding, but other forms of wild surface-growth are not out of place, and too great an attempt at tidiness should not be aimed at.

THE BELT.

The average belt may be defined as an unsuccessful attempt at deception, for it is little else. To plant a narrow strip of trees along the boundary line of an estate or park, with the expressed intention of disguising that line, is about equivalent to obscuring the presence of a distant object by painting it white. An irregular hedge of shrubs and timber trees, which might be taken for park clumps in one place or a plantation in another, would disguise this line far more effectually than a thin belt of timber trees of equal height, size, and depth of crown, and with a transparent interval between the latter and the ground surface. Yet this latter is the form usually taken by the average belt, and the practised eye can detect it at a glance, and does not require to be told that the land beyond belongs to another owner, and that the belt is there to make him believe otherwise.

Apart from its lack of success in this direction, the typical belt is positively ugly, owing to its unvarying height and width, lack of depth, and especially so on flat ground. On sloping and undulating ground the general sameness is not so marked, as the streak of daylight disappears, and the rise and fall of the ground causes irregularities in the level of the crowns. But in either case it is absolutely unnecessary, and therefore expensive and superfluous. A few thorns will disguise a fence, and a group or clump will hide buildings, and these are the only objects that require hiding in a general way. Why a distant view should be objected to because it happens to pass over someone else's property, or a picturesque object hidden because it happens to stand on the farther side

of a boundary line, are things which the ordinary individual finds difficult to understand; and, until he can understand it, we can only advise him to cease from planting belts in the first place, and to have no hesitation about breaking through them where they already exist in the second. Where a back-ground is wanted to a view, the grove is the most effectual means of obtaining it, and, as a general rule, should be employed.

THE GROUP.

A group of trees may be defined as a cluster of two or three stems, the crowns of which unite in a compact mass of foliage. At a distance groups have much the same effect as single trees, but, when approached, the multiplicity of stems and the interlacing of the larger branches invest them with a character which is lacking in single trees. Parks without such groups, therefore, are always more or less tame and monotonous, and devoid of that variety which is desirable when a large number of trees stand on a comparatively small area.

Groups may consist of almost any species, but probably the most suitable are those which do not always make shapely trees when standing singly. Such are Scots fir and other pines, larch, and a few hardwoods, such as ash, oak, etc., which are apt to make a more or less irregular stem when standing alone. Planted in groups, they rarely fail to develop something picturesque. The leaning stem, the one-sided development of branches, and the massive character of the combined stems, usually render them more or less attractive to the lover of nature. The trees in them must, however, be planted closely together at the first, and not at distances which prevent close order, or the combination of crowns until late in life. Four or five trees planted, say, 20 or 30 feet apart, can never form a true group, for the stems then have the appearance of legs supporting a mass of foliage—a condition which they rarely, if ever, exhibit in nature. But when planted so close that their stems, when mature, almost touch at the base, they grow up and develop more as a single tree than as two or three distinct individuals, and form

intact and complete rather than hybrid characters of growth. Groups of twos, threes, or fives, planted in small circles, triangles, or even irregular lines, will, if left alone, settle matters in the proper way, and need not be touched after planting. Two or, at the most, three species may occasionally be used with advantage, for the contrast in stem and foliage adds to the variety. Scots fir and beech, oak and ash, and thorns, mixed with ordinary timber trees, are examples of mixed groups which usually have a good effect.

SINGLE TREES.

Single trees in a park should not be too numerous, but rather be confined to the vicinity of clumps and groves, than scattered at regular distances over an open space. Their exact position must be settled on the spot, and it is only necessary to say a few words on the method of guarding them in a grazed park. Too often, parks are disfigured by too plentiful a use of heavy wooden guards, which completely dwarf the trees they enclose for many years after planting. With iron, or iron and barb wire, this objection is partly removed, but even then they are apt to become unsightly when too numerous. It is difficult, if not impossible, to avoid them altogether, but the period during which they are necessary might be considerably shortened if they were replaced, after a few years, by barb wire, lightly twisted round the stems and fastened here and there with a small staple. This plan will not injure the trees in the least, and affords ample protection as soon as the trees are sufficiently stout to withstand wind, and an occasional pull on the lower branches by a grazing bullock. By planting good stout trees at the outset, with plenty of fibrous roots, and preparing the pits they are planted in by the addition of good soil or artificial manure, their speedy establishment and rapid growth is assured; but, as already said, their number should be limited in any case.

Single trees should always be symmetrical and shapely when young, and irregularity can only be tolerated in old age. The English elm, the lime, the horse-chestnut, the

birch, and the plane, are well adapted for forming shapely single trees at a comparatively youthful age, and may be largely employed; but probably English elm and lime form the most attractive trees of all of them, and are more often planted in the vicinity of the mansion house than any. The English elm, whether seen in summer or winter, always forms a picturesque and handsome tree. Its rich masses of foliage, which never become dingy or faded in the hottest season, and its tufty habit of growth, which is full of shady recesses on the brightest day, cannot be excelled by any other species, while its ability to grow on almost any soil invests it with a value for park-planting which should not be lost sight of.

A special feature of park timber, which should never be mutilated or destroyed, is that represented by double trees, or two trees springing from the same space. Such trees, whatever the species may be, form and mature a single crown, and to remove one of these trees with the idea of aiding the development of the survivor is to practically destroy all that is interesting. It often happens, too, that thorns are found growing from the roots of an old oak or ash, and form picturesque combinations which should be preserved and encouraged as much as possible. In fact, all forms of what may be termed combined growth should be encouraged in park timber, and all approach to artificial formality or the monotony of perfectly shaped trees, when repeated too frequently, should be avoided if possible. The park, within reasonable limits, should be given over to nature in her best and most attractive garb, and nothing can be termed inappropriate which is not absolutely ugly, or foreign to the characteristic type of scenery.

AVENUES.

The antiquity of avenues is much greater than many suppose, although they may not always have been constructed of trees. The remains of stone avenues found in many of our prehistoric temples, such as those at Avebury, Stonehenge, etc., doubtless owed their construction to the same idea which

is responsible for the avenue planted in front of the modern mansion to-day, that is, to add to the dignity of the object at the end of it. Possibly it was suggested, as were so many of our architectural features, by the groves associated with the Druidical religion. In either case, the columns of wood or stone had much the same effect, and the chief modification which ensued was the widening of the distance between the rows, according to the tastes or ideas of the designers.

Coming to comparatively modern times, however, avenues may be considered as introductions from the Continent, as the name, derived from the French *à venue*, indicates. Formed in the first place by cutting long vistas through the forest which surrounded the *chateau* of a French magnate, they lent themselves naturally as a feature of the formal style of landscape gardening which was introduced into England in the seventeenth century. In some cases, like the long walk at Windsor, they ran in two parallel lines into the adjoining park; in others they consisted of rows of isolated clumps which extended beyond the private grounds into the open country, as at Badminton. Another form, which corresponded more closely to the original pattern, is the long glade or vista running through masses of wood, as at Savernake, Cirencester, etc.

In the first of these cases the lines usually consist of two rows of trees standing closely together, so that a walk runs between their stems, and beneath their interlacing boughs. In these days, probably, such avenues alone deserve the name, "glade" or "vista" being a more appropriate term for the other two, and, as such, we may leave them. But the first named, from its frequency, and its fine effect when judiciously planted and properly matured, deserves a little attention.

The chief features of such avenues are their length, width between the inner rows, and species of tree which compose them. The length of an avenue must depend to a certain extent upon circumstances. When, for instance, an avenue leads from a mansion house to a lodge, obelisk, statue, etc., there is no alternative but to continue it throughout the intervening space, or leave it out of the scene altogether. The question of planting avenues, there-

fore, if they are to be ornamental features of a park, turns a great deal upon the most suitable length to which they are to be carried. If too long, they only become monotonous, and are either dwarfed by the distance between their lines, or dwindle to a vanishing point if too narrow. When the length of an avenue exceeds half a mile, it is very difficult to avoid these two errors, unless the ground be of an undulating character. In the latter case, the usual effect is split up into a series of sections, which vary in length with each level, and no two of which are exactly alike. That monotony which would be present on a level plain consequently disappears, and length is a secondary consideration, or may even be an advantage. But on flat ground it is doubtful if half a mile should be exceeded under ordinary circumstances, unless the dwarfing of the trees, which will result when viewed from their own level, is not of importance from the principal point of view. Such may be the case when the latter is on higher ground than the avenue itself, as is often the case.

The width of an avenue should bear a certain relation to its length, in so far that the same effect should be produced as near as possible in all cases, namely, that of bringing the view at the end to a focus by the converging lines of trees. Where an avenue is very short and wide at the same time, these lines do not extend far enough to lead the eye to any definite point, and the usual effect is lost. The precise relation width should bear to length is difficult to decide. In a short avenue one to ten may be a good proportion, but in longer ones, one to thirty may not be too great a difference. In an avenue of 100 yards, for instance, 10 yards is a very fair width for producing the desired perspective, and at that width the trees will eventually close up and form an arching canopy, which constitutes a desirable feature in a short avenue. With a length of 400 to 800 yards, a width of 12 to 24 yards is a good proportion, although, as already stated, the surroundings and levels of the ground must be taken into consideration.

The distance between the trees in the rows may vary from 10 to 50 or more feet. Much will depend upon the situation, the class of tree used, and the ultimate effect

WIDE-PLANTED AVENUE.

CLOSE-PLANTED AVENUE.

desired. When planted at close distances, and allowed to grow up undisturbed, the avenue eventually becomes a hedge on a large scale, and it is impossible to alter its appearance or modify it in any way which will prove satisfactory. When planted at wider distances, the trees develop in the form of individuals to a greater extent, and the distance at which they are planted becomes of more importance. When planted too wide to form an avenue of the first-mentioned type, and yet not wide enough to allow individual development to proceed, the result is rarely satisfactory. The upper parts of the crowns of the trees develop unchecked, but the lower parts meet their neighbours on either side, and are more or less cramped and spoilt. It is far better, in our opinion, to plant either closely enough to destroy the individual character of the trees, or at distances varying at from 10 to 20 feet; or to give sufficient space between them so that they may develop as specimen trees, and thus combine the attractions of the individual with those of the complete avenue.

The class of tree should decide the choice of these two forms to a great extent. Where symmetry is the prevailing character of the tree, as in the case of many conifers, the wide-planting system should be adopted, as formality is a great feature in this class of avenue. Where, on the other hand, irregularly shaped trees are selected, such as beech or other hardwoods, close planting usually gives the best effect.

The situation of the avenue must also be studied in this connection. Where it is undesirable to shut out the view on either side, as is, of course, the effect of close planting, the trees should stand wide enough apart to allow glimpses of the scenery behind them to be visible; and this point must be settled definitely at the time of planting, and the species of tree and system of planting it chosen accordingly.

The species of trees chosen for avenues have a great deal to do with the ultimate effect of the latter. The height, shape, and symmetry of different species vary considerably, especially as maturity is approached. A desirable avenue tree, therefore, must possess the faculty of attaining a fair height when comparatively isolated, must have a shapely

outline, and develop symmetrical proportions. Trees which develop low-spreading crowns, such as the beech, oak, or hornbeam, are not suitable for ordinary avenues, although they may be appropriate under certain conditions. Those, again, which form rugged or irregular crowns, are rarely suitable, such as the Scots fir, Weymouth pine, poplar, etc. On the other hand, such trees as the English elm and lime are particularly well suited for park avenues, as they are naturally tall in habit, and symmetrical in proportions. Probably the lime is really the best of all trees for the purpose, as it looks well both in summer and winter, and, unlike the elm, rarely gets ragged in old age. Its effect, when forming an arching canopy, is beautiful in the extreme. Its buttressed stem and arched branches, which often terminate in a sort of pendent a few yards above the ground, are illustrations of architectural features which may be found in almost every cathedral, and it is probable that many of our earliest types of architecture were copied from the branch and stem growth of this tree.

In the case of formal avenues, few trees are more suitable than the Wellingtonia or spruce, although they are not species which should be selected for park-planting, but in drives running through woods or pleasure grounds, Wellingtonia or spruce avenues may often be seen which have a wonderfully good effect, and on certain soils are often the only type of coniferous avenue which it is at all possible to obtain. For the more rugged and picturesque type, Scots fir is also a suitable species, but it is not one which looks well in youth, or so long as the trees retain their formal crown, and yet lose their lower branches in the manner characteristic of this tree. In fact, few species are unsuitable if a proper site be chosen for them; and upon this depends not only their success as individuals, but the good or bad effect of the avenue they compose.

In avenues formed through woods or pleasure grounds much greater freedom may be employed in the choice of species, and both conifers and hardwoods are equally appropriate. Such avenues are usually formed for the effect they produce in themselves, rather than as an adjunct to a building, although they may occasionally be formed alongside the

approach to a lodge, gateway, or monument. In such cases, almost any tree which develops a tall, stately stem is appropriate, and as such may be mentioned the cedar, sequoia spruce, silver fir, etc., amongst conifers, and almost any of the larger species amongst hardwoods. Although both wide and narrow methods of planting are adopted when forming these avenues, there is little doubt that the finest effect is produced by the latter. A drive or walk running through rows of tall massive boles, enveloped in an outer covering of twigs and foliage, has a much finer effect than when the trees are isolated, and the space between them is sufficient to produce a dwarfing effect upon their proportions. In the one case the avenue is complete from end to end, and forms a large but single feature; in the other it is a constant repetition of single objects, which are apt to become monotonous in themselves, and are not relieved by an objective, as in the case of a park avenue.

Amongst types of avenues which deviate more or less from the normal may be mentioned those which run through a belt or wood so as to produce a uniform effect from end to end, but without any regular arrangement of the trees. A well-known example of such an avenue is that at Savernake, known as the "Grand" Avenue. This type can be formed in any wood or belt of trees after they have attained a considerable age or size, and this does away to some extent with the necessity for formal planting so many years in advance. The slight deviation from a straight line in the arrangement of the trees does not materially alter the effect produced, so long as they stand close and regular and do not differ too much in age. A straight ride, running through a fairly thick wood, always produces an effect of this kind, and it is probably preferable, if not overdone, to endless and unmeaning curves.

The planting of avenues in parks is usually effected by enclosing each tree in a guard or cage. This method involves a long period, during which the avenue has a heavy and unsightly appearance, and it is questionable whether a better effect would not be produced by enclosing a strip of ground on either side of the ride or drive with a neat iron or wire fence, and filling up the space between with temporary

trees and shrubs, in addition to the proper avenue trees. When the latter are able to stand alone the fence can be removed, and the temporary growth cleared away. Another method of shortening the awkward period of avenues is by planting a certain number of quick-growing trees, such as poplars, between the permanent trees. In this way an effect may be obtained in half the time that would be the case without them.

Apart from such temporary mixtures, it is probable that only one species of tree should be used in planting an avenue, as a mixture destroys that uniform character and regularity in height and shape which is its most desirable feature. Where mixtures are employed, however, different species should be arranged alternately, so that a regular succession may produce the same effect from end to end. Patchiness is a fault in avenues which can rarely be overlooked, that is, if they are to fulfil their proper function, namely, an architectural feature in the landscape.

The site chosen for a park avenue is of considerable importance. An objection has often been made that an avenue cuts a park in two, and there is no doubt that it does so when run through the middle of it. But, properly placed, an avenue is often the means of adding dignity and character to an otherwise tame and uninteresting park. When the mansion house stands within a short distance of the park boundary, it is often difficult to provide an approach to it which is imposing enough to correspond with the size of the house. The distance is often too short to give the carriage drive those curves and sweeps which render the house invisible until a visitor is close upon it, and thereby increase the effect produced by its appearance. But when the drive between the entrance lodge and the house is bounded by a stately avenue, an immediate impression is received the moment one enters the park. The house appears like a picture framed by the two sides of the avenue, and increases in size and importance the nearer one approaches to it, while the avenue throughout retains its regular appearance. It is in such situations that an avenue is of great value to the landscape gardener. In a short avenue, 100 or 200 yards long, for instance, the two sides should stand close enough

to form an overarching canopy, as in that form a great deal of the house is concealed until one is close upon it, and the avenue itself is more imposing. But in an avenue of greater length the width should be determined by the size of the house. When the latter is small, as in the case of a manor house of the Elizabethan type, it is probably better to give it that form recommended for short avenues, as nothing is gained by seeing a small object at a great distance. But, in the case of large mansions, castles, etc., the width should be sufficient to enable them to be fully seen from the first, as no reason exists for concealing them.

CHAPTER XII

THE ENEMIES OF ENGLISH WOODLANDS

AMONGST the various foes to which woods are exposed at one time and another of their life-history, the most serious may be said to be living organisms, such as animals and fungi, and frosts and storms amongst climatic influences. Compared with these, all other enemies, such as fire, hail, etc., sink into insignificance.

RABBITS.

In the animal world, rodents, such as rabbits and hares, are the most persistent and inveterate that young woods have to contend with, and their depredations are too well known to require describing. The best and safest way of combating their attacks in the early stages is by a free use of wire netting—the only practical method with very small trees, and which has already been dealt with in the chapter on Planting.

On areas where wire netting cannot be economically used, however, other means may be employed which are successful to a greater or less extent, although involving more trouble and attention than when netting is used at the outset. Amongst these, the most common are the protection of individual trees by old netting, sticks, etc., pushed in, or brushwood tied round the stems; painting the stems with sticky compositions, and so on—all of which methods can be used with trees over 3 feet in height, provided the trouble and expense are not objected to. When systematically carried out, painting the stems is the cheapest and most effective plan, for it can be done by boys or old men for whom only

limited employment is available, and also can be more rapidly done than more troublesome methods. These compositions can be purchased, or manufactured at home, as may be most convenient. The principal ingredient is Stockholm tar in either case. The other ingredients in the purchased compositions we do not pretend to know, but a fairly effective composition may be made up with Stockholm tar, a little paraffin, the sweepings of a blacksmith's shop, and cow manure, mixed up into a fairly stiff compound, and sufficient *Renardine* added to give it a smell. This mixture, laid on with an old and large paint-brush, will protect trees from ground game for at least twelve months, and longer in many cases. When the trees are planted in compact clumps, as they always should be, an occasional inspection will enable the forester or woodman to see if the mixture is still effective or not. As soon as the nibbling of a few trees is noticed, the whole clump should be repainted at once, and not the individual trees nibbled attended to only, as will be the case if left to the average labourer. The idea of the latter is to smear over and disguise the barked portions of the stem and leave the rest untouched, the result being that fresh portions of the bark are nibbled off, and the paint-brush called into constant requisition. The cost of painting trees in this way need not exceed 3d. per hundred, and, if we allow for two or three paintings in the first two or three years, and an average of a thousand plants to the acre, it will be seen that this form of protection is much cheaper than netting for small or irregularly shaped areas, where the latter alone possibly runs up to £4 or £5 per acre.

In the case of older plantations from which the netting has been taken down, or which is no longer an effective protection from ground game, it is more difficult. Painting in such cases is not easily done, as the thickness of the trees and the presence of their branches prevent men or boys moving freely amongst them, and the carrying about of a paint-pot is still more awkward. Yet, as pointed out elsewhere, beech, ash, and other hardwoods are in as much need of protection ten years after planting as they are at first, unless rabbits are kept down to a low figure. Perhaps the cheapest method of protection in this stage is to prune off superfluous

side branches, or cut down a few of the weaker trees from time to time as required during the winter. These provide the rabbits with food and take off their attention from the stems of the larger trees, and, although it may not prove always effectual in a hard winter, it will at least reduce the damage to smaller proportions than it would otherwise be.

SQUIRRELS.

The damage done to coniferous woods by squirrels may often prove serious if their numbers are not kept in check. Larch is a favourite tree for attack, and in bad cases they will bark the upper portion of the stem or crown part entirely round, and bring about the destruction of the tree above that point. Shooting is the only method of reducing their numbers, which work is usually entrusted to the gamekeeper, and is consequently, more often than not, left undone.

The chief damage done to trees by squirrels is usually effected during the spring months. Probably the bark at that period contains a sweeter kind of sap which attracts these animals, and renders the tree more deserving of their attention than any other time of the year. This damage is further aggravated by the fact that the bark is not only more easily removed at this time of the year, but can be peeled or torn off in larger pieces than those actually bitten, with little difficulty. The exact loss occasioned by the attacks of these creatures is very difficult to estimate accurately. We have known instances where the value of young larch plantations has been reduced by at least 75 per cent., and it is seldom that a plantation badly attacked ever turns out a really satisfactory crop. Where, therefore, the keepers cannot or will not keep these creatures in subjection, the forester ought to have full power of doing the work himself; for, however harmless they may be in small numbers and in certain years, there may come a time when immediate and energetic action is necessary to prevent damage, and immediate and energetic action is seldom taken when left to a disinterested party.

INSECTS.

The insects injurious to trees at one period or another of their existence may be divided into two classes—those which attack healthy individuals, and those which confine themselves, under ordinary circumstances, to sickly or unhealthy specimens. In dealing with the former class, war must be waged against the insects direct, either as larva, pupa, or imago; but, in the case of the latter, attention to the health of the trees by planting them on suitable soils, or by attending to cultural details, is the most effectual means of preventing attack.

The insects which have any practical significance as being injurious to healthy trees are chiefly found amongst the *Lepidoptera*, *Colcoptera*, and *Homoptera*. They include the oak-leaf roller moth (*Tortrix viridana*), the winter moth (*Cheimatobia brumata*), the larch aphid (*Chermes laricis*), the pine beetle (*Hylurgus pinniperda*), the pine weevil (*Hylobius abietis*), the cockchafer (*Melolontha vulgaris* and *Hippocastaneæ*), and the garden chafer (*Phyllopertha horticola*).

This list might be extended until further orders, but it is only intended to deal with those which may now and again prove themselves to be dangerous pests to healthy timber trees in woods and plantations. Hundreds of insects attack trees more or less every season, but the majority of such attacks do not permanently injure the trees, or appreciably reduce their production of timber, and consequently they do not bring themselves within the range of practical forestry. The average forester has usually more than enough to do to cope with the ordinary routine of estate wood-work, and has rarely time to undertake any but urgent measures of insect prevention. Fortunately for him, some of the worst forest pests are unknown in this country, or only known as entomological curiosities. Black-arches moths, fir-spinners, and others, which destroy thousands of acres of pine forests in one season in the north of Europe, do not jeopardise the existence of British woodlands at periodic intervals. Even our worst pests are sufficiently harmless, and few in numbers, to escape notice in an ordinary season, and it is only at rare intervals that a really serious visitation occurs,

suggesting the advisability of preventive or remedial measures.

Taking those insects in the above list in the order named, it is proposed to give as briefly as possible an outline of their life-histories, and describe any practical methods that may be taken to suppress them. Many of the remedies often suggested are not practicable on a large scale, and their adoption is a more troublesome and expensive process than the damage done by the insects justifies.

THE OAK-LEAF ROLLER MOTH.

This moth makes itself most conspicuous in the south of England, and in woods or coppices more than on hedgerow or park trees. In some seasons it is scarce enough to escape notice altogether, in others it appears in such immense numbers that the trees are entirely stripped of their foliage by the middle of June, and appear as bare as in midwinter. The caterpillars of this moth appear in May, and at once begin feeding on young foliage. At first they are of a greenish hue, later on becoming of a dark brown colour, with rows of black tubercles on each side, and a black head. When disturbed they let themselves down by a thread to a distance of several feet, and sometimes to the ground itself. After feeding for about a month they pupate at the apex of an oak-leaf, which they roll up into a hollow tube and cement together by a web derived from their bodies. The moth appears in July, and may be seen flying about the crowns of oak trees preparatory to egg-laying. The eggs are laid on the current year's shoots, and remain there throughout the winter until the following spring.

Where oak woods or coppices exist, it is impossible to devise either preventive or remedial measures in any way adequate to meet the case. The attack must take its course, and the remedy be left to nature, which, by means of the midsummer shoots, reclothes the trees with fresh foliage after the insects have done their work. Woods on deep fresh ground rarely suffer any permanent injury from this moth, but on light sandy ground, and with stunted trees,

repeated attacks no doubt weaken them to a dangerous extent, although whether weakening of already stunted trees can be called a serious injury is open to question.

As preventive measures which may be adopted when forming a young plantation, may be mentioned the mixing of oak with other species, such as beech, hornbeam, and so on; but probably the greatest aid to the forester lies in the fact that the sessile-flowered oak is rarely, if ever, attacked, and on dry soils it is undoubtedly the proper species to plant, as much on silvicultural grounds as to prevent insect attack. Reliable evidence points to the fact that this variety makes much more growth and more healthy growth than the pedunculate variety on dry sandy or gravelly soils, where the results of attack by the moth are most serious. Beyond such measures as these little else can be done, for we have not yet got to that stage in entomological bacteriology when a few phials of the germs of some deadly disease can be squirted over the caterpillars, and set an epidemic to work which will destroy them in the course of a few weeks.

One reassuring feature of the attack is the irregularity of its occurrence. For one, two, or three years it may be widespread, and then for several years following practically disappear. This may be accounted for by the existence of some epidemic disease, as suggested above, which affects the caterpillars, parasites which destroy the eggs, or by the absence of oak-leaves on which the caterpillars can pupate, and which compels them to choose less suitable sites, and indirectly aids in their destruction. The idea prevails to a great extent that cold, dry weather has something to do with bad attacks. It may aggravate them, no doubt, but the real cause must lie in the number of eggs laid in the previous season, and their successful hatching out into caterpillars; and this leads to the inference that bad attacks are preceded by ordinary ones until the climax is reached, and some cataclysm occurs which reduces their numbers to a minimum, and they practically disappear for a time. Amongst birds, rooks are fond of these caterpillars and get rid of a good many, and the same may be said of starlings and other insectivorous birds.

THE WINTER MOTH.

The caterpillars of this moth are often injurious to oak and ash, although it is looked upon more as a garden than a forest pest. The attack resembles that of the oak-leaf roller moth, both as regards the period and method of attack, and the caterpillars also let themselves down by threads, but in a more remarkable way. The peculiarity of this moth lies in the fact that the females are almost wingless, and that the eggs are laid in late autumn or winter. The females must crawl up the trees before the eggs are laid; and this offers a method of prevention, which is easily taken advantage of by gardeners, namely, that of smearing or placing tarred bands round the base of the trees, and thus catching the moths on the sticky surface. In the case of forest trees, however, this could not be done on an extensive scale, and, as it is only occasionally that serious damage is done to small areas, methods of prevention are outside practical forestry.

THE PINE BEETLE.

Where pure crops of young Scots fir or other pines exist, this beetle may do a serious amount of injury just when its presence may be unexpected by those unacquainted with its work. The pine beetle may be well included in both those classes into which we have divided injurious insects, as it not only uses the sickly or dying trees for breeding purposes, but between its emergence as a mature beetle, and its hibernation in the thick bark of old trees, it spends a short holiday (as it may be termed) in the current year's growths of Scotch fir, or in those of other species of pine. It is in this respect that it proves most injurious to the forester, for the shoots thus bored into die or are blown off by the first strong wind, and, when this occurs year after year, the trees become bushy and flat-topped, and their height-growth seriously interfered with.

The life-history of this beetle has been worked out very completely, and by none more thoroughly than by

Dr. Somerville, the results of whose labours are published in the *Transactions of the Highland and Agricultural Society of Scotland* for 1891. It appears that the number of generations or breeds which develop in one season vary with climatic conditions. Where the summers are long and warm, as many as three broods may occasionally be reared in one season, or, where they are short and cold or wet, not more than two, or possibly only one brood may be brought to perfection. In the south of England it may be taken for granted that two broods are always developed, and in long summers three may occasionally occur. In the former case the beetles emerge from their winter quarters early in March (we have found them boring into felled trunks on the 10th of March). The earliest laid eggs hatch out in a few days, and mature beetles from these will appear in May or June. The majority of these beetles do not appear to bore into small shoots, but proceed to swarm and raise a new generation at once.

The second generation appears in August, and the majority proceed to the crowns of healthy pines and bore their way into the pith of the same year's shoots. They feed there for two or three weeks, boring their way up until they have approached the terminal bud, or, in the case of a long shoot, until they have satisfied their appetites. They then leave by their entrance, or by making an exit hole at the upper end of the boring, and find their way to the base of old pine stems with thick coarse bark, where they bore a short gallery, sufficient to shelter them through the winter, and there hibernate. But there is every reason to believe that a few of the August brood swarm and raise, or attempt to raise, a third generation. In long warm summers the second generation will appear early in August, and their progeny have at least two months (the normal period of development) to mature. Probably the presence or absence of suitable breeding material may make a great deal of difference in the habits of these and other beetles as regards the number of generations in one season, and absolute agreement amongst observers in different districts and among different conditions can scarcely exist.

But the main point in practical forestry is to discover

easy and effectual methods of prevention. Fortunately, no insect pests can be dealt with so readily as the pine beetle, provided the area it frequents is placed under uniform treatment at one and the same time. It is little use for the one forester or proprietor to put preventive methods into force, while his neighbour over the way or over the ditch, as the case may be, allows things to take their chance. Where large numbers of pine beetles have managed to hibernate or breed on an area of, say, one square mile, preventive methods must be exercised in places liable to attack over the whole of that area, if the foe is to be successfully fought. What form these measures should take depends upon circumstances. The most frequent cause of large numbers of beetles existing on a definite area is usually the leaving about of fallen or blown timber in the woods through the summer. In such cases, not only does every pair of beetles which has hibernated find feeding and suitable breeding material in this timber, but the eggs laid by each pair develop into a new and much more numerous generation in a couple of months. This means that each pair of beetles at the beginning of a season is multiplied into at least fifty pairs by the middle of it, and these fifty pairs are again multiplied by fifty if a third generation is able to develop. It is easily seen, then, that a month or two's neglect may bring about enormous swarms of beetles, which, sooner or later, will continue their existence in the crowns of growing pine trees within a certain radius. The extent of damage done in such cases varies, of course, with the age of the trees attacked. The loss of a few shoots in an old pine tree which has finished its growth is not a serious matter, as the loss of a comparatively small number makes no appreciable difference to the production of wood; but, in the case of young or middle-aged trees which are still adding to the growth of their leading shoots, the loss of the latter may seriously affect the ultimate yield of the plantation, and also produce crooked stems which depreciate the value of the trees.

The importance of preventive measures becomes all the greater, therefore, the larger the area of young pine trees happens to be. Where nothing but mature timber is present, the economic significance of the beetle is not great, as the death

of a few sickly individuals, from their stems being used as breeding material, is not a serious matter. But when young and old woods are mixed together, as is usually the case, every reasonable precaution should be taken to prevent the existence of the beetle in large numbers. To stamp it out altogether may not be within the range of practical forestry, but it is possible to keep it sufficiently in check to prevent any serious damage being done.

Felled timber being the most frequent material for breeding it on a large scale, attention should first be directed towards its being cleared away to a safe distance from the exposed area early in the summer, or at latest by the middle of May. Its presence up to that time is beneficial rather than otherwise, as it attracts those beetles which have hibernated in the surrounding trees, and prevents them from turning their attention to other material, such as suppressed or weakly stems. If cleared away before the first generation appears, the larvæ or pupæ are removed with it to a distance which renders attack impossible, and no extra cost is incurred in the way of direct preventive measures. Where pine timber is felled more or less annually, an endeavour should be made to cut in the autumn or winter, and arrange that buyers should clear it away in good time. As a rule, there is no excuse for leaving the timber about more than three months after its purchase, and in cases such as these, its removal should be firmly insisted upon, or the timber confiscated or removed by the vendor himself at buyer's expense.

When cases do occur in which the timber cannot be removed at the proper time, as when large numbers of trees are blown down by spring gales, and a clearance cannot be effected under two or three months, other methods of prevention must be adopted. The one usually recommended is to bark the trees, and burn the tops and brush-wood. This plan is effectual enough, no doubt, but whether it can be done at a cost which falls short of the advantage gained, is a question which deserves consideration. The burning of the brush-wood, simple as it sounds, is comparatively expensive, and the barking of the trees is still more expensive, while it is objectionable from a technical point of view, owing to the

trees drying too rapidly when exposed to the sun. Burning the brush-wood is, however, advisable at anyrate, and it is very probable that, by doing this in March or early in April, large numbers of swarming beetles may be driven off by the smoke hanging about the timber strewn around; but the fact remains that preventive measures of this kind are often more difficult to carry out in practice than many may think. In game preserves especially, fires are objected to about this time, as the smoke is said to disturb the nesting pheasants. Whether it does so or not we do not know, but, if the keepers say so, the fact or otherwise is a mere detail. At any rate, there is no certainty about any such measures being possible on average estates, and no reliance can be placed upon methods which may be looked upon as heroic and progressive, and outside the scope of ordinary practice.

THE PINE WEEVIL.

This beetle is chiefly confined to the north of England and Scotland, and gives little or no trouble in the south, where extensive coniferous woods are not so common. It has been reported in the New Forest, and Miss Ormerod mentions it having been found in West Gloucestershire some years back.¹ So far as can be learned, however, its occurrence in large numbers south of the Trent is not common, although its presence may be anticipated in districts containing large fir woods.

The life-history of the beetle is somewhat as follows:—The beetle appears early in summer—May, June, and July. Some of these beetles appeared the previous year, and have hibernated under moss or leaves during the winter; but those from eggs laid the previous year have come direct from the cocoons, in which they have pupated in stumps and roots of felled trees. Their next proceeding is to pair and look out for suitable feeding and breeding places. To find a piece of

¹ Since the above was written we have found a few weevils in recently planted larch in the Longleat woods (August 1904). They occurred in two different places on limited areas adjoining ground cleared of Scots pine, etc., the previous year, but they appeared to be few in number.

ground recently planted with conifers, and in which comparatively fresh roots and stumps still remain, is the summit of their ambition, and in this they will spend the summer in egg-laying and feeding on the young trees. This egg-laying is a slow and steady process, and continues throughout the summer, and is recommenced after the winter rest, the eggs being laid in stumps, exposed roots, or logs partly embedded in the ground. The grubs from these eggs eat their way into the bark, making galleries one yard in length, and take about fifteen months to mature. They usually hibernate as full-grown larvæ, and pupate the following spring; and Altum¹ points out that, where the breeding material is limited in quantity, and the swarming beetles numerous, the following generation appears much about the same date. Eggs may be laid throughout the summer, but the grubs from the later laid ones have no opportunity of developing, owing to the breeding material being either already occupied or already worked over. Where breeding material is always at hand, however, as where the stumps of felled trees are present in large numbers, the grubs may hibernate in a half-grown condition, and thus spend only the one winter instead of the usual two in the full-grown condition.

The chief injury done by this beetle consists in its attacking recently transplanted trees, and eating off patches of bark to an extent which may completely kill the plant. Conifers are the only class of trees which suffer from its attacks, although Altum mentions instances of oak being attacked in Germany.² The localities most affected are those which have recently been cleared of a coniferous crop, and which contain quantities of stumps and roots in which the weevil is able to breed. So extensive is the damage done in such cases, that it is considered useless to plant conifers until at least three or four years have elapsed since the clearing off of the old crop, and time has been given for the resulting swarms of beetles to die off, or depart elsewhere.

Various remedies have been tried, and some are said to be successful, but the majority are too troublesome and costly to pay for doing on a large scale. The painting of

¹ *Forst Zoologie.*

² *Op. cit.*

individual trees, the spreading of bare soil round the stem of each tree, or the sprinkling of lime, etc., round about the trees, may do very well on an acre or two of ground, but could hardly be practised on forty or fifty acres without an undue expenditure of time and trouble. The simplest and easiest method is that of leaving the ground unplanted for two or three years; but this is not only a loss of time, but may not have the desired effect after all. The stumps of felled trees on that particular area may be no longer suitable for breeding purposes, but, where timber is being felled annually, the surrounding ground may provide all that is necessary to furnish a numerous host of weevils. The Continental method of preventing the weevils reaching the young trees is that of digging a trench round the planted ground, into which the weevils fall in attempting to cross it. This method is effectual enough, as a rule, but the trenches must be watched and the beetles collected from time to time, or they will find their way out again by some means. This plan is inexpensive on ground which is free from large stones, and with which the sides of the trench can be kept perpendicular; but where the ground is full of large stones, or so light and dry that the sides are continually falling in, it is difficult to make it effective, and other means must be tried as well. Amongst these may be mentioned the laying about of pieces of bark, bundles of twigs, etc., under or into which the weevils crawl, and from which they can be collected daily. This is also expensive on a large scale, but, where weevils are troublesome, some expense must be incurred in dealing with them.

Perhaps the cheapest and most effectual method of all, however, is that of arranging the clearing and replanting of ground in such a way that a considerable interval elapses between the clearing and replanting of two adjoining pieces of ground. By so doing, that constant supply of breeding material which is chiefly responsible for successive generations of beetles is interrupted, and the weevils are thus forced to leave the locality before the next planting is carried out. No doubt, a few weevils will always be found in the vicinity, but, the farther the breeding grounds lie from the young wood, the smaller will be the numbers that will reach

the latter, for the pine weevil is not a great flier, and does not trouble to go farther than necessary. In fact, methods of prevention in the case of this, as with all forest insects, must usually be combined with expediency in relation to something else, and are rarely adopted as preventive measures pure and simple.

THE COCKCHAFFER.

On sandy soils the grub of the common cockchafer often proves a serious enemy to nurseries and young plantations in England. Rarely, if ever, however, does it occur in such numbers as on the Continent. In France and Germany immense numbers of this beetle often appear in May and June, and attack deciduous trees, such as beech or oak, and strip them entirely bare of foliage. In England the occurrence of the chafer is on a much more limited scale, and it is seldom that more than two or three dozen beetles are seen in one spot. Climatic conditions are probably less favourable to the speedy development of the grubs into beetles, and their natural enemies have thus greater chances of dealing with them.

The life-history of the cockchafer, according to Ormerod and others, is as follows:—The mature beetles emerge in May, and for two or three weeks feed on foliage and other growth. During this period pairing and oviposition take place, and the female beetle lays her eggs in clusters on the ground—on bare soil, if possible. The resulting larvæ feed very little the first season, and large numbers are probably destroyed by moles, birds, and insectivorous creatures generally. The larvæ descend deeper into the ground in autumn and lie dormant during the winter. In spring they again become active, ascend near the surface, and feed on a large scale until the third year, when they pupate, and the last winter is passed as a mature beetle under the surface.

The most favourable time for attacking this insect is in the two or three years in which it exists in the larval stage. In ground cultivated annually the grubs are frequently

turned up by the spade or plough, and in such cases they can be picked out and destroyed, while birds have also an opportunity of destroying them. With such crops as potatoes, the digging of the tubers also turns out and destroys a good number, and others are brought near the surface and injured by frost. Pheasants, poultry, and rooks are fond of the grub, and doubtless destroy a good many in one way and another; but probably man's greatest helper in this respect is that persecuted little creature, the mole. His work below the ground is constantly bringing him in contact with the grubs of this beetle, and he doubtless makes the best of his opportunities, and, whatever the faults of the little "gentleman in velvet" may be in other respects, he probably does much good in this one.

The egg-laying beetles are said to dislike pig manure, or ground on which pigs have been running. This is probably an instinct of self-preservation, as eggs laid on pig-frequented ground would have little chance of surviving long, and this instinct affords an opportunity of preventing egg-laying on definite areas. In nurseries, for instance, ground already planted might be rendered safe by scattering pig manure between the rows in May. Beds of seedlings recently put in are particularly liable to attack, as the beetles select such ground for egg-laying, and the resulting grubs run no risk of disturbance for the next two or three years. Beech is a favourite tree of the older grubs; but no seedlings seem safe from them, and in some seasons large numbers are either destroyed or seriously injured, without the damage being visible until it is too late to prevent it.

In addition to the ordinary cockchafer, the grubs of the rose-chaffer (*Phyllopertha horticola*) also do great damage in certain seasons. This beetle sometimes appears in enormous numbers in June, and hundreds of acres of meadow land may be seen almost alive with them. The grubs of this beetle only take one year to develop, and their feeding time is thus restricted to autumn and spring. They do considerable damage to nursery stuff on light sandy soils, especially to small plants; but egg-laying may be prevented in the same way as that described for the cockchafer. Their natural enemies are pheasants, rooks, poultry, etc.,

which often tear up considerable areas of grass in order to reach the fleshy grubs lying below, while moles also destroy large numbers.

THE LARCH APHIS.

This aphis is sufficiently plentiful, and its presence is so conspicuous, that the most careless observer can hardly avoid noticing it on young larch plantations. Foresters who have assisted in thinning young larch have more or less vivid recollections of its unpleasantly sticky nature, due to the resinous matter in which the insects are enveloped. The life-history of the aphis is comparatively complicated, having what is known as an alternation of generations. The mother aphis, which has hibernated in the axil of a leaf-bud or a crack in the young bark, awakens up from her dormant condition in April, just as the short spurs of the larch are breaking into leaf. Her one and only duty consists in egg-laying, from twenty to forty eggs being laid in a cluster on the spot she has lain on since the previous autumn, after which she dies. These eggs hatch out in a week or ten days, and the larvæ at once proceed to infest the young larch needles, from which they derive their nourishment by piercing the soft tissues of the needle and feeding on the sap. These develop into winged or wingless aphides, and successive generations are produced at intervals of about six weeks until autumn, when the last laid eggs are said to produce the mother chermes, which is destined to carry on the swarms of the following year.

It has been asserted that the larch aphis and the spruce-gall aphis are alternate generations of one and the same species. Whether this is so or not we are unable to say from personal observation. We have seen winged aphides on spruce shoots while the larvæ in the galls were still young and immature at the end of May, but whether they were connected with those in the neighbouring larch we do not pretend to say.

In ordinary plantations, attacks of larch aphis must be

contemplated with resignation, as nothing can be done on a large scale to prevent the attack, or remedy it after it has commenced. In good growing seasons it is not particularly conspicuous, owing to the more rapid growth of the shoots, and the aphides being spread over a wider area. But in dry summers, or cold blighting Mays, the slow growth of the trees reduces the area over which the multiplying aphides are spread, and the trees gradually assume that mealy appearance which is characteristic of a bad attack. Eminent authorities have expressed the opinion that an intimate connection exists between the larch aphis and the larch disease, and that the presence of the former is responsible for that of the latter. Plausible as this theory looks on the face of it, we have not yet seen any direct evidence adduced to prove any connection between them. It is an obvious fact that larch badly infested cannot be perfectly healthy, and that unthrifty larch is, in all probability, more prone to disease, or suffers more from the effects of it, than trees with a strong vigorous growth; but this does not necessarily prove that if the aphis were absent so would be the disease.

According to M'Intosh, the larch bug first appeared in England in 1800, and was very prevalent in that and the two following years, which were very dry. Pontey, in his *Forest Planter*, states that it was very prevalent in the south-west of Yorkshire, and that by 1808 it had almost disappeared. His experience was that it was least injurious on light sandy and calcareous soils. Whether it first appeared or was first noticed in this year it is difficult to determine, as until it assumed the character of a pest it would not be likely to attract the notice of practical foresters. Since then, however, it has certainly been more or less prevalent in pure larch plantations, and has been most conspicuous in dry, hot summers, which have been unfavourable to the healthy growth of the tree.

It is often observable that the attack of the aphis is worse in some parts of a plantation than in others, whereas its presence is more or less universal. This can only mean that the less vigorous growth of the trees in such places intensifies the injurious effects of their presence, and not

that their numbers are necessarily greater on a given area. There is a time in the history of every tree, originally healthy, when its susceptibility to parasitic attack arrives at a critical stage, and the balance of power in host or parasite rest with one or the other. When certain trees, or parts of a plantation, are singled out for more than the average share of attention from these pests, there must be a reason for it, although this reason may not be apparent on the surface, and may, to begin with, be more or less of a temporary nature. Trees which are in that condition most favourable to aphid attack are also the trees which would most easily feel the effect of the larch blister, and it is nothing extraordinary to find the one more or less a contemporary of the other.

In nurseries, aphid attack may be fought with some prospect of success. Washings or spraying of the various insecticides in general use reduce their number, if they do not altogether destroy them. But when nursery stock is badly infested with this pest, it is an indication that something is wrong somewhere. Dry, hot summers none can remedy, and it is impossible to avoid a certain amount of injury being done in that way, especially on dry soils. But when otherwise healthy larch is affected in an ordinary summer, it indicates that the soil and situation are not quite as they should be, and the best policy is to select a better locality if possible for that particular crop.

INSECTS WHICH ONLY ATTACK UNHEALTHY OR DYING TREES.

This second class of insects is such a numerous one that it would be outside the province of this book to do much more than enumerate them. A few, however, may occasionally do sufficient damage to standing and growing trees to be ranked as "injurious," although the extent of the damage done is rarely large enough to be taken seriously. The majority of the *Bostrichidæ*, or bark beetles, are invariably included under the head of injurious insects, but they seldom deserve the term any more than saprophytic fungi deserve to be termed injurious to growing crops. Insects which attack

dying trees alone merely hasten natural decay, and it is only when exceptional circumstances occur that they attack and possibly kill trees which, otherwise, would carry on a more or less sickly existence. Such circumstances occur when trees of a large size, or those scantily furnished with fibrous roots, are transplanted. The check in their regular growth experienced by such trees, and their inability to meet the extra call made upon their resources, in all cases throws them into a temporary state of debility, and in many cases permanently cripples them. This weakened condition is often taken advantage of by insects which, under normal circumstances, would be perfectly harmless. Amongst such beetles may be named the elm-bark beetle, the ash-bark beetles (*H. fraxini* and *crenatus*), *Tomicus bidens*, etc. Of these, *T. bidens* appears to us to be the most troublesome. Newly planted coniferous trees are frequently attacked by this beetle, and often destroyed outright. Such trees are, no doubt, weakened by transplanting, but not to an extent which would render recovery impossible under normal conditions. But when attacked by *T. bidens* in May and June, the burrowing of the beetles has a most injurious effect upon the trees, and it is seldom that an attacked tree recovers. It is one of the most impartial bark beetles in the country; for, although its most frequent host plant is Scots fir and pines generally, it may be found on larch, spruce, deodar, cupressus, and conifers of all kinds.

FUNGI.

In common with the vegetable kingdom generally, trees have their fair share of enemies amongst those fungi which are known under the name of "parasites." Whether *genuine saprophytes* can be termed injurious to living trees or not, is a difficult question to answer off-hand; but there are certainly one or two of them which bear a very doubtful character. But probably the worst foes the forester has to deal with are those which combine the properties of both, and are able to exist as a parasite to-day and a saprophyte to-morrow. Such fungi are known as "facultative," and it

can easily be understood that a very slight weakness on the part of the host may convert a harmless saprophyte into a dangerous parasite at any time, and it is often an open question whether the bad health of a tree is the cause or the effect of fungoid attack.

Amongst the fungoid pests which come within the range of practical forestry, not more than half a dozen can be considered of serious importance. These may be summed up as follows:—"The Larch Disease" (*P. Wilkommii*), the "Heart-Rot," the "Honey Fungus" (*Agaricus melleus*), *Trametes radiciperda*, the "Beech and the Ash Canker" (*Nectria ditissima*), and one or two others, such as *Hysterium pinastri*, *Peridermium pini* on Scots fir, *Peronospora* on beech seedlings, etc. As in the case of insect pests, there are dozens of others which might be included in a formidable catalogue, but, under ordinary circumstances, they are comparatively harmless, or their presence is, as already said, as much the result of bad health in the host as the cause of it. The most serious, from a general point of view, is considered the

LARCH BLISTER DISEASE.

To describe the larch blister to practical foresters is almost superfluous. Everyone knows its characteristic appearance in the stem and branches of trees of all ages, and most foresters have a pet theory of their own to account for it. Some say it is frost in late spring, others that the weight of snow on the branches is responsible for it, another will put it down to deteriorated constitution arising from home-saved seed, while the majority of young and up-to-date members of the profession get Hartig's definition of it off by heart, and repeat it whenever they get the opportunity.

Eminent mycologists have studied it, and all differ over some one or other of its numerous peculiarities and methods of attack. One believes that it can only enter by a wound, while another states that wounds are unnecessary. By a third it is said to be indirectly due to the attacks of the larch aphid. In fact, one theory has been taken up after

another, announced with a flourish of trumpets, put to the test, found wanting, and thrown aside as useless. Yet, in spite of all the attention that has been directed to it, and all the research that has been spent upon it, the disease still remains as great a mystery as ever, so far as the incidence of attack is concerned.

We believe the first accurate diagnosis of the disease in this country was made by the Rev. M. J. Berkley in the pages of the *Gardener's Chronicle* in 1859. It had been noticed earlier in Germany as a disease associated with fungus, and the first scientist to classify it was Wilkomm under the name of *Corticium amorphum*, but Hartig subsequently proved it to be a distinct species. In 1860 a small book entitled *The Larch Disease* was written by Charles M'Intosh. The greater part of the book is taken up in describing various theories on the "disease," by which "heart-rot" is referred to, and not blister. That this is so we cannot but conclude, from the following extract from M'Intosh's book:—

"There is *another* form of disease prevalent in many parts of the country which assumes somewhat the appearance of gum and canker in fruit trees. First one branch gives way and then another, and at the points of union of such branches with the trunk a blackish liquid issues. The ascent of the sap seems to be impeded, and the alburnum is dispersed in rather large quantities on each side of the affected part, which gives the trunk a very gouty appearance."

M'Intosh states that two of his correspondents informed him that the ulcerous disease appeared in the plantations at Drumlanrig and Netherby Hall exactly at the same period, namely, in 1845, "a year remarkable for atmospheric epidemics—the potato disease, for instance."

In 1882 Michie published his *Larch*, and dealt with the larch disease. He believed that it originated chiefly in late frosts and badly ripened wood, due to cold, wet soils or overcrowding, and considered that the disease was most prevalent in the south of Scotland and north of England.

The first complete description of the life-history of the fungus in the English language was given by Professor

Marshall Ward in *Timber and some of its Diseases*. As this account of it is generally accepted as correct by all competent authorities, it may be briefly given in detail here.

The spores of the fungus germinate in the presence of moisture, but only infect a healthy tree through a wound. From this wound the mycelium spreads in the soft bast, partly between and partly in the cells, and killing and browning the tissues. In summer the growth of the mycelium ceases, and an unusually broad layer of cork is formed between the sound and diseased tissues. In autumn the mycelium again succeeds in entering the living bast by piercing this cork layer, and continues its growth until the following spring in the wood and bast. This is, briefly, the course of events which is continually going on in every larch blister on an infected tree, and there is no reason to doubt the accuracy of Hartig's conclusions as regards the life-history of the parasite after it has once gained a footing.

In 1891 a valuable paper by Dr. Carruthers on the disease was published in the *Journal of the Royal Agricultural Society*. Dr. Carruthers considered that the disease was most prevalent in crowded plantations, while, on the other hand, open woods and especially single trees in mixed plantations are less subject to attack. Dr. Carruthers also stated that the spores could germinate on unwounded bark, providing that it were not more than four or five years old, and his only remedy, beyond favourable cultural conditions, was that of excising the blister and dressing the wound.

In 1893 the English Agricultural Society sent out circulars to a number of its members, containing a list of questions in connection with the disease. The replies to these were collated by Dr. Somerville as follows:—

- (1) The primary cause is a fungus, *Peziza Wilkommi*;
- (2) the disease is as prevalent now as it has ever been;
- (3) the trees are most liable to attack between seven and fifteen years of age;
- (4) blisters are most likely to occur near the surface of the ground or at the base of a young branch;
- (5) low and damp situations are factors predisposing to disease;
- (6) trees at high elevations are less subject to

attack than elsewhere; (7) trees in mixed woods are less liable to attack than those in pure ones; (8) the larch aphid interferes with the transpiration of water by the leaves, which favours the spread of the fungus; (9) although the disease is not hereditary, it is prudent to avoid collecting seed from trees which have actually contracted disease; (10) it is possible that the disease occurs in nurseries, and may be transmitted to plantations at the time of planting out; (11) home-grown seed is preferred to foreign; (12) self-sown larches appear more immune from attack than planted ones; (13) when once the disease has obtained a footing on a tree, a return to a healthy condition cannot be looked for.

In 1902 the eminent mycologist, Dr. Massie of Kew, published in the *Journal of the Board of Agriculture* the results of experiments on the larch disease, more particularly in reference to its method of infection. Dr. Massie's chief conclusions were that the fungus was a genuine wound parasite, thus agreeing with Hartig and Marshall Ward, and that the majority of the wounds through which it entered were the work of the larch aphid. He believed that, if the latter could be got rid of, the larch disease would eventually disappear.

The above paragraphs give a few of the more important opinions held and facts noticed in connection with the observance of this pest. To digest all that has been written on the subject from time to time would require a book to itself, and not very much more definite information than that given above would be obtained from it. All scientific investigators have endeavoured, to a greater or less degree, to discover the conditions under which the fungus spores penetrate the tissues of the bark, and obtain a footing on the branch or stem. To say that they can only enter by means of wounds does not help us much, or satisfactorily explain all cases of severe attack.

The first thing to decide is the definition of such a wound. If it means any injury to the stem by which the bark is removed or broken, then we can point to hundreds of such wounds which show no trace of infection, although they exist within a few inches of undoubted blisters. On

the other hand, we agree with Dr. Carruthers that numerous blisters can be found on young bark which does not show the slightest trace of wound or injury. But if by a wound is meant a microscopic puncture, such as an aphid would make, then we require more proof than that now forthcoming that the spores enter only by such minute punctures, and, further, as to the extent to which two- or three-year-old bark is punctured by aphides. The latter practically spend their summer on the needles, and those that hibernate do so chiefly in the axils of the buds. Do the fungus spores enter through these damaged needles? If so, then stem blisters ought to be most prevalent on two-year-old shoots, whereas this is far from being the case, as every practical forester knows. Secondly, there is no evidence that the hibernating mother aphid does more than rest on the bud or bark, or that she punctures the latter in any way. Every year a certain number of buds die on most larch shoots, and it is generally these buds that form the nucleus of a blister. But when the extraordinary number of aphides is considered, and their universal distribution over every twig on the tree is taken into account, it seems hardly possible that they can be responsible for the death of about 1 or 2 per cent. of these buds, and that their presence can have no fatal effect on the remainder. That spores do effect an entrance at places more or less damaged by aphides is quite probable, as on badly infested trees it would hardly be possible for them to enter otherwise; but the connection between the presence of the aphid and that of the blister does not seem clearly enough proven to justify any satisfactory conclusions on this point to be made.

As regards the statement that bark is not infected when over four or five years, we think this is not conclusively proved, although it may be true in a general way. On the stems of fast-growing trees there are always cracks and fissures in the true bark which penetrates to the bast below, and there seems no good reason why a spore which has been washed or blown into one of these fissures should not effect an entrance as readily as on young bark. In any case, we have found the fungus growing on bark at least eight or ten years of age, and an examination of the bast below revealed

the fact that the mycelium was eating its way into the latter. In such cases it is possible to remove the entire diseased area with the point of a knife during the summer, as it will slip out like an acorn out of its cup, owing to the cork layer which separates the dead and living tissues.

Leaving the opinions or theories of the scientists for a time, let us look at those advanced by practical foresters, which, from a forestry point of view, are equally as important. The most prevalent are those which attribute the existence of the blister to frosts in April and May, at a time when the dwarf shoots are coming, or have come into leaf. The injury done to larch by these frosts depends a good deal upon their severity in the first place, and upon the state of the trees when the frost comes in the second. What may be termed a ground frost of five degrees or less rarely cuts larch back, unless it happens to be seedlings or young trees of not more than 3 or 4 feet high. Now ten degrees of ground frost are not uncommon in March, but it is seldom that larch is far enough advanced in that month to suffer from them, although in early districts a certain amount of damage is undoubtedly done in this month. But in the south of England, April frosts of more than two or three degrees are not common except in low-lying hollows, in which frost is almost of double intensity to that on high ground. But in all cases frost injuries are most severe at the surface of the soil on low flat ground, and decrease the higher the leaves or branches stand above it, or the surface rises above the general level; and one can almost define the level of the frost-line in a coppice or plantation, to a foot, which has cut back the tender shoots as late as the month of May. If spring frosts are sufficient in themselves to account for larch blister, therefore, we ought to find it more numerous on the branches near the ground, and on trees growing in low-lying situations, than on branches higher up the stem, or on trees on hillsides or eminences. Yet, when we come to test this theory on the ground, can any conscientious observer maintain that it is supported by facts, or that facts justify one in forming a theory on such a basis?

That spring frosts do injure larch to a great extent no reasonable individual would attempt to deny; but, when an

attempt is made to connect the prevalence of blister with that of injury by spring frosts, difficulties at once present themselves. As already said, spring frosts do most damage in hollows and low flat ground, where the air tends to stagnate during a frosty night. Larch growing in such spots ought, therefore, if the frost theory is to hold good, to be the most affected by disease, but, as a matter of fact, it is not. We find larch blistered as badly as it can be blistered on slopes and at elevations of 500 or 600 feet above sea-level, and we can also find it fairly free from disease at the bottoms of valleys, and in exactly those spots where the frost ought to damage it most. We do not assert for a moment that trees growing in frosty hollows are more free from disease than those on high ground, but we do assert that the one is just as likely to escape as the other, and therefore some other cause than frost alone must account for the disease when it occurs, and the absence of frosts cannot be credited with its non-appearance.

Then, again, the theory that snow, by bending down and straining the branches near their junction with the stem, tends to fracture their resin ducts, allows the contents to escape, and thus gives rise to a blister without the co-operation of the fungus, requires a good deal of additional proof. Possibly snow does act in this way in some districts in the north, where wet snow is as frequent an occurrence as rain is in others. But when the fact is considered that wet snow, which accumulates on the branches of trees in this way, is neither an ordinary nor an annual occurrence in many southern districts in which blister is as much a scourge as it is anywhere, then the theory falls to pieces. But, apart from climatic conditions, the position of blisters on most stems and branches does not bear out this theory. If blisters only occurred near the base of a branch, and at the point at which the greatest strain would be experienced, then we might entertain such a theory until something better turned up. But, as a matter of fact, blisters originate and develop on parts of the stems and branches at which no strain of this description could possibly occur. We find it in parts of the stem more or less distant from branches, and it occurs on the latter at their extremities as often as near their base, and

still oftener on branches too small to carry more than a few grains of snow at the most. In fact, the more one ponders on this theory, the more one is convinced of its unsoundness, and it may be put on one side as exploded.

Another theory, which has found much favour at one time or another, is that which attributes the disease to cold, wet soils, tending to produce badly ripened wood. When larch is diseased on such soils, it is quite possible that badly ripened wood has something to do with it, as we know, by experience of other trees and parasitic fungi, that badly ripened wood is most susceptible to attack. The larch has a great tendency to prolong its growth well into September, and when the succeeding October is wet and cold, and accompanied by frosty nights, the last year's growth runs a great risk of getting cut back when severe weather sets in later on. The ends of shoots thus damaged facilitate spore infection to a much greater extent than ordinary wounds. In its capacity as a saprophyte the fungus attacks these dead ends, vegetates within them for a time, and ultimately finds its way to otherwise healthy tissue. When small branches near the main stem are cut back in this way, the dead branch often forms the nucleus of a blister which may prove permanent, and considerably depreciate the market value of the tree. But, as blister is quite as prevalent and destructive on dry soils as on wet, it is obvious that the occurrence of the disease on the former is not explained by the theory that badly ripened wood is the sole cause of it, although it may quite possibly be one of the causes when the conditions are as stated above.

The theory that larch has deteriorated through the use of home-grown or badly selected seed has received the support of many experienced foresters of late years. It is a well-known fact that many breeds of plants and animals deteriorate when bred away from their native habitat, and that it is necessary to constantly introduce fresh blood from the original stock in order to preserve their stamina and constitution. This deterioration is all the more likely to occur in the case of a breed originating in a cold climate and transferred to a warmer one. The more stimulating and exciting conditions bring about a more rapid but less robust

growth, which in the first place acts upon the individual and ultimately upon its progeny, giving rise to a weakened stock, and one more prone to disease. In the same way the larch raised from home-saved seed, if not actually deteriorated as regards its sexual reproduction, may yet possess weakened vegetative powers, which only come to light when adverse conditions of soil or climate prevail. It is a notorious fact that hundreds of old specimens of larch have grown, and are still growing, sound and in good health on soils and situations which cannot be induced to grow younger crops in a satisfactory manner. One reason for this is possibly explained, as stated in Chapter IV., by the fact that early introductions were planted singly or in small groups amongst hardwoods, and consequently under conditions more favourable for their healthy growth. But it is also a perfectly reasonable assumption, that the more vigorous constitution of these early introductions, which originated from introduced seed, is as much responsible for their better health as the more favourable conditions of growth. We are not aware that any experiment of sufficient length to furnish an answer to this interesting question has yet been made, but careful observations on the growth of trees and plantations raised from these respective sources will partly, if not entirely, settle the entire question at some time or other.

So far, we have reviewed the more important of the various theories which have been advanced from time to time in connection with what is considered to be the most troublesome pest which English foresters have to deal with, and have given our reasons for doubting the accuracy of the conclusions which have been drawn from them. It may be presumptuous on our part to question the opinions and statements of scientists who are admittedly at the head of their profession, but the larch disease is a subject which can be studied with the naked eye as well as with the microscope, and, if the former cannot detect the germination of the spore, it can at anyrate see the result of its germination after a few months. But, if those we differ from are in the right, our dissent can make little difference to them, and in any case no harm can be done by giving what the author considers

is the most likely explanation of the most puzzling problem of the forestry world.

It may be stated at the outset that the life-history of the fungus, as given by Hartig, Marshall Wood, Massie, and others, has less connection with the practical side of the problem than many suppose. For all practical purposes, the life-history of the fungus may be generally accepted as following the same 'course on every soil, and in all parts of the country.

The problem for solution is the cause of the great difference in the degree with which one plantation, or one part of a plantation is affected, as compared with another. The disease is practically universal. Why, then, should its virulence differ to the extent that it does? Without pretending to solve this problem off-hand, it may be worth while discussing a few sides of the question which seem most pertinent to it, and which may throw stronger light on those points which have not hitherto received the full attention that they deserve.

The first thing to settle, in our opinion, is the real nature or significance of the disease in the life-history of the host. Is it a cause of bad health or the effect of it? Nine out of every ten foresters, and ten out of every ten scientists, would probably say the former. Yet we do not hesitate to question the accuracy of this opinion. To explain our meaning quite clearly, it is necessary to examine the somewhat ambiguous statement that a perfectly healthy larch may be diseased. Most practical foresters know that the great majority of thriving larch trees carry blisters caused by *Pezizi Wilkommii*, and that these blisters can exist without affecting the growth or commercial value of the tree in the least. In such cases, therefore, it may be said that healthy trees can also be diseased. But, when practical men speak of diseased plantations, they invariably refer to those cases where the growth of the tree is apparently affected, and its market value is undoubtedly decreased by the presence of numerous blisters which occur on stem and branches, and which cripple and deform its entire habit of growth. As both of the above-cited examples of blister attack may exist side by side, or within

the same square mile, it is not unreasonable to lay particular stress on the question as to why the disease (if the disease be the *cause*) produces a harmless effect in the one case, and a destructive effect in the other?

The simplest way to answer this question, if it can be answered, is to consider the prevailing conditions under which most diseased plantations are growing, and notice wherein these conditions differ from what is usually regarded as the ideal. Larch plantations may become badly affected with disease from the time of planting up to twenty years of age, and occasionally older plantations are subject to attack. As a general rule, however, from five to twenty years may be considered the critical period in the life of a young plantation, and, if it reaches the latter age without showing serious signs of injury, little anxiety need be felt regarding it, so far as the *genuine* blister disease *per se* is concerned. When plantations are diseased before the age of five years, it may be safely concluded that either the plants were diseased when planted, or that the conditions under which they were planted were very far from right. It would, we suppose, be rank heresy to suggest that the larch disease exists in public nursery stock, although no good reason can be given why it should not. As a matter of fact, however, there is probably little to complain of in this respect, and it may be taken for granted that the plants become diseased after they have been planted out.

What, then, are the usual conditions under which larch is obliged to exist for the first five years or so after planting? On heathy soils and moorland this tree is usually slitted or notched, not necessarily, into the soil, but into the upper six inches of material nearest the surface. On heathy soils three or four inches of this material often consist of dry peat, full of the roots of heath or grass. In such cases only the extremities of the larch roots come in contact with the true soil below, and with careless slitting they may only rest on the top of it, as on gravelly soils it is often difficult to get the spade far into the gravel. Planted under such conditions in the spring, what chance has a young larch to grow during a dry summer? In the first place, it has to form new roots in a soil which is not only poor in itself, but is also suffocated

under a thick blanket of peat which is practically air- and water-tight. In Chapter IV. we have noticed the peculiarity of the larch in throwing out long surface roots for feeding purposes at an early age, and, if anyone takes the trouble to examine plants put in about a year or so previously, these roots will be found pushing out from the collar just below the surface. But it is obvious that, in dry peat, such roots can find no food worth having, while the growth of roots below the surface is almost as hopeless. The natural result is that the plant is starved for one, two, three, or more years, as the case may be, until its roots are able to reach more favourable feeding ground, and become more or less independent of the surface stratum. Somewhat similar conditions of growth prevail when the plants are put in on turf-covered soil, or ground recently cleared of coniferous wood. In either case, with a covering of peaty *débris*, the true food-holding soil is covered in and buried under the impervious layer above, and semi-starvation is the fate of the plant for two or three years. In a wet summer a certain amount of aerated moisture reaches the roots and enables a better growth to be maintained, but the conditions even then are far from the ideal, and the plants are thrown into a more or less weakened condition for an indefinite period.

In all such cases as those described above—and they probably represent the majority of recently planted larch plantations in England—we have larch plants more or less exposed to fungoid attack on the one hand, and with reduced powers of resisting it on the other. The general distribution of larch plantations, and the almost invariable presence of disease in them, provide an abundant supply of spores always on the look-out for resting-places, and a certain proportion of these are sure to find their way to recently planted ground. In this way disease gains a footing on a scale more or less commensurate with the reduced vitality of the trees, and undoubtedly the condition of the latter determines the ultimate effect the blister will have upon them. When situated on the main stem, a blister on a badly thriving tree of four or five years of age will generally prove fatal, at any rate to the part above it, owing to its gradually embracing the stem. On a vigorous plant it will leave a permanent

injury, which may or may not shorten the life of the tree, but will certainly lower its market value to some extent. This liability to disease continues until the trees are thoroughly established, which may be in two or three years, or may not occur until the fourth or fifth under adverse conditions and dry summers. But in all cases, with a surface covering of peat, turf, or decaying *débris*, it may be taken for granted that larch has an uphill task for the first year or two, unless extra trouble has been spent in removing the surface layer, or thoroughly breaking it up at the time of planting. When the trees are eight or ten years of age, and have been able to develop those powerful side roots on which their healthy growth depends, the success or failure of larch plantations principally depends upon the character of the soil and situation. When these are of the right kind, larch usually does well under any circumstances or method of thinning, although the existence of trees which have contracted disease in the earliest stage will still give the plantation a more or less diseased appearance.

That the above-mentioned conditions cause a great deal of disease in young plantations we are perfectly convinced. Those who doubt that such is the case cannot do better than clear a piece of ground of the overlying turf, peat, etc., as the case may be, and compare the growth and development of the larch planted on such a piece with those growing on ground in its natural condition around them. Watch its growth on a bank of loose earth, or ground with a surface of more or less bare stone or gravel, or on spots where beech or other hardwoods have been growing amongst a cleared-off crop of Scots fir, and where the peaty surface is absent. If these instances are not convincing, so far as they go, then the much greater immunity of such plants from disease must be mentioned as further proof of the reasonable character of the theory. But when the soil or subsoil is unsuitable, either through being too dry and arid, wet and peaty, or through some inimical ingredient in its composition, such as iron, a healthy growth after the first ten years need not be expected. On such soils we cannot expect larch to succeed any better than we can oak in peat-moss or Douglas fir in chalk. Some consideration must be paid to the tastes of the larch if success

is desired, and the practice of sticking it in everywhere is not a more judicious proceeding than that of many other practices in British forestry. So long as the roots are in the surface soil and the latter fairly suitable, they will grow, but when they descend to lower depths they suffer and quickly become diseased.

Another indirect cause of disease is the practice of planting larch pure or unmixed. Pure crops of larch do succeed in some instances, we admit, but we rarely get such good specimens as when they are scattered about among hardwoods. The reason for this is, we believe, in part the same as that given for its better growth on a bare surface, viz. the greater chance its surface roots have of developing and obtaining a proper supply of food. When mixed sparingly with deep-rooting or compact-rooting trees, the larch roots can spread without meeting with much opposition, while their more rapid stem-growth gives them a lead over the other species from the first.

But, when planted pure, it is a case, as with all pure plantations, of the survival of the fittest, and only a small proportion of those planted manage to get the lead and keep it. The fact may be noticed in many larch plantations, more or less diseased, that a tree here and there will show a cleaner growth and greater freedom from disease than the average; and these are they that have secured a more rapid hold of the ground than their neighbours, and have kept the advantage thus early gained. The weaker individuals are consequently kept back, and fall a more easy prey to disease, although on the most suitable soils it often happens that disease is comparatively rare throughout, however thick the trees may stand.

It is very probable that the above are the most likely reasons for the greater freedom from disease and more vigorous growth of larch, when sprinkled with such hardwoods as oak or beech. But the better shading of the ground, and the moister condition of the surface soil with a hardwood humus layer, may also conduce to healthier growth, especially on rather dry soils, and in such cases the additional moisture may be the more potent factor in promoting the health of the trees.

The idea that larch mixed freely with other species is less subject to disease, on account of the greater isolation of individual trees, seems to us difficult to prove. The absence or presence of a few millions of fungus spores, more or less, cannot be of great importance, or affect the general spread of the disease one way or the other, unless the proportion of spores with germinating powers is much smaller than is generally supposed.

It would be absurd to pretend that the arguments advanced above cover all the ground over which the larch disease ranges. But our contention is, and long has been, that the disease is as much the effect as the cause of the bad health and the unthrifty condition of hundreds of plantations throughout the country, and that the temporary debility which is induced by the conditions under which planting is, and in many cases must be, conducted, are largely responsible for a great deal of it.

The practically permanent nature of the blister when once established renders the result of this temporary debility a more serious matter than it otherwise would be. If the return to normal health and growth were accompanied by the disappearance of the disease, little harm would be done. But the existence of a blister once established is perpetuated indefinitely, and in most cases only ceases with that of its host, and the occurrence of a blister on the stem of a young tree is a much more serious business than it would be on a branch or older stem. Cases do occur, although they are not too common, of the disappearance of the blisters when the trees recover their health and vigour. We know of a plantation about twenty years of age on the Greensand, more or less mixed with beech, where numbers of old blisters are gradually becoming "occluded" by the surrounding wood. That they were genuine blisters is proved by the remains of the *Peziza* cups still observable, and the only possible theory respecting their disappearance must be found in the improved health of their hosts.

Another point of importance in the discussion of this question is the fact that the fungus is found as a saprophyte on the healthiest trees and in the highest crowns. Pick up dead twigs or branches under the largest, finest, and most

isolated larches that can be found, and the fructifications are invariably present on them. This fact is sufficient to prove that the mere existence of the fungus does not necessarily lead to diseased trees—using the term “diseased” in its practical sense.

HEART-ROT IN LARCH.

Although the true larch disease has received its full share of attention of late years, and is considered by many to be the most destructive pest that we have in England, it is probable that a careful examination of the various plantations throughout the country would reveal the fact that “heart-rot” is equally, if not more, destructive to the tree, and more detrimental to the value of the timber than *Peziza Wilkommi*. That this has not met with such attention as the latter in late years is probably due to its obscure nature, and to the fact that it is only when the trees are cut down that it can be diagnosed with certainty. But fifty years ago it was considered to be the only disease that affected larch to any serious extent, and, when old foresters spoke of the larch disease, heart-rot was always referred to. M‘Intosh, in his book already cited, devoted a great deal of time to its examination, and collected all the existing literature and opinions available on the subject, although no very definite conclusions were arrived at after all. Hartig refers to it under the name of “root-rot,” but more in reference to trees generally than larch in particular. He considers it due to stagnation of the air in wet or compact soils, and often to the cultivation of the ground previous to planting, and its subsequent settling down after the roots have spread freely into it. But, whatever the authority we consult, all agree in believing it to be the direct result of unsuitable soil, although the belief that wet soil is the cause has as many adherents as that which attributes it to dry.

The average heart-rot in larch, however, must not be confounded with that caused by *Trametes radiciperda*, although the latter produces the same effect in its early stages. But attacks by *Trametes radiciperda* invariably kill the tree in a year or two, while the progress of heart-rot may continue

for many years in a slow and indefinite manner, and without affecting the functions of the sap-wood of the trunk, or killing the side roots outright. In its earliest stage, heart-rot may be detected, when a tree is cut, by the dull foxy-brown or liver-coloured patches of wood which are irregularly distributed amongst the lighter-coloured heart-wood, and these patches often extend irregularly into the sap-wood. The term "pumped" is often applied to trees which are found to be hollow when cut, but we believe that typical pumping is the direct result of fungoid attack, while heart-rot may arise in the deterioration of the tree itself. The former disease may be found in trees of considerable age, and which are otherwise healthy and vigorous, and the pumping often follows the line of the annual rings more or less definitely; whereas heart-rot seems to be a slow but irregular change and deterioration in the tissues of the wood, much as if the natural sap were extracted from the heart-wood to supply a deficiency in the sap-wood, and may be found at the age of ten years and upwards. In fact, the particularly early age at which it appears is its worst feature, for it often renders entire plantations perfectly worthless for any useful purpose before their twentieth year, whereas merely blistered trees are often as sound and durable as any.

As already said, no definite conclusions appear to have been arrived at as to the cause of this disease, beyond the fact that it is due to soil. Had it been caused by a specific parasite, no doubt its life-history would have been worked out by half a dozen investigators, and we should have had scientific controversies over it in abundance. But forestry scientists rarely help us much in cases of this kind, and when mere everyday influences are at work we have to fall back on practical experience.

Our own belief is that heart-rot is due to defects in the chemical and physical properties of the soil, and that the disease is merely the first stage of that premature decay which results from imperfect nutrition, and, later on, fungoid infection takes place and accelerates the process, probably *Polypori* of various kinds being the common source of infection. Of the two, it is much more common on dry soils than wet, unless the former are subjected to a wet climate; and it is a

more common disease on sands and chalk than on clay or gravel. On moist, springy ground it rarely proves troublesome, although a certain proportion of trees in most plantations are affected with it. Remedy, of course, there is none, beyond the planting of larch on suitable ground, and then we cannot always be wise until after the event.

As with the blister disease, heart-rot may be caused by a constitutional deterioration of the tree. But, whether this is so or not, there can be little doubt that soil is the greatest factor in inducing or preventing it, and that a fairly moist and porous soil is the one least likely to favour the disease, as is the case, more or less, with blister disease. Thin, dry soils, on the other hand, are particularly subject to it, and on many of these it is a rare thing to meet with a really sound tree after the twentieth year or so after planting. On dry soils lack of moisture also aggravates the evil, by rendering the surface strata more or less incapable of supporting growth, and the roots have no alternative but to descend.

Certain geological formations, again, appear to favour the disease more than others. As already said, thin chalky soils rarely grow sound larch, while the oolite, which is very similar to chalk in many respects, produces first-rate larch timber. This may possibly be due to some physical or mechanical difference in the soils of these two formations, which enables the roots to reach water-holding and aerated strata in the one case, but not in the other. The larch is very susceptible to any favourable or adverse conditions of the surface soil, and the development of its surface roots, as already said, is of the first importance, although in exceptionally porous soils they may penetrate to a fair depth. But in a soil which prevents surface rooting, and compels the roots to descend to badly aerated soil below, their normal functions are interfered with, and their vitality decreased. Under such conditions heart-rot becomes more or less general, and must be regarded as a foregone conclusion.

The immediate cause of heart-rot in the stem is the death and decay of one or more of the main roots, from which the stem is an upward continuation. It may arise in some instances from fractures or injuries sustained by these roots,

but the most common and frequent origin of the disease must be attributed to the soil.

THE HONEY FUNGUS (*Agaricus melleus*).

This is another of those facultative fungi which can be either a parasite or saprophyte, as circumstances permit. Probably its true character is that of a saprophyte on hardwoods, and it attacks conifers in order to make the most of its time. Its life-history is one of the most interesting amongst the fungi with which the forester has to deal, for its marvellous adaptation to environment would almost lead one to believe that it possessed reasoning powers above the average amongst members of the plant-world. According to Hartig, the spores of the fungus are distributed by wind or other agencies in autumn, and, upon these germinating, the root-like mycelium is formed, which in one form or another is one of the characteristic features of the organism. This mycelium finds its way to the roots of some tree susceptible to attack, such as an old and decayed hardwood, young Scots fir, or other conifer, and then proceeds to develop beneath the bark of its host. In its early stages, and when a plentiful food supply is present, this mycelium is a pure white felted mass, which completely fills the space between wood and bark. But when food is scarce, as on wood already dead, the mycelium assumes the character of brown, rope-like threads, which are known under the name of "rhizomorphs," and which carry the mycelium over sterile spots until it again reaches more favourable material. These rhizomorphs ramify and spread beneath the bark, in much the same way as ivy will cover a stem externally, and they may be found running up the dead tree to a considerable distance from the ground. It can also make its way through soil, along the underground face of a wall, between boards, and along or through any other crevice or medium which is dark and moist. In a freshly attacked tree this mycelium sends out hyphæ into the medullary rays of the wood, extracts the nutritive materials they contain, and in conifers destroys the parenchyma surrounding the resin canals, and allows the

resin to escape at the surface of the ground, or to soak into the dry wood. The gradual decomposition of the wood ensues up to a certain point towards the centre of the stem in the upper part of the tree, but in the roots and lower parts of the stem the whole gradually becomes decomposed into a mass of white mycelium. The fructifications are brown, possess a scaly cap or pileus, and a long stalk which is thickened at the base, and are easily identified again when once seen.

The dangerous nature of this parasite lies in its power to spread from tree to tree by means of its underground rhizomorphs. Where it once gains a footing in a plantation, the disease radiates from a centre until it is stopped by some obstacle which prevents its further advance, or its supply of feeding material is completely exhausted. As may be inferred from its life-history, it is most troublesome on ground planted with conifers after an old crop of hardwoods has been cleared off it. Scots fir seems to be an especial favourite for attack, while larch usually escapes. Hardwoods generally are said to be only attacked when in bad health or decaying, but conifers of all kinds are more or less subject to attack. Its antiquity is proved by its having been found in fossil wood of the coal measures; and as it may reasonably be presumed to have existed in this country since the Glacial Period, and to be little if at all more virulent to-day than it was a thousand years ago, the English forester ought not to exaggerate its importance as a fungoid pest, although it is undoubtedly troublesome in odd corners, and in places where it is not wanted.

Beyond the grubbing out of old roots before replanting ground with pines or firs, the chief remedy seems that of isolating infected areas by cutting trenches round them. Whether this is worth doing on the chance of effectually cutting off the rhizomorphs under the surface, must depend upon the nature of the ground, and the value of the crop to be benefited. The rhizomorphs are not supposed to attack roots beyond a few inches below the surface (Hartig says seldom more than 4. inches), but one is never sure of extending the trench far enough from the centre of infection to ensure all the rhizomorphs being intercepted. When a trench is dug, however, it is advisable to fill it with gas or

quicklime, or any other cheap fungicide, and to plant up the ground, after a decent interval, with a hardwood species.

TRAMETES RADICIPERDA.

This fungus behaves in much the same way as *Agaricus melleus*, and, like the latter, is both a saprophyte and parasite under certain conditions. Unlike that fungus, however, it appears to attack larch as freely as Scots fir, and a certain proportion of the heart-rot of that tree may usually be traced to it. But a peculiarity with the rot caused by *T. radiciperda* is its tendency to spread vertically rather than laterally, and to follow the wood-rings of certain years more than others. This may be due to certain wood-rings being harder and more resinous than others, and more capable of resisting the entrance of the mycelium. The same reason may possibly explain the fact that it rarely rises above the roots of Scots fir, owing to the greater abundance of resin at the collar or base of the stem.

The life-history of the fungus resembles that of *A. melleus* in many respects. It is able to infect sound trees by the mycelium spreading from root to root under the surface, while its spores may be carried by wind, mice, or rabbits to a considerable distance from the fructification which produces them. In this country it is most conspicuous in Scots fir plantations, in which it often causes considerable gaps when allowed to spread unchecked. Larch and spruce are also killed by it, and it may also be found attacking thorns in hedges round plantations.

The remedy for the attack of this fungus is the same as that for *A. melleus*,—isolating the infected area by means of a trench, and filling in the latter with something that will kill the mycelium, or prevent it from crossing.

NECTRIA DITISSIMA.

The cankers so often seen on ash and beech stems are usually the work of this fungus, and the trees attacked are

often crippled to such an extent that it renders them quite useless for economic purposes. The attacked trees are in much the same position as larch attacked by *Peziza Wilkommi*, although the absence of resin in hardwoods renders the attack of the latter more deadly, and also gives it a different aspect. The fructifications of this fungus are so minute that they may easily escape notice, but a careful search will reveal them on the margins of the cankers as bright red dots about the size of the head of a small pin. The mycelium, which perpetuates the canker in the same way as that of *Peziza Wilkommi*, spreads in the tissues of the wood, and Hartig believed that it was capable of producing cankers from within, and independent of outside infection.

On healthy trees and favourable situations this fungus rarely gives much trouble, nor does it occur over sufficiently large areas to occasion much alarm. Partly suppressed trees, or those growing in wet, stagnant spots, are most likely to become attacked, and in such situations it is doubtful if the trees would be of much greater value if the fungus were absent. Cutting them out, and removing them from the wood, is the only practical remedy, if remedy it can be called, for it is not at all clear that the fungus has any great power of spreading or propagating itself on trees in average health.

In conclusion, it may be said that the suppression of all woodland foes, whether animal or vegetable, depends largely upon the aid which nature gives in the work. In many cases the forester is almost powerless in the matter. Fungi, for instance, which spread and multiply by means of millions of invisible spores, can only be detected in their work after the damage is done. Insects, again, such as the larch aphid, or caterpillars of various kinds, come and go in a way which it is almost impossible for a human being to hinder or prevent. The best and easiest way of preventing or discouraging attack by any of these foes, with the exception, perhaps, of squirrels, rabbits, mice, etc., is that of giving each species of tree the soil and situation best qualified to meet its requirements, and to maintain its perfect health and vigour. Many insects, and certainly the majority of fungi, only attack trees which

are declining in health, or lacking in vigour. Certain individuals, of course, will be in such a condition in every plantation, and when these are attacked, the obvious course to adopt is their speedy removal; but, outside this course, it is doubtful if the forester is justified by results in going to any great expense in fighting insect or fungoid pests on a large scale. His most strenuous efforts are so futile, and the numbers of his foes so enormous, that he is almost impotent in any work he may undertake in this direction. The disease or the attack invariably wears itself out, or, if it does not, the crops attacked must disappear, and in either case the loss sustained is usually inevitable. By taking all reasonable precautions in the various ways indicated in this chapter, he not only does as much as can be expected of him, but he is also exercising true economy in the interests of his employer.

WIND, STORMS, AND FROST.

Of all the enemies of English woodlands, probably no class is more familiar to the average individual than that which includes storms, gales, and late frosts. In each of these cases the effect on trees of all sizes is well marked, and is brought forcibly home to the dweller in both town and country. Our severest gales usually come from the south-west, and, as the winds during the greater part of the year also come from that quarter, it is not surprising to find their effect on all woodlands exposed to that point of the compass. Such effect cannot, of course, be altogether avoided by any method which can be adopted by the forester. The flat and more or less leaning stem, characteristic of all trees growing on an exposed westerly site, are general features of both isolated and plantation trees, but they are much more pronounced in the case of the former. In a thick wood one tree shelters the other, the plantation grows up as a solid mass, and every inducement is given it to produce as tall and straight trees as the situation will allow; but when gaps occur in an exposed plantation, either by natural decay or artificial felling, the remaining trees, if lanky and drawn up, suffer severely, and may be swept down by the acre.

The forester who has to deal with exposed hillsides, upon the face or shoulders of which the wind sweeps with full force, has to make an early choice between two methods: he must either accustom his trees to the situation from the first by giving them plenty of room, and thus favouring the formation of stout, short stems, which stand up better against the wind than any; or he must adopt a system of thinning and felling, which will avoid all dangers to surrounding or surviving trees. The first method involves the production of coarse and inferior timber, and is only adapted for shelter belts, and woods maintained for landscape effect, where the production of saleable timber is of secondary consideration. Where the latter, however, is the object in view, wind must be guarded against by arranging the fellings in such a way that the sides of the blocks, or area suddenly exposed, should be on the east, and not on the west side of the plantation. When so arranged, recently planted ground is always sheltered by the older wood to the windward, and, when the latter in its turn has to disappear, the trees are too small, and stand too thickly on the ground, to suffer from the exposure. When a long and unbroken westerly slope has to be cleared and replanted, therefore, the proper course to adopt, if other circumstances will permit, is that of cutting in long narrow strips across the face, and commencing at the top of the slope, replanting these strips as soon as possible. Where horizontal strips do not allow the timber to be removed conveniently, they may be cut obliquely across the hill, or at an angle of about forty-five degrees to its slope, the great point to guard against being direct exposure of the older trees in any way.

Where the ground is very broken and irregular, forming a series of exposed ridges across the line of the wind, the retention of permanent shelter belts across their crest is also advisable. These belts should consist of hardy, deep-rooting, or bushy trees, which will break the wind where most required, and so prevent that sudden exposure which would follow clear felling. But the necessity for such belts is most urgent at the margins of plantations on exposed sites. In some cases the retention of a row of outside trees will provide all the shelter necessary, and break the wind to the desired

extent, and, as such trees are rarely of much value for timber, their value standing is greater than when down.

Careful thinning, good drainage, and a certain proportion of naturally deep-rooting trees in the crop itself, are all favourable to the avoidance of damage in ordinary plantations. Careful thinning prevents the swaying of the crowns, which is the cause of immediate injury. Good drainage encourages a deep and well-developed root system, while deep-rooting trees give the plantation a stiffness and rigidity it would not otherwise possess, when the crop chiefly consists of shallow-rooting conifers. In spite of all precautions, however, some damage must be expected from severe gales, and it is a well-known fact that there is no certain relation between this damage and the sheltered or exposed condition of the situation.

LATE FROSTS.

Late frosts are clearly beyond the power of the forester to control or prevent, and it is only possible to minimise their effects by planting hardy species in situations most exposed to them. Such situations are damp hollows, or flat, low-lying land which is favourable to stagnant air during windless nights. Where ground to be planted occupies a large area of flat land, it may not always be possible to select none but hardy species. In such cases any tender species must be protected by older and larger trees during the early stages, so that the critical stage of its existence, which may be said to be that period during which the leading shoots are within 20 feet of the ground, may be safely gone through. Ash, beech, Douglas fir, silver fir, etc., are all particularly sensitive to late frosts, and, when planted on ground subject to them, a hardy species, such as birch, elm, Scots fir, etc., should be planted in advance, and allowed to reach a height of 20 to 30 feet before the others are introduced in the form of a second storey.

In frosty hollows of small extent tender species should never be planted, and only those able to endure a spring frost in April or May of three or four degrees are fit for such spots.

CHAPTER XIII

THE ENGLISH FORESTER

WHEN royal forests and private chases constituted the greater part of the woodland of England, the equivalent of the forester of to-day had a very limited existence. The term "forester" in olden times was applied to an individual who had more to do with the hunting of the game than the trees which sheltered them, and his duties consisted chiefly in representing the king in his absence, and waiting upon him during his hunting expeditions. The chief forester of a royal forest appears to have been a person of some importance, and usually a gentleman of rank, who held land in or round about the forest, or who had received his appointment as a mark of royal favour. The office was often hereditary, and handed down from father to son through many generations. We find, for instance, that the ancestors of our chief land-owners in many of our now extinguished royal forests were originally the foresters of Norman or Plantagenet times. As an instance of this may be mentioned the family of Bruce, now represented by the Marquis of Ailesbury, which, many generations ago, found the chief foresters for the royal forest of Savernake. At the present time this forest is entirely private property, and is owned by the family already named.

Under the chief forester were a number of subordinate officers, most of whom had duties connected with the deer or game. But the most important officer, from our point of view, was the wood-ward, who, according to Manwood, was responsible for the preservation of the vert, or trees and shrubs of the forest. This official had to present his hatchet, as an emblem of office, to the Lord Justices in Eyre, whenever

called upon during the holding of the Forest Courts. The exact nature of his duties is not very clearly defined, but in all probability they were connected with the supply of timber, firewood, and other forest produce, for which grants were given, or which was demanded by the commoners in or around the forest. The first indication of a modern forester, outside the office of this individual, is comparatively recent. When enclosed estates were small, and the area of woodland on them limited, it is scarcely probable that employment could be found for such a man, and we must therefore come down to the period of enclosures, and the economic development of private estates, before we can find much trace of him.

In the eighteenth century, when landscape gardening began to occupy the attention of estate owners, it was the custom to call in some authority on that art, and the latter more or less performed the duties of forester, so far as planting was concerned. It was sometimes customary for the landscape gardener to contract for the whole work of improvement, the owner finding horses, material, etc., according to the nature of the work. The avenues planted by de Notre in the seventeenth century were chiefly elm, and the work was probably done under the gardener's supervision, with the assistance of a staff of ordinary labourers. "Capability" Brown at a later period did a great deal of his work in this way, and it is almost certain that early professors of the art, if they did not contract, at any rate chose the species of tree and method of planting it.

In fact, up to the end of the eighteenth century we can find no evidence that men were employed above the rank of labourer for the express purpose of taking charge of the woods of an estate. One reason may be found in the fact that estate woods previous to that time were not extensive, for it was not until the middle of the century that the great development of large landed properties took place. Few estates had more than a thousand acres under wood, and much of that was worked on a system which required little skill beyond what a working woodman could supply. Most of the supervision which is now performed by the head forester

was then undertaken by the proprietor himself, or, on large estates, by the land steward—the latter class usually belonging to the now extinct yeoman type. Estates which now employ a resident agent, half a dozen estate office clerks, and as many heads of departments, were then managed by a land steward of this kind—the gardener being perhaps the only department which had a distinct existence, and by whom a certain amount of forestry was done. The few men in the country at that time who made forestry a speciality were either nurserymen who had a more or less direct eye to the sale of young trees, or those who made all branches of estate work a speciality, and included forestry amongst the rest.

It was not until the introduction of the larch and other coniferous trees adapted for planting waste land that the modern forester came into existence to any extent. He doubtless originated in Scotland, for, owing to the far greater extent of waste land in that country, planting, when it did begin, was conducted on a far larger scale, and was therefore more rapidly specialised. When the extensive planting operations, which resulted from the enclosure of wastes and the desire to improve the landscape, were inaugurated about the end of the eighteenth and beginning of the nineteenth centuries, proprietors began to look out for men who understood the work better than the local woodman, and who could devote more time to it than the estate gardener. The old-fashioned land steward had been replaced, to a great extent, by Scotch agents, and the latter naturally had a preference for their own countrymen, independent of their greater skill in the work of planting waste ground. The history of forestry on most estates consequently shows traces of Scotch foresters about this period, and it is highly probable that they, or their descendants and disciples, revolutionised English forestry to a great extent. Mixed plantations of conifers and hardwoods, and pure plantations of larch, Scots fir, or spruce, took the place of or rather succeeded the old coppice with standards, which had been the prevailing system in England for the previous two hundred years. Much of the land then planted was of course too poor for coppice, but very little of the latter appears to have been planted on even good ground.

The appearance of the professional forester was also

accompanied by a sharper line of division between his department and the land steward or agent, and we find the work done about this time was done better and on a larger scale than at any subsequent period. One reason for this was probably the cheapness of labour, combined with the liberal spirit in which the cost of these improvements was met. Money was plentiful, and proprietors who carried out improvements of a more or less novel nature attached more importance to the successful termination of the work than the cost of doing it. Plans were drawn up and executed about that time on a scale which subsequent proprietors have found a great deal too large for the rental of the estate to carry on, and it is nothing unusual to come across a great deal of work then done now fallen into irreparable decay.

From about 1800 to 1860, or thereabouts, the position of the English forester on large estates reached its culminating point of prosperity. His social position had been gradually improving for two or three generations; proprietors took a keen interest in their woods, and were quick to note ability, and reward it accordingly; and agents were practical men, and knew the difference between spending and wasting money, and left the forester to do his work pretty much as he liked. The majority of the woods were also in a fairly profitable condition, for the plantations formed in the previous century were beginning to mature, and able to furnish saleable timber in large quantities; and this made the forester's department a satisfactory feature in connection with estate accounts, and the necessary expenditure was not so grudgingly sanctioned, as is often the case when returns are small. There is little doubt, that the foresters of this period were more or less extravagant in their ideas, and that money was spent in various branches of wood-work which the resulting crop of timber could not pay for, especially on wet and heavy grounds. Reference has been made to this in Chapter I., and in many other directions it is evident that money has been spent more lavishly than wisely—at any rate, on many large estates in the hands of wealthy proprietors. When bad times came, the reaction which set in was consequently the more marked, and a spirit of economy (or what was regarded as economy) succeeded the previous system of unlimited

outlay. Old labourers of the present day are eloquent on the subject of those bygone days, and their accounts of the men employed, and the work that went on, make it clear to the intelligent listener that luxury was a greater feature than economy, and that these good old times were often the moral ruin of those who lived in them.

The training received by the average forester up to the end of the nineteenth century varied more according to his necessities and opportunities than to his needs. The appointment of foresters on large estates was always of a more or less haphazard nature, and a man who had little or no previous experience of the work had as much chance of getting an appointment, provided he had influence behind him, as a more capable man with no influence beyond his own abilities. It is only too apparent that, while some filling the posts of foresters have been born foresters, with all the instincts of trained silviculturists, although perhaps without the fulness of their knowledge, others again have been mere makeshifts who have adopted or followed the profession from mercenary motives alone. Incompetence in English estate forestry is a fault which may remain undetected for a lifetime, and the effects of which may not be revealed until the offender has finished his career; and it is an unfortunate fact in many ways that inferior men, so far as outward appearances go, make as good a show for a time as those who have the interests of the estate woods more at heart. Until quite recently (and to some extent even now) it was no uncommon thing to find all classes of men filling the position of estate forester. Any man with a general knowledge of estate work was considered qualified to manage the woods, more especially on those estates on which the area under wood chiefly consisted of coppice with standards. It required no great ability to manage a squad of half a dozen woodmen, to mark and measure the necessary number of trees for estate use or sale, and to see that hedges and fences were more or less in good condition. Such were about the extent of the duties of the majority of estate foresters, so far as the woods were concerned, on English estates of moderate size, and it is evident that forestry proper did not enter into them beyond those details already mentioned.

When, for any particular purpose, planting was carried on, it was, and still is, usual to get a nurseryman to do it by contract at so much per acre, and leave the method of planting and choice of species to him. In such cases the resulting plantation is not always all that can be desired, but it is usually quite good enough to serve as food for rabbits or shelter for game.

No doubt, during the last hundred years it has been customary for a young man, anxious to work his way up as a forester, to serve some sort of apprenticeship in the woods of an estate, but the value of such an apprenticeship depended more upon the man undergoing it than the quality of the instruction so given. Forestry is a slow business at the best, and the relation between cause and effect is not so patent to the individual observer as in gardening or farming, where a crop can be planted and reaped in one season, and the necessary deductions made from the results. In forestry a man may see good practice in planting or thinning, but he cannot see the direct result of it, and he may see the result but not the causes which produced it. Empirical forestry instruction, consequently, greatly depends upon processes of induction and deduction, and, as these processes may lead to correct or incorrect inferences, according to the reasoning powers of the individual, it is not difficult to understand that rule of thumb played an important part in all forestry instruction in early days. In fact, the training of the forester was almost entirely confined to the manual labour of planting, timber-cutting, and so on, and the principles on which many of the technical operations were conducted were very imperfectly understood. The general result of this training has left its marks more or less clearly on English plantations formed during the last century, as we have already seen; but a careful examination rarely fails to reveal that a greater difference has existed between the practice of individual foresters than can be attributed to training alone.

Of course, on many small estates the system prevails of tacking the supervision of the woods on to some other department, and no pretence is made of keeping a proper forester. In other cases the agent professes to manage the woods, and a low paid forester is paid to work under him

and supply the knowledge of detail which the agent lacks. This latter system is bad in principle, and rarely leads to satisfactory results. A man who knows his business thoroughly can rarely do himself credit when working under the direction of someone else. If the employment of a forester is necessary at all, it is also necessary that he should carry out the duties for which he is employed, and it is impossible for him to do this unless he has full control over his work, whether this work be purely and simply forestry, or a combination of forestry and something else.

On many estates the forester's duties are of a more or less indefinite nature, and his staff is often called away at a day's notice to augment the staff or do the work of another department. In such cases it is impossible for him to do his work as it should be done, and it is also extremely difficult for a man whose work is subject to such interruption, to take the interest in it which he ought to do. No doubt, on every estate it is necessary that one department should be dovetailed into another to a greater or less extent, and the forestry department, owing to the wide area over which it works, is more exposed to this dovetailing business than any other. But this is not a sufficient excuse for making it do the odd work of every other department on the estate, or for making the forester an odd man who is expected to obey the beck and call of every head of a department who wants something done in a hurry. Where odd work must be continuously done by the forester's staff, let a certain number of men be told off for such work and no more. When one odd job is finished, let this squad go on to the next, but never augment it by withdrawing men from the legitimate wood staff, or the woods will sooner or later feel the effect of it. Nothing is more convenient for the clerk of works, gardener, or bailiff, to be able to put a hand on two or three of the forester's men at a moment's notice, whenever they are wanted. It saves the necessity for a good deal of forethought and planning on the part of those officials, and the manner in which these sudden calls upon his resources are met by the forester himself is a very fair indication of his value as a forester. If he meets them with an air of amiable resignation, so much the worse for the woods; but if they call forth

remarks which are more forcible than polite, then he deserves better conditions for working under, and it is in the interests of his employer that he should get them.

When, then, a forester is really wanted on an estate, let him be a forester first, and, if necessary, a supervisor of odd work afterwards. If the forestry is only to be done at odd times, it will probably be found cheaper not to employ a forester at all, but to employ a handy man with a few elementary ideas on wood-work, and so on, and let him do it to the best of his ability. We do not suppose that any estate proprietor who engages a forester has the faintest idea of engaging him under false pretences. And yet this is what it practically amounts to when a man is engaged as a forester, and ostensibly for the management of estate woods, and then finds, when he enters upon his duties, that the forestry part of them is merely a detail. An estate owner does not engage a farm bailiff to attend to his carriage horses, or a gardener to grow oats or mangels. Why, then, should he employ a forester to act as ganger over a miscellaneous squad of labourers, or as a sort of general foreman to two or three estate departments? No forester of average intelligence considers any estate work beneath his dignity, provided it is entrusted to his charge in a business-like manner. But he has every right to object to being made a tool of, or used as a stopgap, for the benefit of another department, and to the detriment of his legitimate work.

There is little reason to doubt that both the capabilities of the forester and the improvement of the woods entrusted to his charge would be vastly improved if he occupied a more definite position on the estate. It matters little whether he receives a salary of one, two, three, or four pounds a week, provided that he is able to feel that the woods are his special charge, and that their condition or improvement depends more or less upon his own exertions. If his mind is satisfied on this point, the condition of his woods will soon indicate the extent of his ability, and his employer can easily estimate its value to himself or the estate. But when a forester is expected to act on his own responsibility to-day, and act on orders received from someone else to-morrow, it is impossible for him to do justice to himself, to acquire

confidence in his work. We consider that every forester ought to be directly responsible to his employer, so far as his woods are concerned, and occupy exactly the same position as a gardener, coachman, or gamekeeper. Yet, as often as not, the proprietor practically hands over the forestry department to his agent, and leaves him to settle the principal details of the work of the woods. When the aim of the latter is to make everything look well on paper so long as he holds the agency, his invariable policy, so far as the woods are concerned, is that of combining a maximum income with a minimum expenditure. Sales are forced, immature woods are cut into, and all outlay on planting or other improvement discouraged as much as possible. When this sort of thing has gone on for a few generations, the condition of the woods is well-nigh hopeless, and they can only be brought round again by wholesale planting operations and lengthened periods of rest. In such cases the influence of the forester is practically *nil*, and, for all the good his professional training does him, he might just as well have spared himself the trouble of acquiring it. All that is needed in such places is a man able to measure timber and superintend the felling of it, and it is easily understood that men of this description suit some estates a good deal better than those really qualified to take the entire charge of woods and improve their condition.

It is, perhaps, for this reason, that the employment of properly trained foresters, if not actually discouraged, at least meets with little encouragement on estates. It is evident that the only course open to a competent man is the complete reversal of the ruinous policy that has so long been adopted, and this simply means an increased expenditure and a diminished income. Where proprietors themselves are aware of what is going on, and sanction it by tacit consent, one cannot of course blame the agent or anyone else for not altering a system which can hardly be avoided. But where a proprietor is really anxious to do the right thing by his woods, and is willing to bear the necessary expenditure, there is no good reason why a competent forester, if one is employed at all, should not be allowed to spend the amount necessary to accomplish the owner's object in view, and spend it in his

own way. To cut down expenses, and spend one pound where two are required, is not economy but waste, and the money so spent might, as often as not, be thrown away, for all the good it does in the long-run. To erect cheap netting, buy cheap seedlings or plants, or withhold the necessary expenditure on labour, does more than anything else to render woods unprofitable. Yet such transactions are often forced upon the forester against his better judgment, and he is blamed behind his back for the failures which result from them. A great deal more might be done towards the improvement of woods without incurring a greater expenditure, if it were only gone about in the right way; but when the work is entrusted to the joint control of two or three individuals, the efforts, inclinations, or ideas of one are sure to run counter to those of another, and the final result be partial or complete failure.

A great deal of trouble might be avoided if every woodland proprietor required his forester to place his views and opinions before him, once a year at the very least, in the form of a report of past operations and a programme for the coming year combined. A programme for the coming season's work is especially desirable, showing the nature of the work needed or contemplated, the cost of doing it, and the benefit likely to be derived on the part of the woods. A forester who simply works from hand to mouth has no definite ideas as to what he will spend or is expected to spend, and no definite aims in view with regard to the management of the woods, and can hardly be expected to do good work or achieve satisfactory results. A great deal of work might be done at odd times, or in short periods, when routine work is more or less slack, without any inconvenience, if premeditated and decided upon beforehand; but when the forester is ignorant as to the actual sum he is expected to spend, or the returns he is expected to make in timber or money, his work throughout must be more or less aimless and haphazard, and a great deal of valuable time will be invariably wasted, because he is unable to begin work with any definite guarantee of its being carried to a satisfactory conclusion.

THE FORESTER'S EDUCATION.

The most suitable form of training which an English forester of the present day should undergo must vary a great deal with his capabilities and aspirations. The man intended to occupy a post on a large estate needs a more thorough and lengthened training than one who simply aims at filling the post of a working woodman or foreman on a small estate, or where the area of woodland is limited. In the former case the aspirant to a forestry appointment must not only have a fairly good general education, but should be more or less conversant with the elements of science and art. Botany, chemistry, geology, zoology, land surveying, and book-keeping, are all more or less important items in the education of such a man, although it is not necessary for him to be an expert in any one of them. But as regards sylviculture, or the planting, tending, and felling of woods and selling of timber, he should claim a considerable degree of expertness before he can consider himself a qualified forester.

How can these qualifications be best acquired? We will suppose that the intending forester leaves school at the age of fifteen or sixteen, by which time he is fairly well up in most branches of general education. The first step he should then take must be of a practical nature. Lessons learnt at this stage of his life will leave a more lasting impression upon his mind than those acquired after his mind and muscles have become set, and run more or less in grooves. At this age, hard manual exercise is neither necessary nor desirable. He cannot be considered physically fit for the laborious work connected with the axe or the saw, but there are many branches of wood-work which he can perform without affecting his health or overstraining his muscles.

The first step in his career, therefore, should be that of obtaining a footing on a large and well-wooded estate, if such can be found within reach of his paternal home. On such an estate, nursery-work, planting, cleaning of young plantations, the burning of rubbish, the tending of rides, roads, drains, and so on, are continually going on, and a strong healthy lad should be quite capable of taking his share in such work. He may, at this stage of his career, receive

much benefit from a little theoretical coaching from the forester under whom he is employed, assuming that that individual is capable of giving it. By the time he is seventeen or eighteen he should become acquainted with the use of the axe, saw, hand-bill, and any other tools used in woods or wood-work. He should also get an insight into the measuring of timber, the setting out of drains, the principles of road construction, the theory of forming plantations, and the thinning of woods—all of which he can pick up with the aid of ordinary intelligence and observation.

After undergoing a training of this kind until he is eighteen or nineteen years of age, he should be able to judge as to his fondness for the work or otherwise. If the work goes against the grain, he had better, to use a common expression, "chuck it up" at once, for English forestry does not make capitalists, Trust directors, or any positions of that kind. But if his occupation is as much a source of pleasure as a provider of drudgery or hard work, he will, in all probability, find the life has other advantages than can be seen on the surface, or which are apparent to the outsider. The phases of the various seasons, the natural phenomena which are constantly cropping up before his eyes, and the observations on trees, plants, birds, insects, and all forms of life generally, will convert him into a naturalist, and which will compensate him for the loss of many advantages he might derive from following other walks in life. If, then, he feels that the work satisfies all those ambitions he is likely to acquire in the course of life, he may take it for granted that English forestry is the right occupation for him.

Now comes a period during which he ought to acquire touch with those sciences which have already been referred to. To do this, he cannot do better than attend one of those centres, in various parts of England, at which these sciences are taught with more or less thoroughness. The choice of such a centre should be guided by the facilities it also affords for attending a course of lectures on advanced forestry. At the present time there are at least two or three such centres in England or Scotland, and a six or twelve months' course at one of these will prove of inestimable advantage to him in after-life.

The opportunities which such a course presents of visiting other parts of the country in which woods are numerous or well managed should not be missed, and it may be of advantage if this can be associated with employment in a public nursery, where planting contracts are being undertaken, which afford facilities for travelling about. By working in a nursery he can get an insight into the practical side of raising and propagating trees and shrubs from seeds or cuttings. Such nurseries are also good training-grounds in the direction of forest botany, the extensive collection of trees and shrubs grown within their boundaries, and the necessity of naming or recognising the various species in the course of their working, enabling one to recognise them at a glance—in their young stage, at any rate.

By the time he is twenty-one or twenty-two he should be capable of taking a foreman's situation on a small estate, or working as an assistant forester on a larger one. The more shifting about and travelling he gets at this period of his life, within reasonable limits, the more likely is he to acquire a general experience which would be difficult to obtain in after-life. Generally speaking, two or three years longer in work of this kind should qualify him for taking a situation as head forester on a moderately sized estate. This may be considered a critical stage in his career, for it is undoubtedly a fact that the class of situation he is able to obtain at the outset will have an important effect on his after-life. If he is fortunate enough to get on an estate where advanced forestry is fostered and encouraged, as far as is possible, all well and good. On such an estate his earlier ideas will develop, his qualifications will be increased by the exercise of his mental capabilities, and his enthusiasm, if not actually encouraged, will at anyrate not receive a check, which is often fatal to good work.

If, on the contrary, he is unfortunate enough to get on an estate the woods of which are simply regarded as game-covers, where the gamekeeper is an autocrat, against whom he dare not lift a finger nor raise a complaint, and where his sole duties consist in the routine work of marking a few trees, keeping clean the roads or rides, and the raising and encouraging of various kinds of rubbish for the sake of game-

cover, he is as likely as not to acquire a distaste for his work at the outset, which does a great deal to lessen his value as a good servant or an intelligent forester.

Unfortunately for English foresters as a class, it is impossible to know beforehand the advantages or disadvantages of an ordinary estate in these respects. In our opinion, it is only fair to a forester who has gone to the trouble and expense of qualifying himself for the best situation that he can obtain, to tell him at the outset, and before he accepts any appointment of this kind, exactly what his duties are, and the relative position he will hold in connection with the woods. To call a man a forester upon an estate where he is little more than a medium between the estate agent and the ordinary workman, is a species of terminology which is at once misleading and dishonest. No doubt, it is to the advantage of the estate to get a good manager of men, and one whose training and education prevent him from practising that petty dishonesty and carelessness which is largely the result of ignorance and a lack of intelligence. But to the man himself it is certainly better that he should wait a bit longer, and continue in a subordinate position on a properly managed estate for a few more years, than to take a situation of the kind last described.

The training of working foresters or foreman woodmen has not, up to the present, received much attention. It is generally considered sufficient if a man has an ordinary experience of manual labour and the ordinary routine of woodland work. Yet it is practically certain that many intelligent workmen might be rendered doubly valuable to their employers if they were to acquire, or had the means of acquiring, a little knowledge of the elements of their calling. A working woodman does not require any great knowledge of science or art, but he certainly ought to know something about the functions of roots, leaves, stem, or branches, the life-histories of commoner insects and fungi, and the general principles of silviculture, pruning, etc., which have a constant bearing upon his daily work. How such knowledge can be brought home to him without incurring that grave danger which is constantly in the mind of some of

our educational authorities, namely, the raising of a man above his work, is a problem which has not yet been satisfactorily solved, or given much attention to. Yet, to anyone who has taken the trouble to enter into conversation with many of our older woodmen, it is apparent that they possess a more intimate acquaintance with the principles of forestry than is generally attributed to them. Unfortunately this acquaintance is mixed up more or less with popular errors in connection with trees and natural history generally, and therefore the exact causes of many effects which they can see and appreciate are not recognised by them. A little training, such as could be afforded by practical demonstrations in woods and nurseries, might do away with a great deal of ignorance and carelessness on their part, and make our working foresters and younger woodmen more valuable servants to their employers, and more efficient custodians of the woods entrusted to them, than is generally the case now.

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