PRACTICAL
FORESTRY

WEBSTER

WEBSTER'S
PRACTICAL FORESTRY.

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TO
LORD AVEBURY,
WHO HAS DONE SO MUCH
TO FURTHER THE INTERESTS OF BRITISH FORESTRY,
THIS VOLUME
IS RESPECTFULLY DEDICATED.

WEBSTER'S PRACTICAL FORESTRY:

A POPULAR HANDBOOK ON THE
REARING AND GROWTH OF TREES
FOR PROFIT OR ORNAMENT.

By A. D. WEBSTER,

*Author of "Hardy Ornamental Flowering Trees and Shrubs," (2 Editions);
"Foresters' Diary" (3 Editions); "Hardy Conifers"; "British
Orchids" (2 Editions); "Flora of Kent"; "Forest
Flora of Carnarvonshire"; "Greenwich Park,"
etc., etc.*

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PREFACE TO FOURTH EDITION.

To the author at least, it is gratifying to know that in ten years three editions of *Practical Forestry* have been sold out, and that a fourth is urgently called for.

Several important chapters are now added, particularly with reference to Afforesting Waste Lands, and The Education of Foresters, on both of which questions the author had the honour of giving evidence before the Departmental Committee on Forestry of the Board of Agriculture.

Regent's Park, 1905.

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INTRODUCTION.

In my long experience of British Forestry, which in a practical way has extended over a period of thirty years, I have become more and more convinced that in order to place it on a systematic and sound economic footing, State aid and the afforesting of large areas of comparatively waste lands are first necessities.

For the past five and twenty years I have not failed to urge on the State, as well as private owners of suitable land, the pressing question of afforestation; and though in this matter a start has been made, yet this can only be looked upon as a faint, half-hearted attempt that is quite unworthy of our country and the vast interests at stake. As early as 1883 I drew attention to this matter in "Woods and Forests," and at later periods in most of the leading journals and papers of the day; while in my evidence given before the Select Committee on Forestry, and in a paper contributed by special request to the Board of Agriculture, I went fully into the question of afforesting, and pointed out what a boon to the unemployed, and what a saving to the country would be effected by a well organised scheme of tree planting. Eight years ago I urged the Government to take up the question of the larch disease,

the ravages of which I then described as little short of a national calamity. To the Highland and Agricultural Society of Scotland and the Royal Scottish Arboricultural Society I have contributed twenty-three papers on different topics connected with forestry, for which special medals have been awarded, while my "Practical Forestry" has now passed into a fourth edition.

In connection with the afforesting of waste lands I have travelled over the greater part of the Kingdom and examined much of the ground that could be set aside for this purpose, including the peat bogs of Ireland; while at altitudes up to 1,100 feet I have formed plantations on the bare and wind-swept hill-sides of Wales and Scotland, which to-day are not only a boon to the farmers in the way of shelter, but a considerable source of profit to the owners as well.

The above, combined with examinations of and reports on several of the largest woodland properties in this country, which I made at the request of the owners, have given me a wide insight into the forestry problem generally, but particularly with reference to our requirements in the near future, as by far the largest timber importing country in the world.

A. D. W.

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WEBSTER'S PRACTICAL FORESTRY.

CHAPTER I.

AFFORESTING WASTE LANDS.

For the past five and twenty years I have not failed to urge on the State and private owners of woodlands the pressing necessity for planting up some at least of the waste and unprofitable lands of our country, in order to provide a sufficiency of timber for the future and leave us less dependent on the supplies that are annually sent us from abroad. When we consider that the total area of woodlands in this country is only a little over 3,029,000 acres, that fully 15,111,000 acres of waste lands exist, and that we annually import over 10,000,000 tons of timber, at a cost of about £25,000,000, the necessity for an increased area of woodlands, so that a portion at least of this vast sum may be kept at home, will be apparent to all, and the more so as a dearth of timber is imminent, and outside supplies are being rigidly conserved while our home demands are ever on the increase. England being a residential country, the retention of a certain amount of heath, mountain and common lands, for the purpose of deer forests, grouse moors, game coverts, and golfing links, is imperative, and will considerably reduce the acreage of land available for afforesting purposes. But I think that I am well within bounds in allotting out of the 15,000,000 acres of waste land 1,000,000 to afforesting and 14,000,000 to game preserves, deer forests and rough pasture.

Having personally explored much of the mountain and heath lands in England and Scotland, and some of the vast tracts of bog land in Ireland (the latter extending to fully $1\frac{1}{2}$ million acres), I have carefully computed that of land up to 1,200 feet altitude, where timber would grow perfectly well, about 9,000,000 acres are available for afforesting purposes. As far as I have been able to find out, the average rental of the ground referred to is a fraction under 3s. per acre, and I am quite confident that any land which does not bring in at least three times that amount for grazing or agricultural purposes would be more profitably employed in carrying a crop of timber.

It is unfortunate that much of these waste lands are private property, the owners of which, even could they afford it, have little inclination to sink, for a period of say twenty years, the necessary capital required to be expended on the formation of woods and plantations. Equally unfortunate is it that owing to an injudicious system of management many plantations in this country have been wrongly formed—in so far as adaptation of soil and trees are concerned, the results being that financially speaking the woods are a failure, and proprietors in consequence fight shy of further planting operations. I have examined and reported on several of such woods in various parts of the country, one of the most noticeable being in Nottinghamshire, where a large area of ground was planted with a crop of oak, for which tree the soil was quite unsuitable, the result being that over the whole ground the average production of timber per tree was under 10 cubic feet in 60 years. When pressing home the question of woodland extension I have frequently been confronted by the argument that past experiences do not warrant further expenditure in that way. That this is true cannot be denied, but let us hope that such will be remedied by the better education of our foresters in the near future, and more attention to the relation of trees and soil.

With the severe agricultural depression through which this country is passing, and the disinclination of owners

of land to engage in extensive planting operations, the question naturally arises: What is the most feasible way to overcome the difficulty?

In answer, and without the slightest hesitation, I would say that the State should acquire and plant suitable waste lands at the rate of 40,000 acres annually for a period of twenty-five years. Such lands could, in England, Scotland and Wales, be gradually and cheaply acquired by the State with a change of proprietors; while in Ireland vast tracts of peat bog would willingly be handed over to the Government at the present time at a small cost per acre. Taking the British Isles as a whole, the cost of procuring suitable lands would be at an annual rental of about 3s. per acre, or 40s. per acre for purchase. On the Gwydyr Estate, Carnarvonshire, 7,412 acres of land, described as rough grazing and sheep walk, were lately sold by public auction for £15,670, or at the rate of £2 2s. 3d. per acre. I have little faith either in the State advancing money to landed proprietors towards afforesting, or in Municipalities coming to the front as planters of woodlands. The State only can readily acquire the needed land in sufficient quantity and on the best terms, and I am fully convinced that plantations formed under this supervision will, in an economic sense at least, be far ahead of those planted either by private persons or public bodies. Again, the resources and continuity of a nation will always make the State the best and most desirable custodian of forest property; indeed, regularity of action and large wooded areas are first necessities to successful timber culture.

The difficulty of housing and providing for the workmen employed at afforesting out-of-the-way lands has been brought to my notice, but from personal experience of similar work in Scotland and Wales I anticipate little difficulties in that way. In these cases, where a good deal of the work was carried out by contract, the workmen gladly walked to and from the adjoining villages each day, often to a distance of three or four miles, bringing their mid-day meal with them, which was heated or cooked on the ground. Then, as the plantations increase in age and size, and saw mills are required, the

ever-increasing industry so created will cause hamlets to spring up in the wooded regions, just as we find is the case in mining and quarrying districts.

After careful computation I have no hesitation in saying that the area of plantations in the United Kingdom could at once be doubled by the planting of waste lands which at present do not bring in over 2s. per acre per year of rental, with infinite benefit to the country generally and a vast increase in the value of land both to the owner and farmer who cultivates it. In the matter of afforesting a grain of practice is worth a ton of theory, and as I have personally supervised every operation, from marking out the plantation boundary on the exposed hillside, to draining, fencing, planting, thinning, and disposing of the produce, my opinions on the question are at least worthy of consideration.

Cost of Forming Plantations.—Taking the British Isles as a whole the cost of forming plantations cannot be put down at a lower figure than £5 per acre. Of course much will depend on the site of plantation, quality of soil, and cost of labour in the particular district where planting is to be engaged in, but generally in dealing with waste and mountain ground the conditions are much alike. The cost of fencing and draining will frequently make a difference of fully £2 per acre; while where neither have to be engaged in owing to the natural lie of the ground I have known planting to be carried out at a less cost than £3 per acre. The following prices which have actually been paid for forming plantations will be interesting as coming from various parts of the country:—

ENGLAND :

Yorkshire (North Riding) ; 70 acres, 600 feet

altitude.	Cost of planting per acre ...	...	...	£3	1	0
	Cost of Fencing	„	...	1	17	9

TOTAL ... £4 18 9

SCOTLAND :

Ross-shire ; 3,950 acres, 100 to 1,200 feet

altitude ; heathy soil. Planting per acre £2 10 0

Inverness-shire ; 1,295 acres, 800 feet altitude.

Cost per acre (including £1 per acre for enclosure) £3 10 0

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WALES :

Carnarvonshire ; 270 acres, up to 1,000 feet
altitude. Cost per acre, including fencing £5 2 0

IRELAND :

Co. Wicklow ; 700 acres, 700 to 900 feet
altitude. Cost per acre, including fencing £4 13 11

The Ross-shire plantation referred to formed a bleak and barren moorland, which the crofters, who used it as a common for their cattle and sheep, absolutely refused to rent at 1s. per acre per annum.

These plantations having been formed on the particular class of soil under consideration, the expenses for all practical purposes may be considered as identical, and, as before stated, a fair amount to put opposite each acre of ground for fencing and planting will be £5. This, with £2 for cost of purchase, and 5s. for incidentals (actually expended in some of the plantations above referred to) would bring the initial total expenditure to £7 5s. per acre. We have already suggested that altogether 1,000,000 acres should be planted over a period of twenty-five years, at the rate of 40,000 acres per year, which would be an outlay of £290,000—a small sum, it will be admitted, when compared with the £25,000,000 annually expended by this country on supplies brought from abroad.

Financial Returns.—The extensive hill-side plantations formed by the late Lord Powerscourt in Ireland, by the Duke of Athol between Dunkeld and Blair Athol, on Glengoy, in Inverness-shire, at Strathkyle in Ross-shire, in Aberdeenshire, and throughout the principality of Wales—all of which were formed over thirty years ago, and the cost of planting and after-management carefully recorded—are surely sufficient evidence not only of the feasibility of afforesting mountain lands but of the profits which have attended the undertaking, and the vast benefit that has been secured in the way of shelter to the dreary, treeless wastes and the bleak-exposed uplands where the planting was carried out. As far as actual profit is concerned, it will be prudent to assume that for the first twenty years no return whatever will be derived from

hill-side plantations, the thinnings up to that time doing little more than covering the expense of cutting and interest on first cost. From twenty-five to forty years an annual return of fully 12s. per acre has been forthcoming, while the value of the standing crop at that age was found to be about £60 per acre.

I do not think that these figures would be, generally speaking, too high, as on the estate of Balfour, in Scotland, the larch, at forty-three years' growth, on a hill-side, were valued at 20s. each, while a similar valuation was made of the individual trees, principally larch, on the slopes of the Snowdon range of hills in North Wales at the age of forty years. From this it will be seen that land under plantations yields not less than £1 of rent from the time of planting onwards, for, say sixty years, at which date the crop will be ripe for felling, especially larch, which is the tree above all others for afforesting the waste and mountain lands of Scotland and Ireland at least.

In the case of the plantations above referred to the lands were rented at an average figure of 2s. 8d. per acre, and when this is compared with the 20s. per acre now returned under a crop of timber, besides the interest on the money originally expended, the value of the lands will be found to have increased almost seven-fold.

Advantages of Tree Planting.—Not only for their value as timber producers, but for shelter for farm stock, improving the adjoining lower-lying lands, and clothing and ornamenting our bare hill sides, plantations are of vast importance, indeed, their value in that way can hardly be over-estimated. On a spur of the Snowdon range of hills, where fierce blasts were of almost constant occurrence, I formed a belt of plantation at an altitude of 400 to 600 feet, and the amount of shelter and warmth it affords to the farm stock and lower-lying lands would hardly be credited. Previous to forming this particular plantation, the adjoining lands were incapable of cultivation, but now crops are gradually creeping up the hill-side, and the farm stock find the much-needed shelter and warmth; in fact, as the farmer of the land told

me, the plantation, as a shelter to both man and beast was simply a God-send. The ground in this case is of the usual kind found on our mountain sides, with patches of broom and furze and rough-growing grasses, and would apply generally to that under consideration. But in many parts of Scotland, particularly Perth, Inverness and Aberdeenshire, equally good results have been obtained by judicious tree planting. Regarding peat bog I might mention that in 1862 my father formed several plantations on such in the County Armagh, Ireland. (A full description of which will be found in "The Transactions of the Highland and Agricultural Society of Scotland," for 1873, and need not be repeated here.)

On examining these plantations in 1900, I was agreeably surprised at the height to which the trees had attained, the amount of timber they contained, and price at that time realised. In passing, it might be noticed that the ground previous to planting was of little value, except for snipe-shooting and the production of turf for fuel. The trees used were the larch, Scotch, spruce and Douglas firs, with a few hard-wooded species. On the same estate, on a tract of peat bog, from which fuel had also been cut, the larch, with clean shafts 80 to 90 feet in height, and containing about 60 feet of timber, were used as piles for the iron bridge which spans the Blackwater about three miles from Lough Neagh. But on many other estates, such as the Earl of Ranfurly's and the Earl of Charlemont's, good results may be seen of the planting of larch on peat bog. Now, it is well known that in an economic sense the larch is by far the most valuable coniferous tree grown in this country, though, unfortunately, throughout England and Scotland it suffers severely from the *Peziza*—a cankerous growth that spreads with terrible rapidity, and renders the timber of trees so affected practically useless for the more important purposes to which it is to be applied. But not so in Ireland, for after a careful examination of many plantations and perusal of reports sent me from timber merchants throughout the country, it is quite evident that on peaty soil the larch is almost free from the dread scourge referred to. Here, then, we have one of

our most valuable timber-producing trees, for which both demand and price is everything that could be desired, thriving on peat bog of which over a million acres are lying waste in Ireland. As pointed out in my report to the Board of Agriculture, what an industry would be opened up, in Ireland especially, by the afforesting of waste lands! And what a boon to the poor and unemployed! First there would be the fencing, clearing and planting the land, the tending of which would give employment, though in a limited sense, until the plantations had attained the age of twelve to twenty years, after which the erection of saw-mills and converting the timber would give remunerative work to hundreds of the unemployed.

In many of the outlying parts of Scotland and Ireland, which are far removed from road and rail, it is difficult to get rid of the small amount of timber periodically thinned out from the woodlands, but were a continuity of supply forthcoming I feel certain that merchants would be prompted to make special transit arrangements. On several occasions I have been asked by Irish landowners to recommend buyers of good larch and oak timber, but after negotiating I have invariably been told by the timber merchant that the quantity offered was too small to allow of special facilities for delivery being entered into. They stated, however, that if a specified number of cubic feet could be guaranteed annually for a few years that they were quite prepared to buy specially good oak and larch, which were always in demand in England. These, then, are cases in which a continuity of supply, as would be possible if my scheme of afforesting was carried out, would insure speedy sales, at moderate prices, in places where at present it is difficult to dispose of the small quantities unless under unreasonable conditions.

CHAPTER II.

THE EDUCATION OF FORESTERS.

When giving evidence before the Select Committee on Forestry last year, I was asked by the Board of Agriculture to submit a scheme which I had prepared some time before on the Education of our Foresters.

Briefly this scheme was that the State should acquire certain areas of waste land in England, Scotland, Wales and Ireland, and in connection with the planting and after-management of these, the establishment of four schools of Forestry and the education of young foresters could go hand in hand. Each school should be under the charge of a competent British forester, whose duty it would be to superintend generally the laying out, fencing and planting of the ground intended for afforesting, and at the same time to impart to the assistant foresters, at classes held in the evening or at other convenient times, such knowledge regarding the various subjects connected with his work as could not be well taught in the open. Preparatory to entering the State forests each assistant should have served at least three years on an estate where the formation and management of woodlands was intelligently carried out, it of course being assumed that he had previously received a fair education.

The assistants would act as foremen, and see that the work sketched out by the head forester was properly carried out, and give such assistance and advice as might be necessary in levelling, fencing, draining and planting.

Five students could be kept at each of the four Schools

in England, Scotland, Wales and Ireland; and as it is proposed to plant altogether 1,000,000 acres this would give 250,000 acres for each of the four countries, which, spread over a period of 25 years, works out at 10,000 acres to be dealt with annually at each of the stations. By employing five assistants each would be entrusted with the planting of 2,000 acres. I have purposely spread the planting over a period of twenty-five years in order to lessen the annual expenditure, and so as to insure that by the time the last portion was dealt with the first formed would be annually producing a fair and increasing quantity of timber. A substantial building should be erected at each station, for the accommodation of the head forester and ten assistants, and also for lecture and other rooms. The assistants should remain at the State School of Forestry for a period of three years, after which they may be allowed to fill vacancies as head foresters as these crop up. By this means, not only will the assistants receive a good education in forestry work generally, at a fair remuneration, but the State would be benefited by the employment of such men in the laying out, planting and after-management of the woods. During that period of the year when planting cannot be engaged in, the repairs of fences, drainage, removal of rough growing grasses from the young plants and many other operations will demand the attention of the assistants and a small squad of men. After a period of six to ten years, thinning will occupy a large share of time and attention. For purely technical purposes, however, the plantations will not arrive at full value till about the twelfth year, after which, when systematic thinnings are engaged in, the whole curriculum necessary for the forester will be readily obtainable, both planting and thinning being engaged in annually. Later on, the conversion of the timber by saw mills, in order to lessen carriage rates and meet the demands of the trade, will require serious consideration.

The practical part of the education should include draining, fencing, planting, pruning, thinning, timber-seasoning and preserving, timber measuring and valuation,

levelling and surveying, road-making, and the formation and management of tree nurseries. The home classes might include entomology—as far, at least, as injurious forest insects are concerned, bird and animal life in the woodlands, chemistry, geology, book-keeping, plan-drawing, and forest botany. Previous to entering the State forests it is expected, as before stated, that each pupil has received a fair education, which, with his three years' training on an estate where forestry is intelligently carried out, and three years under the Crown, should render him fully competent to undertake the duties of head forester when opportunity occurs.

During their stay in the State woods each pupil should receive a weekly wage of 25s., with use of rooms and free attendance at evening and other classes.

For purely technical purposes the plantations, as before stated, will not have arrived at their greatest value till after twenty years, but for the first ten years the pupils may receive much benefit from visits to the older Crown and other woods where the felling and converting of heavy timber is in operation.

By such a system of procedure our foresters will be enabled to gain a thorough practical knowledge of woodland work generally at no appreciable cost, the State at the same time receiving valuable aid from the students at a small outlay per annum. The employment in the past on not a few estates in this country of the carpenter, gardener or farm bailiff in the management of woodlands is to be deprecated, and has been attended financially with very unsatisfactory results. At the few existing centres of forestry teaching in this country the most serious drawback has been the want of woodlands, but with the State as owners, practical instruction would, to a great extent, replace the theoretical and book-work, and do away with the necessity of students, after having attended their course of lectures, applying to the officials of our public parks in order to learn the names of our forest trees and to what the various timbers are applied.

Regarding the most desirable places to establish the

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Schools of Forestry and commence planting operations, I would suggest those counties where not only the greatest areas of mountain and heath-land are to be found, but where other advantages are offered, especially in the way of timber removal and ready sales.

- ENGLAND - Yorkshire and Northumberland, with 1,019,924 acres of waste land.
- SCOTLAND - Inverness and Argyllshire, with 3,087,412 acres of waste land.
- WALES - - Merioneth and Breconshire, with 461,320 acres of waste land.
- IRELAND - Donegal and Kerry, with 657,337 acres of waste land (exclusive of 172,436 acres of bog-land.)

From these figures it will be seen that, were such necessary, we could get all the ground required for afforesting purposes in one county of England, one of Scotland, and three of Wales and Ireland. But, for various reasons, such a course would be undesirable, and the better plan would be to take portions from two English, two Scotch, three Welsh, and three Irish counties.

CHAPTER III.

THE HOME NURSERY—

ITS FORMATION AND MANAGEMENT.

IN the course of my experience on large estates few things have been more particularly impressed upon me than the importance of having a well-managed and well-stocked home nursery, where the propagating and raising of trees and shrubs required for forest and ornamental planting may be taken in hand. The numerous advantages of a home nursery, especially where planting is extensively engaged in, are now so well known and appreciated by every proprietor of large estates that comment on this subject seems almost unnecessary.

Where ornamental planting, the formation of woods and plantations, game coverts, or hedging is performed on an extensive scale, the convenience of a home nursery cannot be over-valued, the plants being at hand when wanted, of the size and in the quantity required, and known to be well rooted, sturdy, and free from disease.

The advantages in these cases are too well known to require comment, and plants, more especially those of a large size, sent from even a short distance by either road or rail, cannot be expected to succeed equally with those raised and planted on the same day. The extra soil, or ball,

with which large plants can be removed for a short distance is also much in their favour, but it is next to impossible to retain this where packing and transit have to be resorted to.

It is well known that too sudden a change from rich, well-sheltered nursery borders to bare, exposed hill-sides often proves fatal to young plants; and, when we consider that few public nurseries are at a greater elevation than about 300 feet, the necessity of proprietors rearing their own stock, whose plantations are, perhaps, upwards of 1,000 feet above sea-level, will the more readily be seen. There are certain difficulties to contend with in planting high-lying ground, more especially if the soil is poor and thin, and the situation exposed, and in these cases the advantages of using hardy plants that have frequently been transplanted in a well-chosen home nursery at a fair altitude are only too perceptible, especially when contrasted with others that have been grown under more favourable circumstances and in a sheltered position. Some plants seem better adapted than others for this removal, but in the majority of cases the shock sustained by transferring from low-lying ground to that at a great elevation is only too apparent, and from which the plants seldom recover.

Of late years in particular, a good deal of comment has taken place as to the necessity of rearing trees from seed sown on the site of the future plantation, and although the suggestion has many points in its favour, still artificial planting is better adapted to the wants of our country, and is not at all likely to be superseded by artificial reproduction, which is more fitted for countries differently situated from our own.

The nursery treatment of plants is, therefore, sure to remain a prominent feature of British forestry, and this being the case, the soil and situation, as well as the most successful treatment of these, with a view to producing plants suitable for the positions they are intended to occupy, will require due consideration. This will vary much according to the situation of the estate and ground to be planted. In choosing the site of a home nursery, a great deal will depend on the general elevation and exposure of

the estate. The situation should neither be too much exposed nor yet too sheltered, and should have a southern or western aspect; for, although too sudden a change from sheltered to exposed ground often proves fatal to young trees, this should not altogether form a criterion for rearing them in situations unfavourable to the development of strong, healthy plants. The soil should be good, friable loam, on an open, porous subsoil; but the quality of ground required for different seedlings is so diversified that it is next to impossible to suit all within the small bounds required for a home nursery.

As water is indispensable where seedlings are raised, as well as for numerous other purposes in the nursery, it is well to have provision made for a continuous supply, either by a stream running through the ground, or in close contiguity to it, or by having a pipe laid on from the main water-supply.

From six acres to ten acres will be found sufficient nursery ground for most estates, but it is always advisable to add a little more than is really required, so that the breaks may not be all under forest trees at the same time, but undergo, when found necessary, a course of green crops, which will not only enrich, but clean, the ground, and leave it in good condition for replanting with seedling forest plants, bearing in mind that farmyard manure should always be applied first to the green crop, and never directly to the plants themselves. When a plot has become impoverished by repeated croppings of forest trees, a heavy coating of well-decomposed farmyard manure should be applied, and the ground planted with potatoes, or sown down with turnips. This has an almost magical effect in improving, regenerating, and cleaning the ground, and leaving it in the best possible condition for receiving a crop of forest plants. Land intended for nursery ground should be thoroughly trenched to the full depth of the soil, taking care, at the same time, that the best soil is kept within a reasonable distance of the surface, and, where necessary, heavily manured or enriched by the addition of lime, vegetable soil, or loam as the case may be.

In laying out the ground into breaks it will be found convenient to have these either square or rectangular in shape

PRACTICAL FORESTRY.

and, if possible, parallel by each other. The breaks should be of different sizes, and divided from each other by walks or hedges, but the fewer of the latter the better. It is well for convenience sake to have a border, say 12 ft. wide, running around the nursery, which may be stocked with such

PLAN OF NURSERY.

Roadway, 9 ft. wide; Paths, 4 ft. wide; Border, 12 ft. wide.

trees and shrubs as are only limited in demand. A narrow border like this is of great value, too, for planting out seedling stock of the less common kinds, for the insertion of cuttings of the rarer shrubs, as well as for any odds and ends that may be collected.

The site chosen for the seed-beds should be naturally sheltered, or, failing this, such artificial shelter as is found necessary should be provided, as exposure of the young plants to cold, cutting winds causes them to become stunted and bark-bound. There should be a few cold frames for raising choice seeds and cuttings, but, as a rule, the less glass the better. In stocking the home nursery, it is always preferable to buy young plants of the kinds most needed, as also a few older specimens of such kinds as it may be deemed advisable to propagate from layers or by cuttings. Seedlings of many trees and shrubs can be procured from plantations on the estate, and when such are grown on, and carefully transplanted for two, three, or four years in the nursery borders, they soon form stout, bushy, and well-rooted specimens of the greatest value for forest planting. This is a good and inexpensive way of getting up a stock of many trees and shrubs, but particularly such as are reproduced plentifully in a wild state. In the management of a home nursery the amount of care and attention required is certainly great; but any trouble, as well as expense, connected with starting and keeping it in good condition afterwards will be amply repaid by the increased value and superiority of the stock obtained.

In the working of the home nursery no hard-and-fast lines can be laid down, the nature of the season having much to do with the time at which the various operations may be taken in hand. A wet spring retards seed-sowing, a damp summer the killing-out of weeds and cleaning of the ground, and early autumn frosts transplanting.

For the various seasons the nursery-work might, however, be sketched as follows:—

Spring.—By February, all trenching, digging, manuring, top-dressing, and such-like work should be completed. Larch and thorn should be planted at once, as they start early into growth, following up with the various kinds of hardwoods and pines. Layers should be planted out and trees for grafting and budding made ready. Collect larch and pine cones, and when quite dry store away in a cool, airy place, until wanted for sowing. During March and April general grafting may be taken in hand. Ornamental coniferæ may be

TOOLS REQUIRED IN NURSERY.

pruned and transplanted, and towards the middle of April plants from the seed-beds may safely be lined out in a sheltered part of the nursery. Tree seeds of all kinds should be collected as opportunity offers. In February sow yew, holly, and thorn; in March, birch, beech, and alder; in April, larch, silver fir, Scotch, Austrian, and Corsican pines; and seeds of the less hardy coniferæ may be sown in pans or boxes and placed in a cool frame. General nursery-work should be finished up by the end of April.

Summer.—The keeping down of weeds, watering and shading seed-beds, and turning over and mixing of compost-heaps will be the principal work for the months of May, June, and July. Hollies should be planted out in May, and seedlings of the same kind lined out in the nursery borders.

Elm seeds may be collected as they ripen, and some of these sown in well-pulverised beds in June.

Autumn.—Weeds will still require attention, particularly in seed-beds, and amongst young trees that have been recently planted out. General transplanting of shrubs, particularly evergreens, may now go on, and seedlings be lined out. Cuttings should be inserted in light sandy soil by the middle of August, or when the temperature of the earth and air is most nearly equal.

Trim nursery fences, cut grass, clean walks and roads, and attend generally to neatness and order. Look over the breaks of pines, and remove and burn such as are attacked by any of the various insect pests to which they are liable. The seeds of ash, hornbeam, yew, and thorn should be collected and placed in barrels with about an equal bulk of sand, to hasten the decomposition of the outer coating.

Winter.—The early winter months will be a busy time in the nursery, the lifting and dispatching of trees for forest-planting being one of the principal operations—at least, so long as the weather remains mild and open. As time permits, two and three year old plants should be lined out, well-rooted cuttings lifted and transplanted, and layers from old stools carefully cut away and placed in the borders for a year or two before being finally planted out. Turn manure-heaps, and add a small quantity of fresh lime to hasten

PRACTICAL FORESTRY.

general decomposition, to sweeten the soil, and deprive the seeds of weeds of their germinative properties.

Sloe, holly, and similar berries may be collected as they ripen, and stored in the usual way.

In November and December, horse chestnut, oak, and hazel may be sown in well-pulverised beds of good, rich soil. Ash and hornbeam are sometimes sown in January.

19,400

000

CHAPTER IV.

COLLECTING AND HARVESTING TREE SEEDS.

FAR too little attention is usually bestowed on the collecting and harvesting of the seeds of trees and shrubs, the result, in not a few cases, being weak and unhealthy plants and an uneven and irregular crop. The best seeds, it should be remembered, are those collected from healthy trees in the prime of life, and grown under conditions favourable to their perfect development. An unhealthy tree will often bear a heavy crop of seed, but, although the inducements to collect such are great, they should be discarded, those from the most robust specimens being chosen in preference.

Regarding the best way of collecting tree seeds little need be said, the exigency of the case pointing out the best method to be adopted. The seeds of not a few trees may be collected as they fall, and this is especially the case with those of the oak, beech, elm, etc., all of which may be swept into heaps and gathered in quantity from beneath desirable trees. In the case of the various Coniferæ this method of seed-collecting will not answer—indeed, in the majority of instances, these should be gathered, or rather picked, from the trees just before they become fully ripe, as in falling the seeds get loose from the cone-scales and are lost. When collecting the cones of coniferous trees, a long, light ladder should be brought into request, and the climber, ascending this, with a light, hooked staff with which to draw the branches towards him can readily procure an abundant supply. A bag or satchel should also be in the possession of the seed-collector, and into this may be put such kinds of

cones as fall readily apart, and from which the seeds easily escape and are lost. Sometimes, as in the case of rare seeds and when only a few cones are borne near the top of the tree, the seed-collector must have resource to climbing up by the stem and branches : but, in such cases, so as to avoid injury to the bark, he should be provided with a pair of elastic shoes or slippers. Great care is required in the collecting of such seeds as those of *Abies nobilis* and *A Nordmanniana*, the cones, when fully ripe, falling to pieces on the slightest touch. This, however, applies with equal force to almost every species of *Abies*, whereas, with the Pines and Spruces, the cones remain intact for an almost indefinite period of time, and that, too, although the seeds may have fallen out on becoming ripe.

The proper harvesting of tree seeds rarely, except in the case of experienced nurserymen, receives sufficient attention, although this operation should be as carefully attended to as in the case of the seeds of any form of crop. After being collected, the seeds of all trees, unless such as are mixed with sand for the purpose of rotting, should be thinly and evenly spread out in a sunny spot until thoroughly dry. They may then be deposited in a cool, airy place, and in thin layers, until wanted for sowing. An occasional turning is all-important and should never be neglected. The smaller and less common seeds may, for convenience sake, be hung up in calico bags, but they, too, should be occasionally examined to prevent dampness and heating.

The number of plants of various kinds that may be expected from a bushel of seed of average quality varies very much, and may be approximately given as follows :—Horse chestnut, 2,500 ; oak, 6,000 to 8,000 ; Spanish chestnut, about 3,500 ; walnuts, 5,000 ; Norway maple, 12,000 ; sycamore, about 12,000 ; ash, 14,000 ; beech, 10,000 ; elm, 1,000 ; birch, fully, 16,000 ; holly, 17,000 ; Scotch fir, 9,000 to 1 lb, of seed ; spruce fir, about 9,000 ; larch, 3,000, and the cluster pine, silver fir, and some others about from 500 upwards.

For convenience in regulating orders for nursery purposes the following table will show at a glance the approximate

COLLECTING AND HARVESTING TREE SEEDS.

and relative number of seeds of the various commonly cultivated forest trees contained in 1lb. weight :—

Abies nobilis	...	...	...	...	about	19,400	
Abies Nordmanniana	...	...	...	...	,,	10,000	
Ash	...	...	...	...	,,	6,800	
Beech	...	...	...	...	,,	2,700	
Douglas Fir	...	...	...	...	,,	95,200	+
Horse chestnut	...	...	...	...	,,	36	
Hornbeam	...	...	...	...	,,	9,968	
Larch	...	...	...	...	,,	65,000	
Lawson's Cypress	...	...	...	...	,,	131,400	
Lebanon Cedar	...	...	...	...	,,	10,800	
Norway Maple	...	...	...	...	,,	4,600	
Oak	...	...	...	...	,,	100	
Pinus austriaca	...	...	...	...	,,	35,000	
Pinus laricio	Cosican Fir	...	...	...	,,	43,000	
Pinus Pinaster	...	...	...	...	,,	12,000	
Pinus sylvestris	...	...	...	...	,,	75,000	
Spruce	...	...	...	...	,,	64,500	
Silver fir	...	...	...	...	,,	14,960	
Sycamore	...	...	...	...	,,	4,624	
Walnut	...	...	...	...	,,	36	

These figures must only be taken as approximate, the seed of various trees of the same species seeming to vary in number to the pound in a marked degree. The results of careful analyses of one or two kinds may be cited as examples. In one case the number of seeds in 1 lb. weight of Scotch fir was 69,600, while in another it had increased to 90,600; and in the larch the numbers were 63,900 and 68,000.

These differences are, however, readily explained by the individual seeds being weightier in one case than in the other, probably owing to the age and health of the tree from which they were collected, the situation and exposure to which it was subjected, etc. However, for all nursery purposes the above figures may be accepted as a fair standard.

The preparation and management of the different forest

seeds vary so much that a brief description of those kinds most commonly planted will be found of use.

Alder seed should be gathered from the trees, and sown in spring.

Ash seeds are ripe in October, when they should be collected and kept in moist sand during the winter, and sown in March.

Austrian, Corsican, and Weymouth Pine seeds are treated in every respect like those of Scotch fir, varying the kiln heat according to the looseness of the cone-bracts.

Beech seeds are collected in October and November, placed in sand, and sown in April. The young plants are readily affected by frost, and should, therefore, not be sown earlier than the time mentioned.

Birch seed must be collected from the trees just before it becomes fully ripe, else it is scattered broadcast and lost for cultivation. March is the time of sowing.

Cupressus Lawsoniana seed is usually ready for collecting in October, but should not be sown before the first week in April.

✓ **Douglas Fir** seed is, in most cases, readily removed from well-ripened cones by threshing or by pulling the cone to pieces, but, in some instances, particularly where the quantity is large, kiln-drying is resorted to. The seeds should be gently watered and sown at once.

Elm seeds are ripe in June, when they may either be sown at once, or dried and kept in stock for planting in March and April.

Hawthorn seed, or berries, may be sown when collected, or the outer coating rotted off by keeping them during the winter in moist sand.

Hazel nuts may be collected in autumn, and sown at once or kept till spring.

Holly berries require to be placed in sand for about eighteen months so as to rot off the fleshy outer coating, and may be sown in March. The mixture of sand and berries, which should be about in equal proportions, must be turned frequently. They are usually sown with the sand in which they have been lying.

Horse and Spanish Chestnut seeds may be taken together,

the collecting and sowing being nearly alike in both cases. They are ripe by the beginning of November, and may either be sown at once or kept till spring. One seed to four inches square will be close enough.

Larch cones, when ripe, are of a rather bright brown colour, and require to be collected from the trees. This should not, however, be done till spring. They part with the seeds far more readily than those of the Scotch fir, and consequently require less heat when in the kiln.

Maple seeds are ready for collecting about October, and should not be sown till the beginning of April.

Mountain Ash, indeed all the *Pyrus* family and others of a like kind, require the berries to be placed in sand, and when the outer fleshy coating has rotted away they may be sown either in autumn or spring.

Oak.—The acorns may be gathered or swept from the ground in November, and either sown at once or stored away in a cool, dry place till spring. One acorn to every four square inches will be ample in the seed bed.

Scotch Fir cones are better not collected till early in January, but the time may even be extended till March. When quite ripe they have changed from the bluish-green tint to a light grey colour. As the cones part tardily with the seeds artificial means have to be resorted to. This consists in placing the cones thinly over a kiln heated to about 112° Fahr. or so. They should be turned every third hour, and after about thirty hours the kiln should be cooled down and the cones extracted as quickly as possible. By beating with a flail the seeds are readily removed from the cones, but it is best to do this before the cones have cooled down or immediately they are removed from the kiln. The seeds are then swept together and collected, and stored away until wanted for sowing. When not required for sowing at once, the seeds should be thinly spread out on the floor and slightly moistened with water from a fine-rosed watering-can. They should then be turned about until perfectly dry before being stored away.

Silver Fir seed does not require much, if any, artificial heat to cause it to part from the cone. By placing the cones

in the sunshine, and beating and turning freely, the seeds come out without much trouble. In all cases, wherever possible, it is wise policy to dispense with artificial heat or kiln-drying, as, unless this is carried out most carefully, the vitality of the seeds is greatly impaired.

Sycamore seeds are ready for gathering in October, but should not be sown till the end of March or beginning of April.

✓ **Walnuts** are collected, when ripe, in autumn, and sown in late spring.

Yew seeds are usually washed of the pulpy matter before being sown.

In the case of large seeds, such as those of **Araucaria imbricata**, **Pinus Sabiniana**, and **P. macrocarpa**, the best way is to cut the cones to pieces and carefully remove the seeds; but this should be performed with great care, so that the hard seed-coating may not be injured.

With conifers in general I have invariably found it the best plan to allow the seed to remain in the cones until wanted for sowing. By keeping the cones in a cool, dry place, and occasionally turning over, there need be little fear but that the seeds will turn out well.

CHAPTER V.

PROPAGATING TREES AND SHRUBS.

(1) **From Seed.**—This natural process of reproduction is that most commonly adopted where large numbers of trees are required—indeed, certain species, particularly of the Coniferæ, cannot successfully be raised in any other way. The preparation of the seed-beds is a point that deserves far more attention than it usually receives, and that not only on economic grounds, but in view of the general appearance of the nursery borders as well. To tumble the seeds indiscriminately into the ground as if they had fallen in showers from the trees is highly objectionable; and just as censurable is the too oft-repeated practice of sowing these in rough, cloddy, and ill-prepared ground.

Systematic arrangement in the laying-out of the beds, as to the number and requirements of the future seedlings should also be attended to.

The ground intended for seed-beds should be trenched or deeply dug up; but this operation would, for the mellowing and cleaning of the soil, have been better performed the autumn before than at the time of sowing down.

In any case, just before sowing, the ground should be carefully turned over, all hard clods being broken down, and large stones raked off, the surface soil for the depth of 3 in. or 4 in. being made as fine as possible. Dry weather must be chosen for the formation of seed-beds, as also, indeed, for the sowing of the seeds. The beds are marked off and prepared as follows:—A light, strong line is stretched along the ground at, say, 3 ft. from the boundary fence or path, and,

after being fixed at each end, the first alley, or path, is marked out by treading the soil alongside of the line. The length of the bed thus marked off on one side is quite immaterial, but the width is of great importance, and should never exceed 4 ft. ; 3 ft. 6 in. is nearer the mark.

Adjoining this first line, a bed the above width is marked off with a peg or stake at each end, the line reset and a second alley marked off. The alley, or path, between each couple of beds need not exceed 15 in. in width, and this for the sake of convenience in sowing, weeding, watering, shading, and otherwise attending to the bed and its occupants. Outside this follows a second bed, and so on, until the desired number has been formed. Some persons raise the seed-beds a little above the level of the paths, but, except in very retentive or damp soils, this is not to be recommended. The beds should in no instance, however, be below the level of the paths. There are two methods employed in opening up and preparing the beds for the reception of the seeds either of which, if carefully gone about, is well suited for the exigencies of the case. My own way has always been to level and smooth the surface of the bed with a small-toothed rake, and after sowing the seeds to cover lightly with fine soil and ashes carefully sifted over the bed by means of a small-meshed riddle. This plan has many advantages, not the most unimportant being the covering of the seeds to an equal depth, and the employing of only the finest class of soil. The other method is by using what is termed a "cuffing-board"—that is, a board about 8 in. wide, placed on a handle, which is inserted on the centre, towards the back, the handle being fully 5 ft. long. A skilled person is required to use this tool, who stands first on one side of the bed, in the alley, and then in the other, pushing or drawing towards him from the surface of the bed a thin coating of soil along its full length and from about two-thirds of its surface.

As to the amount or depth of soil taken off, this is regulated by the particular kind of seed to be sown, as well as the nature of the soil.

The next matter, the depth at which the seed should be sown, is one of great importance. Usually seeds are sown

unnecessarily deep. In the majority of cases a safe guide is to place the seed, be it of whatever kind, about three diameters below the surface of the soil. The conditions most favourable to germination are moderate dampness abundance of air, and a temperature of about 45° , and, so as to insure these, the depth at which the seeds are placed will be seen to be of the greatest moment. Generally speaking, the less seeds are covered, consistently with their receiving a sufficient supply of moisture, the better, and but for their destruction by birds, many of the smaller seeds would vegetate just as well if cast upon the ground-surface, and pressed in, as by being covered with soil. The following interesting experiments with Scotch fir seeds were made by Professor Bauer, of Hohenheim :—

“ Those buried one-fifth of an inch came up first, but were subsequently less vigorous—they soon, however, acquired vigour ;

Those covered from one-third to one-half of an inch came up more slowly, but evenly and strong ;

Those buried from two-thirds of an inch to one inch came up in deficient numbers ; and

Those buried from one to two inches never showed any signs of germination.”

These statements are equally applicable to the sowing of seeds in general, but especially if their relative size and the hardness of their covering are taken into account.

Immediately after the bed is prepared the seed should be sown, the amount used varying according to quality, which latter may readily be tested by examining the embryos of a dozen seeds picked up at random from the heap. To ascertain whether seeds are good, the simplest way is to cut open with a sharp penknife, when the kernel ought to completely fill the entire coating or shell. Small seeds might be crushed by the nail, and if good, will leave traces of moisture or emit an odour of turpentine. Another method is to place, one after the other, say, a dozen seeds taken at haphazard from the heap, on a red-hot iron. If good they will turn about with a cracking report ; but if otherwise combustion is slow and smoke is given off.

Seed may, however, be considered good if the germinating test gives, say, 70 per cent.

The quantity of seed to be sown on a given area will depend mainly on the quality and particular species.

When sown broadcast, about a pound weight of larch, and full half-a-pound of Scotch, is allowed per 100 square feet of seed-bed.

Generally, however, drill sowing is resorted to, and in this case the following may be considered as about an average of the quantity used per 100 square feet :

Alder	...	...	...	...	...	$7\frac{3}{4}$	OZS.
Ash	...	...	...	...	...	5	„
Austrian Pine	...	...	...	...	...	$4\frac{1}{4}$	„
Birch...	...	...	...	...	...	$6\frac{1}{2}$	„
Elm	...	...	...	...	...	$3\frac{1}{2}$	„
Hornbeam	...	...	...	...	...	$2\frac{3}{4}$	„
Larch	...	...	...	...	...	$7\frac{1}{2}$	„
Maple	...	...	...	...	...	5	„
Scotch fir	...	...	...	...	...	$2\frac{3}{4}$	„
Silver „	...	...	...	...	...	13	„
Spruce „	...	...	...	...	...	$3\frac{1}{2}$	„

Sometimes a small quantity of guano or other manure is sprinkled over the seeds, after which they are gently pressed down with a light roller, and the soil, which was temporarily deposited along the margin of the bed, replaced by the "cuffing-board" or riddle. When seeds are sown early, and with care, on well-prepared ground, watering is seldom necessary ; but still, with small seeds and in very dry ground, an occasional sprinkling the last thing at night is highly beneficial. Great care is, however, necessary to insure the soil being thoroughly moistened. Protection from mice and birds must be afforded such as by coating the seeds with red lead ; and an occasional shading of the bed in very warm weather might be advocated. There are not a few kinds of seeds, such as those with a hard covering, that it is almost imperative to steep in water before sowing. Larch seed, in particular, can be soaked for a week without fear of harm, and many leguminous seeds for two or three days with,

great advantage. Some seeds do not come up until the second year, such as the ash, *Pyrus*, thorn, etc., and in these cases it is but a waste of ground to sow them as collected. They should be mixed with sand, as before directed, and stored away for a year before being sown.

It should also be remembered that, as a rule, the sooner seeds are sown after being collected the stronger will be the young plants.

Soon after germination, hand weeding must be commenced, and this may most successfully be performed after a shower of rain, as the young plants then suffer less from loosening of the soil, consequent on pulling out the weeds, than would be the case in dry and warm weather.

The above method of raising plants from seeds will fall in with most cases, but with those of choice or half-hardy trees the shelter afforded by a frame is usually provided. In this case the seeds are sown in pots or shallow boxes, according to quantity, and placed in an unheated frame.

The best time for seed-sowing is from the first to the fifteenth of April.

Transplanting the young seedlings may be taken in hand usually after the first year, but no hard-and-fast line can be laid down, so much depending on the season and rate of growth of the young plants; but the experienced eye can always tell when seedlings should be lined out. The best time for this operation is after the spring frosts are at an end, for, if planted out in the autumn, the frost is apt to lift the tiny seedlings wholesale from the ground.

After this they should be transplanted at least every second year until planted out permanently.

(2.) **By Cuttings.**—Propagating trees and shrubs from cutting is at once a simple and inexpensive way of getting up a stock of such kinds as may be increased in that way. The best months are August and September, at which time the temperature of the earth and air are about equal, and when roots are most readily emitted.

Choose a sheltered and partially shady border for the insertion of the cuttings, and be sure that the soil is not stiff and water-logged, but fine, rather inclined to sandy, and

moderately dry. It should be well forked over and cleaned of weeds, large stones being also removed.

The cuttings may be made of the present year's growth, with a small portion—"heel" it is generally termed—of the old wood, and cut clean across beneath where a bud or shoot has protruded, and, until a sufficient quantity has been made, they should be stuck loosely in a heap of sand or soil, and in the shade.

In planting the cuttings, stretch a garden line along the previously prepared ground, and, having removed a trench about 6 in. deep, by cutting in a perpendicular manner with a spade along the front of the line, proceed to place the cuttings not too closely together, and leaning somewhat backwards in the trench cut out. This being done, it is always well, so as to hasten the formation of roots, to sprinkle a small quantity of sand or grit along at the base of the cuttings, at the same time regulating these as to their distances apart and upward inclination, the remaining portion of the trench being filled up with the soil formerly removed. Firm tramping is one of the chief points to be observed, as cuttings will not take at all quickly in loose soil. The line should then be moved forwards about 12 in., and the same methods of procedure taken in hand until the whole of the cuttings are inserted. For such shrubs as the common and Portugal laurel, privet, box, euonymus, laurustinus, aucuba, etc., the above method will be found the quickest and best for raising young plants from cuttings. It should be stated that cuttings taken from the sunny side of a tree or shrub always root more freely, and turn out a greater number of plants, than such as have been cut from the shady side—indeed, this point should be carefully borne in mind and acted upon. Conifers, such as the various species of Cupressus, Juniperus, the Wellingtonia, etc., are also readily raised from cuttings inserted in the ground out of doors. It is, however, well to put such cuttings in boxes, so that they may have the advantage of being placed in an unheated frame, this greatly enhancing the speedy formation of roots. Two or three large frames are always useful in the nursery for the reception of choice cuttings, seeds, etc., and

if boxes, say, 24 in. by 14 in. by 5 in., are made just to suit the dimensions of the frames, a great number of young plants, cuttings, and seeds of the less common kinds will find a beneficial protection. The boxes should be made of stout wood, and have six holes bored in the bottom of each, so that excess water may readily pass away. Before planting these, fill each with a mixture of half sand, half soil, broken finely down, the cuttings being inserted in small holes made by a sharp-pointed stick. A thin coating of sand placed on the surface will greatly facilitate the process of rooting. Cuttings of coniferous trees should have 2 in. of ripened wood attached to them, and be inserted 4 in. deep in the ground; while, for most others, the cuttings may be 8 in. long, 3 in. being inserted in the soil.

(3.) **From Layers.**—For increasing game coverts, shrub-beries, or some of those trees and shrubs that cannot well and speedily be raised from cuttings or seed, layering will be found a convenient and cheap method. There are several other advantages too, as no protection of any kind is necessary, and the risk of loss is reduced to a minimum. It is, however, generally resorted to as a means of increasing such plants as cannot readily be raised from cuttings, and applies with greatest force to the rhododendrons and azaleas, the magnolias, coniferæ of various kinds, and several species of our hardy deciduous trees.

The operation of layering is very simple, and consists merely in bending down the outer branch of a tree or shrub and bringing it in contact with the soil, it being there held in position by means of a hooked peg. Before fastening the layer with the peg, it is well, however, to remove a portion of the bark from that part of the layer that is to be brought in contact with the ground, this arresting the flow of sap and hastening the formation of roots. The soil beneath the tree or shrub should be first loosened up, and, if found hard and stiff, a small quantity of sand and leaf soil might with advantage be added. The same principle is carried out in all kinds of layering, but the position of the plant will alter the method of bending over and bringing in contact with the soil. In the case of layering coniferæ it is not only necessary

to bend over and peg down the branch, but, so as to form a leader and assist in gaining an upright position, it should also be tied or staked in a vertical position. Generally speaking, trees and shrubs require two years before the branches that are layered are sufficiently well rooted to remove from the parent, but a few kinds require nearly double that time before they can be severed with safety. A good plan is, after the second or third year, to cut through, behind the point that is brought in contact with the ground, the layered branch, and to let it remain in position for another year. It may then, unless in a very few cases, be lifted and lined out with others in the nursery border, and this mainly to get it into a good habit of growth before being finally planted out.

Most varieties of trees and shrubs can readily be increased by layering the side branches in the way above described, and it is a good plan to cover over with a spadeful of earth that part of the branch brought in contact with the ground.

(4.) **By Grafting.**—This may best be described as a makeshift method of increasing trees and shrubs. It has only a few advantages, but many disadvantages, as is well known to everyone on a large estate who goes in for collections of the less common kinds of trees and shrubs.

If a plant cannot be increased conveniently by any of the above methods grafting may be resorted to, but the work should only be intrusted to those who have great practical knowledge of the art, and who have paid particular attention to the attending evils of injudicious grafting. Some of the errors in grafting may be cited as follows: Working on too tall stocks, whereby an unnatural appearance and continual source of danger in windy weather are brought about; grafting small scions on large stocks, and grafting evergreen on deciduous species—all of which have tended, in a marked degree, to lower the art in the opinion of horticulturists generally.

The grafting of conifers may be performed at one of two seasons: either early in spring or about the month of August. Two-year-old stocks are most to be preferred, so that the stock and scion may be of as near a size as possible.

Several methods of grafting are adopted, but that generally practised is what is known as "side grafting." This consists in making a clean cut in the stem, downwards, for about an inch in length. A transverse cut is made at the termination of this first cut, whereby a piece of the bark wood is removed from the side of the stock. The scion is next prepared by being cut off square at the end, and one side of the wood shaved off for about an equal length to the cut on the stock. Place the scion in the notch made on the stock, and be careful that the barks, on one side at least, come neatly together, for on this hangs the whole fate of successful grafting. The scion should, indeed, be made to fit as nearly as possible and replace the wedge cut from the stock. Tie firmly and carefully with bast matting, and cover over with prepared clay or grafting wax. Another method consists in making an incision obliquely in the stock, the scion being so prepared that one side of it forms a sharp edge, in order that it may be readily inserted therein, the bark of the scion and stock coming neatly together. Tie with matting as before directed, and cover over with clay or grafting wax. Inarching, or grafting by approach, consists in bringing the scion into union with the stock without detaching it from its own stem, and the separation is not made until the new connection has been formed.

(5.) **Budding.**—This is usually performed in July, and in the case of certain shrubs has been found useful. The bud should, in addition to its strip of bark, have a portion of the cambium attached, as unless this be present to unite with the cambium of the stock the operation will fail.

The bark of the stock is cut in a T shape, opened with the end of the budding knife, and the bud slipped neatly in. Bast matting will serve for tying, until a junction takes place, which is usually effected in five or six weeks.

HILLSIDE
WITH PLANTING ARTISTICALLY ARRANGED

SAME HILLSIDE
WITH STIFFLY ARRANGED PLANTATION.
(From "Woods and Forests.")

CHAPTER VI.

FORMATION OF PLANTATIONS.

(1.) **Laying out the Ground.**—For the benefit of the trees, for shelter purposes, and for the general appearance of the surrounding country, it would be well were more attention paid to the laying-out of the sites for new plantations. In many cases, however, there is no choice in the matter, the proprietor saying, Here is a field that is of no great value for agricultural purposes, plant it up. But in the case of hillside or moorland planting the matter is usually different, the choice of ground, size of plantation, and method of planting being left entirely in the hands of the forester. Many considerations will tend to determine the position of boundaries—bounds of property, proximity to roads, public paths, and the existence or future probabilities of modes of transit, all being more or less significant factors.

First, however, it is advisable to take into consideration, when planting hillside or moorland, the shelter to be afforded to cultivated land in the neighbourhood, but a combination of this with the aforementioned considerations will be all-important.

The form of the outline must also be laid out with due regard to the prevailing wind, and should always present a convex side towards it, as it is obvious that on striking such a curve the force of the wind would be divided and expend itself in two opposite directions, thereby losing much of its destructive power. Blending one curve with another should be strictly observed, and continuous straight lines should be avoided, not only for appearance sake, but as it is

well known that the most destructive force of the wind concentrates on such outlines.

(2.) **Woodland Roads.**—These are necessary for the removal of timber, access to the wood when thinning, etc., and for sporting purposes. They should either be pegged out or formed before planting operations have been commenced, and need neither be of an elaborate character nor attended with great expense. Usually they are made 20 ft. wide, and only require to have the surface equalised and any stagnant moisture removed by drainage.

It is a good plan, so as at all times to keep the drives in a passable, dry condition, to cut a ditch along each side of the ride, parallel by it, and, say, 18 in. wide by 15 in. deep. The soil so removed will come in for filling up inequalities on the road surface. Steep roads should be avoided by following, in quickly sloping woodlands, the curve of the ground.

For sowing down woodland drives, bridle-paths, etc., the following mixture of grass seeds is to be recommended:—

	lbs.
Timothy grass, hard fescue, tall fescue, and meadow foxtail, 2 lbs. of each	8
Smooth stalked meadow and rough cocksfoot, 4 lbs. each	8
Rough stalked meadow and sweet-scented vernal, 4 lbs. each	8
Wood meadow grass	8
Total	32

In sowing down gravelly or sandy rides, I have found the Lyme or sand grass—*Elymus arenarius*—and the Sea Matweed—*Psamma arenaria*—to answer well, the seeds of each being sown in equal proportions.

Before sowing down woodland rides the soil should be well consolidated, and all surface inequalities levelled.

(3.) **Fencing.**—Local circumstances will often determine the mode of fencing new plantations. Where stones are abundant these may be utilised in the formation of fences,

while in districts where slate abounds excellent fences of this kind may be erected at a cheap cost.

Turf walls and ditches are sometimes formed as plantation boundaries, but unless with a great amount of looking after they are rarely very successful.

Stone and turf walls are, however, now almost entirely superseded by iron fencing, it being not only readily conveyed to any desired point, but quickly erected and moderately cheap.

To recommend any particular system of wire fencing would be out of place, for amongst the numerous kinds now offered almost any desired pattern can be obtained.

In any case the fence need not exceed 3 ft. 6 in. in height, with seven-strand wires, two No. 6 and five No. 7; and, as this is placed in position at so much per mile by the makers, it is always well, so as to avoid bad erection and keep down expense, to have it so put up. Where an abundance of larch fencing-posts are to be found on the estate, it would, perhaps, be unwise to employ iron, but in the majority of cases it will be found cheapest in the end to have the fences erected wholly of iron and wire. Where home-made fences are in use, both the posts and strainers may be of wood grown on the estate.

The straining-posts should be of good, well-seasoned larch or oak, and 7 ft. long by 6 in. square, or if round 7 in. in diameter.

The intermediate posts are usually of larch, $5\frac{1}{2}$ ft. long by $3\frac{1}{2}$ in., by 3 in., or if round, not less than $3\frac{1}{2}$ in. diameter at small end.

Usually the straining-posts are placed in the ground at 150 yds. apart, with an additional strong post at every angle or curve that occurs in the line of fence. The intermediate posts are pointed and driven into the ground along the line of fence at 6 ft. apart.

So as to make a fence proof against the inroads of sheep and cattle not less than six wires should be erected, and galvanised strand wire is preferable. The total height of the fence need not exceed 3 ft. 6 in., and the top wires should be placed further apart than those lower down.

In tightening the wires a straining machine is usually

TOOLS USED IN DRAINING

employed, but brackets for the same purpose are preferable, these being attached to the straining posts.

They are of particular value as the wire can be tightened or slackened at will.

The posts should be rounded on the top or sawn with a slant, so as to run off the rain.

(4.) **Draining and Clearing the Ground.**—Efficient drainage must be considered as one of the most important operations in the formation of a plantation. Every portion of the ground may not, probably, require to be drained, but where it is at all surcharged with moisture the removal of such will be a step in the right direction if the future welfare of the trees is a point of first importance. In commencing draining the position of the main outlet must first be determined, and in doing so every fall of the ground should be taken advantage of. It is quite impossible to lay down rules as to the number, sizes, and distances apart of the various drains, these being points that can only be satisfactorily settled on the spot, and when the nature of the soil, lie of the ground, and amount of rainfall to be carried off are determined. In most cases, however, the main drains should be from 2 ft. 6 in. to fully 3 ft. wide at the top or surface, from 10 in. to 12 in. wide at the bottom, and about 3 ft. deep. The minor drains may be less in proportion to the mains, and are usually 2 ft. deep, $2\frac{1}{2}$ ft. wide at top, and the width of the draining spade at bottom.

According to the nature of the ground so will the distances at which the drains should be cut vary, but in most cases from 15 ft. to 30 ft., sometimes even less, and sometimes considerably more. The minor drains should never run at right angles to the main, but at about 45° , which will prevent the mouths becoming choked up when there is a rush of water in the main. The soil removed from the drains should be evenly spread out over the ground-surface. All rough herbage and shrubby growth is usually either cut away or burned on the plantation-site, but this operation, particularly on exposed ground, is not to be generally recommended, as the shelter afforded by it is frequently considerable. Hitherto the power of young forest trees to

succeed amid a surrounding growth has been greatly underrated.

(5.) **Pitting.**—The advantages of pitting over any other method of planting cannot be questioned, and this is particularly the case with ground that has hitherto been uncultivated. Compared with notch-planting, this system is, no doubt, more expensive, but that the future benefits to the plants are greatly enhanced is admitted by all practical arboriculturists.

It is not, however, to be inferred that, though pitting is preferable, notching is to be abandoned, for there are many precipitous, rocky places where it would be the only practice feasible, and plants so inserted have often succeeded admirably.

The pits should in all cases be opened for some time before planting—indeed, in unfavourable soils and situations, it is a good practice to have such work performed in autumn, and the plants inserted the following spring. By so doing, the earth that has been removed from the pits will lie fully exposed to the mellowing influences of frost and sunshine, so that when the time for replacing it comes round, it will be in the best possible condition for applying to the roots of the young trees.

The pits in uncultivated lands should be made circular, about 18 in. in diameter and fully 12 in. deep, and the sides and bottom well loosened up with a pick. In loose or recently cultivated soil the pits may be much smaller. Take off the surface turf in halves, placing these on one side of the pit, and the soil on the other, for ease and convenience in planting. When the ground slopes quickly the soil removed from the pits should, so as to facilitate quick replacing, be deposited on the higher side.

(6.) **Planting.**—This may be successfully carried out during all open weather from about the end of September to the beginning of April, but, generally speaking, autumn planting is to be advocated. There are several exceptions however: such as when we have to deal with peat bog, water-logged soil, exposed hillsides, or land by the sea-coast. Where the newly-inserted plants have to cope with

prolonged storms, such as we get on hillsides or by the sea, or against very uncongenial soils, it is always wise policy to defer planting until spring, or just when the trees are about to make a start to growth, as they, with their freshness and vigour undiminished by the change from the nursery border to the more trying surroundings just referred to, are more likely to take hold at once and succeed.

The battering and swaying that young trees receive when exposed to the hurricanes of our hillsides or maritime sites so enfeeble them that, in spring, when growth should commence, the majority will be found to be in a very unsatisfactory state, whereas, by inserting in spring, when growth will soon be at its full activity, the chances of succeeding are greatly enhanced. In peat bog the antiseptic properties of the soil act dangerously on the roots of young trees if allowed to remain therein for some time before active growth has commenced. However, with the exceptions cited, tree planting throughout the British Isles generally should be taken in hand as soon as the leaves of the hard-wood species have fallen, which usually takes place about the second or third week of October, much depending on the particular season. Lift the plants very carefully from the nursery breaks, and do not, on any account, tolerate the too-often-enacted practice of tearing the trees from the ground, and before they have been properly loosened on both sides of the lines with a fork. To lift nursery stock properly—and the extra expense incurred in so doing is money well spent—a trench should be thrown out along each side of the line and the soil undermined from beneath the roots, so that the plants can be lifted without tearing or straining the tender rootlets. It is not so important, if the plants are inserted soon after being lifted, that a ball of soil should accompany each, the roots being plentiful and unmutilated making up for the want of soil. Where, however, the plants have not to be conveyed far, such as from the home nursery to a plantation in course of formation on the estate, too much of the soil need not be removed, for if left intact the young tree is far more likely to start away freely than if this was shaken clean off.

TOOLS USED IN PLANTING.

Immediate planting after being lifted is to be strongly recommended, the evil of allowing plants to lie about exposed to wind and weather being well known. Should it, however, not be convenient to plant at once, the nursery-stock should be stood closely together, and some damp straw, leaves, or soil heaped around the roots of the outer or exposed specimens in the lot. In any case, the roots must never be allowed to become dry and parched, or be subjected to frosty winds, as these act most perniciously, and soon destroy the tender fibres and render them almost useless for the purpose intended.

In planting, spread the roots well out in the pits, avoiding all cramping and bundling, placing the largest to the most exposed side, and cover with earth, the finest soil being placed next the roots, and the rougher and grassy on the top. Placing the top turf in the bottom of the pit, cutting it well up with the spade, putting a little earth on the top of this, and then planting the tree, has its advantages, the rotting turf acting as manure by the time the roots have got down to it. Do not place the plant deeper than it stood when in the nursery border, this being an oft-committed evil that is to be zealously guarded against, for to it more deaths are to be attributed than is generally supposed. Tramp the soil around the stem of the plant firmly, and thus will be finished the operation of planting.

(7.) **Slit or Notch Planting.**—This is done by simply cutting the sod or surface by two strokes of the spade, and to the depth of about 5 in. : thus **L** or **T**. With the first stroke the spade is inserted in the ground in an almost perpendicular manner; it is then withdrawn and inserted at right angles to the first notch and at the end of it, and by pressing down the handle of the spade the turf is opened up, the plant being inserted from the blade of the spade towards the further end; the spade is then carefully withdrawn and the turf trampled so as to cause the notches to close completely. This latter should be strictly attended to, as should the notch be left partially open, the plant will suffer from the admission of an undue quantity of air. The operation requires two persons—a man to open the notch,

and boy to insert the plant. It is chiefly employed in bare and hilly ground, and large tracts of ground in Scotland have been very successfully operated upon in this way. With the notch system there are advantages and disadvantages. In the first instance, we have reduced cost expedition, and firm insertion; whilst in the second small plants only can be used, the soil remains unbroken, and the root system presents an unnatural position.

The plants used with the notch system should not exceed 9 in. in height.

The Planting-iron.—This tool has been found of great value for inserting small forest trees in rocky ground, where it would be almost impossible to do so in any other way. It is 17 in. long, weighs 3 lbs., and can be conveniently used with one hand.

Holding the “iron” slackly, the planter strikes it into the ground with a force sufficient to drive the sharp, heart-pointed blade in about 3 in. or 4 in. By pressing it down and towards the planter, with a slight twist to the right, the left corner of the turf is opened up, the plant being carefully inserted with all the roots beneath the ground. The iron is then withdrawn, and the loosened turf made firm by tramping.

Only a small plant should be inserted with the planting-iron, and great care taken to insure the soil and turf being firmly pressed around the stem of the young tree.

CHAPTER VII.

TREES BEST ADAPTED FOR VARIOUS SOILS.

THERE is, perhaps, no soil so bad and barren that it may not be rendered profitable by judicious planting ; but, as might be expected, there is often a great want of knowledge as to the proper kind of trees to be chosen to suit a particular soil. In looking over a large extent of woodland one will generally be struck with the great disproportion in size of the individual trees of a species ; but it will generally be noticed that where the largest and healthiest occur the tree is usually growing upon its own soil, and is found to be flourishing at the expense of all around it. Thus the finest oaks will be found where the soil is deep and loamy, resting on clay ; beech, and the Austrian Pine (*Pinus austriaca*) upon a calcareous gravel, resting on a bed of chalk ; ash and elm, on a dampish, loamy gravel ; birch, in a light, black loam, with a gravelly substratum ; Spanish chestnut, in a good loamy soil, not too damp ; the Scotch and Corsican pines (*P. sylvestris* and *P. laricio*) at fairly high altitudes, and in gravelly, well-drained soils ; and the Cluster and Aleppo pines (*P. Pinaster* and *P. halepensis*), in almost pure sand on the sea-coast. Some trees grow rapidly enough for a few years in almost any soil, but after a time they generally show signs of distress, make little or no progress, and ultimately become stunted and ill-grown ; or, should the soil be very unfavourable, they die outright. Instances of such are, unfortunately, far too common wherever one travels over the country, trees of a kind that are utterly unfitted for the particular class of soil being

planted in a kind of haphazard way, and without any consideration of their individual requirements. For all practical purposes, with reference to tree-culture, soils, generally speaking, may be divided into six distinct classes—peaty, chalky or limey, gravelly, clayey, loamy, and such as contain ironstone, coal, etc.

(1.) **Peat.**—Few trees will succeed well on an unreclaimed peat bog, but, where draining and soiling have been attended to at the outset, the number that grow and produce a fair amount of valuable timber is almost without limit among our generally cultivated trees. Among conifers that have proved themselves suitable for bog planting are the larch, Scotch pine, and common and black spruces (*Abies excelsa* and *A. nigra*). The larch grows rapidly, and is perfectly free from disease on peaty soil—indeed, I cannot remember having seen a trace of any of the diseases which have rendered the tree so precarious of late years in this country. In thinning a larch plantation of fully sixty years' growth, I found the trees felled to be perfectly healthy, and of exceptional quality, with, on an average, 72 ft. of wood in each. The subsoil in this case was clay, and the bog, previous to being planted, had been cut over for fuel. The Scotch pine grows almost as freely as the larch—the average in over fifty trees measured being about an eighth less—under similar conditions. Natural reproduction of the Scotch pine goes on so rapidly that it must be considered one of the very best trees for planting on peat bog. The spruces are excellent trees for planting on reclaimed peat bog, where they produce a fair amount of timber and afford excellent shelter to other trees. Of hardwoods, the beech is one of the best for bog planting, as it grows rapidly and produces a great amount of clean timber. The alder grows luxuriously on peaty soils, and shows no traces of disease nor canker. Another excellent bog tree is the Gean or wild cherry, and this may likewise be said of the holly. Ash and oak are not generally of large size, nor are they always healthy on peat bog, even when it has received a great amount of attention in the way of reclaiming. Birch, lime and poplar of various inds are all suited for planting on well-drained bog.

Among the newer conifers, a large number are well suited for planting in reclaimed peat bog. By way of experiment, I have planted specimens of various kinds in newly-formed plantations, and in nearly every case the trees have grown well, particularly when partially sheltered. *Cupressus macrocarpa* is one of the best, and not one whit behind it are *C. Lawsoniana* and *C. Goveniana*. *Wellingtonia gigantea* and *Sequoia sempervirens* have done well, while *Pinus laricio* and *P. austriaca* grow freely. I find that the majority of the recently-introduced conifers do well on prepared peat bog—that is, where a quantity of loam has been incorporated with the bog and all superfluous moisture drained away.

(2.) **Chalky Soils.**—The beech is peculiarly well suited for planting in chalk districts, for it will grow and produce a large quantity of excellent timber where but a few inches of loam overlie the chalk. It is a fact that, in Southern England particularly, in order to find where the chalk beds lie, one has only to be guided by the line traced out by the largest and most luxuriant beeches.

The beech will grow freely enough on almost pure chalk, but it certainly flourishes best where loam, say, from 1 ft. to 3 ft. in depth, overlies the chalk, or is incorporated with it.

The Norway maple (*Acer platanoides*) revels in a chalky soil, and so does *A. colchicum rubrum*, which are both handsome, hardy, large-growing trees, and well suited for extensive forest-planting under certain conditions of soil. White poplar (*Populus alba*) is an excellent tree for planting in chalky districts—indeed, it is surprising to see to what an immense size it attains on almost pure chalk.

Other poplars that do almost equally well on the chalk formation are *P. monilifera*, and *P. canadensis*, both excellent, free-growing trees. Elms, particularly the Huntingdon and the American, grow rapidly, and attain to a large size, where but a small quantity of loam is present in the chalk. The wych elm grows freely in chalky districts, and this may also be said of the common and silver-leaved lime. False acacia (*Robinia Pseud-acacia*) is an excellent tree for chalky soils, and there attains to

a greater size than almost on the richest of loams. The alder and birch also thrive with vigour on chalky soils. Indeed, most trees which in a state of nature grow in damp or marshy soils, are well suited for planting where chalk is the component of the main soil, and this is explained as follows:—Chalk, although sufficiently porous to allow water to percolate through it, has, like all other calcareous matter, a strong attraction for water, and acts like a sponge in holding it in considerable quantity for a very long time. Among the conifers that are suitable for chalky soils the Spanish fir (Abies Pinsapo) is one of the best. In the chalky districts of Southern England it thrives with unusual luxuriance. The Mount Enos fir (Abies cephalonica) is, likewise, well adapted for growing in chalky districts. Of evergreen trees that succeed well on chalk the number is well known to be limited, and it is important that two such beautiful conifers as the Spanish and Mount Enos firs should there find their most congenial home.

Both the Scotch and Weymouth pines (Pinus sylvestris and P. Strobus) are well suited for planting on chalk, and many fine examples of both may be seen on the chalky reefs of Kent and Surrey.

The common Yew grows freely where hardly a particle of soil overlies the chalk formation.

The Giant Arborvitæ (Thuia gigantea) is peculiarly well suited for planting in chalky soils: and the Lebanon Cedar (Cedrus Libani) is nowhere found in greater perfection than when growing in the chalk but with a fair depth of soil atop.

X Wellingtonia gigantea also does well. *Sequoia gigantea*

(3.) Gravelly and Sandy Soils.—The Corsican pine is an excellent tree for planting on gravelly soils, and some of the largest and finest specimens in this country are growing in a disused gravel-pit, and this may also be said of the Douglas fir (Pseudotsuga Douglasii).

The Scotch pine is well known to be one of the best conifers for planting in gravelly soils, where it reproduces itself in great numbers, when the conditions of growth are at all favourable.

Pinus Pinaster, the cluster pine, is, perhaps, one of the most valuable conifers for planting either in gravelly or sandy soils. The great value of the tree in reclaiming sandy tracts, both at home and abroad, has been so often described that further reference here is not required. The Aleppo pine is a good companion to the *Pinaster*, and grows with great freedom in a sandy or gravelly soil, within the influence of the sea. Gravelly soil also suits the Weymouth pine, in which it produces a fair quantity of very resinous timber. Both the beech and oak produce a large quantity of timber on poor gravelly and sandy soils.

(4.) **Clay Soils.**—The soil here referred to is genuine clay, devoid of stones, and without a particle of sand or loam in it.

It occurred on the slopes, and for some considerable distance along the sides of one of the park roads on an estate in England.

This is recorded simply to show what species of trees are best able to succeed when planted in pure clay. The pits, in this case, it may be well to mention, were dug and the soil thrown loosely up for a month previous to planting, but no soil was added to the stiff clay. Nearly one hundred kinds of trees and shrubs were used, but out of all these not more than eight are doing well, the others having gradually died out, or become so rusty and miserable looking that their removal was compulsory. First among the trees that have succeeded is the giant arborvitæ (*Thuia gigantea*), which seems to revel in what is generally considered the most unkindly of soils. *Cryptomeria japonica* has also done well, but the trees of this kind, though bushy and well furnished, have grown at a comparatively slow rate.

Cupressus macrocarpa also has done fairly well: the growth certainly has not been rapid, but for all that the general appearance of the trees is the reverse of what one might expect from the unfavourable nature of the soil. The Indian Cedar (*Cedrus Deodara*) we have found to be peculiarly well suited for planting in clayey soils, the bright silvery tint that is so characteristic of this cedar when well grown being discernible in the clay-grown specimens. *Pinus austriaca*

has, in a few instances, done well, the foliage being ample, and of the usual dark yew-green. Amongst shrubs the double-flowered gorse (*Ulex Europæus*, fl. pl.) has done best of any—indeed, it has grown and increased freely, and would seem to be quite as much at home as in its natural element—a dry, gravelly bank. These may be considered as the trees that have succeeded best in stiff, clayey soil. Few of the pine tribe did well, and this may also be said of the spruces, cypresses, yews, junipers, arbutus, dogwood, coto-neaster, hollies, and others planted.

It is, of course, far from advisable to plant trees or shrubs in such unkindly soil, without first adding other of better quality; but it is of great value to know that there are a few plants that will thrive almost in defiance of the stubborn and unkindly nature of a stiff clay soil.

(5.) **Ironstone Soils.**—The particular class of soil to which I refer, and which in several districts, occurs in plenty, is on the coal and ironstone formation, where the top soil is usually shallow, and the subsoil consists of a loose, yellowish rag that is largely impregnated with iron. In most places but a very small quantity of soil exists, and that is of the poorest description, and varying in depth according to the lie of the measure. The Spanish chestnut is one of the very best trees for this soil, growing with freedom, and producing a fair amount of good timber, while its appearance indicates perfect health.

Birch and beech do well, although neither of them attains to a large size. The latter reproduces itself freely from seeds, and soon spreads wherever a footing can be got. Sycamore grows freely, particularly where the pan is broken up, and produces a small quantity of good timber. Another tree that seems perfectly at home on the coal and ironstone is the wild cherry, for there it grows to a fair size, flowers freely, and produces excellent timber. Larch cannot be recommended for this soil, but in places where a small quantity of loam overlies the coal and ironstone it grows with great freedom for a number of years, and the timber, if cut early, is of good quality. The common spruce soon dies out, although it may, for a number of years after being

planted, grow freely enough and wear a healthy appearance. Oak and ash do fairly well, but they rarely attain to a large size or produce first-class timber. Rhododendrons almost revel in this soil, and some of the largest and healthiest are growing with their roots in close contact with the coal and ironstone.

Concluding Remarks.—In conclusion it may be pointed out that it is only by a careful selection of soil that we may expect tree planting to be successful, and I have no hesitation in saying that many failures can be clearly traced to errors in judgment in the selection of trees for planting on particular soils. The subject is a wide and complicated one, and it must be admitted that very perplexing diversities occur with the same kinds of trees on what, to all appearance is the same class of soil. There are, of course, other considerations beyond the soil itself which must be taken into account, such as aspect, elevation, and whether the ground is inland or on the coast.

With reference to some of the newer conifers it must be admitted that soil and situation have a wonderful influence on their successful culture, and this applies in particular to such kinds as are not perfectly hardy and liable to injury by unseasonable frost. The too common practice of selecting warm and sheltered spots for such is, in the main, to be condemned.

It may be said that *Abies cephalonica* and *A. Pinsapo* are not worth growing, and in many places they are not, but when planted on limestone or chalk they are highly ornamental.

The same holds good with *Tsuga Mertensiana*, *Picea sitchensis*, and *P. excelsa*, which are rarely seen in good form except on soil of a peaty description.

Everyone at all interested in trees and shrubs knows that there are certain kinds which in a state of Nature are only found growing in a peaty soil, mixed it may be more or less with sand, and any attempt to cultivate them in other soils is productive of very unsatisfactory results.

Who would ever think of planting the so-called American or peat plants, Cape Heaths, &c., amongst gravel or chalk,

PRACTICAL FORESTRY.

or Rhododendrons where lime is present in the soil ? and these facts show us that there is something in the composition of certain soils only suitable for the requirements of a certain class of plants.

Another curious fact is this, that when growing on certain soils the timber of one species of tree is found to be far more durable than in others.

Deep loamy soil and soft peat produce timber that is usually of a second-rate description, being deficient in firmness.

By studying the geological strata of a district much useful information may be learnt regarding the trees best suited for planting.

The following alphabetical table will serve to show at a glance the trees that have been found best suited for planting in the class of soil under which they are enumerated :—

RECLAIMED PEAT BOG.

Hardwoods.

Alnus glutinosa
 ————— *imperialis*
 ————— *laciniata*
Betula alba
Cerasus Padus
 ————— *vulgaris*
Fagus sylvatica
 ————— *purpurea*

Populus alba
 ————— *balsamifera*
 ————— *canadensis*
Quercus Robur, and vars.
Salix fragilis
Tilia europæa
Ulmus alata
 ————— *montana*

Conifers.

Abies concolor
 ————— *bracteata*
 ————— *nobilis*
 ————— *Nordmanniana*
Cedrus Deodara
Cryptomeria japonica
Cupressus Goveniana
 ————— *Lawsoniana*
 ————— *macrocarpa*
Juniperus chinensis
 ————— *recurva*
 ————— *Sabina*
Larix europæa

Larix Kæmpferi
Pinus austriaca
 ————— *excelsa*
 ————— *laricio*
 ————— *sylvestris*
Retinospora ericoides
 ————— *plumosa*
 ————— *aurea*
Taxus baccata
Thuia gigantea
 ————— *occidentalis*
Thuiopsis borealis
Wellingtonia gigantea

CHALKY OR CALCAREOUS.

Hardwoods.

Acer colchicum rubrum
 ————— *dasy carpum*
 ————— *Negundo*
 ————— *platanoides*
 ————— *Pseudo-platanus*

Æsculus Hippocastanum
 ————— *rubicunda*
Alnus glutinosa, and vars.
Amelanchier Botryapium
Amygdalus communis

TREES BEST ADAPTED FOR VARIOUS SOILS.

CHALKY OR CALCAREOUS—*cont.*

Betula alba
Castanea vesca
Catalpa bignonoides
Cerasus Padus
Cratægus (nearly all)
Cytisus Laburnum
Fagus sylvatica
 — *purpurea*
Fraxinus excelsior
 — *Ornus*
Gleditschia sinensis
 — *triacanthos*
Koelreuteria paniculata
Populus alba
 — *balsamifera*
 — *canadensis*
 — *candicans*
 — *monilifera*

Populus tremula
Pyrus Aria
Pyrus Aucuparia
 — *Malus floribunda*
 — *spectabilis*
Quercus Ilex
 — *Mirebecki*
 — *rubra*
 — *Turneri*
Robinia Pseud-acacia, and vars.
Salix alba
Tilia argentea
 — *europææ*
Ulmus alata
 — *glabra*
 — *montana*
Virgilia lutea

Conifers.

Abies Amabilis
 — *magnifica*
 — *nobilis* +
 — *Nordmanniana*
 — *Pinsapo*
 — *Webbiana*
Cedrus atlantica
 — *Deodara*
 — *Libana*
Cupressus Lawsoniana
 — *macrocarpa*
Juniperus chinensis
 — *communis*
 — *Sabina*
 — *tamariscifolia*
Larix europææ
 — *Kæmpferi*
 — *leptolepis* *Japanese*
Picea excelsa

Pinus austriaca *Austrian*
 — *Cembra*
 — *excelsa*
 — *laricio* (*Carican Pine*)
 — *Pinaster*
 — *Strobus*
 — *sylvestris* *Scotch Fir*
 — *tuberculata*
Retinospora ericoides
 — *filicoides*
 — *plumosa*
 — *aurea*
Salisburia adiantifolia
Taxus baccata, and vars.
Thuia gigantea *X*
 — *Lobbii*
 — *occidentalis*
 — *Warreana*
Thuopsis borealis

GRAVELLY AND SANDY.

Hardwoods.

Alanthus glandulosa
Alnus cordata
Betula alba
Carpinus betulus
Fagus sylvatica
 — *purpurea*
Fraxinus Ornus
Gleditschia horrida
Ilex, many vars.
Juglans cinerea
 — *nigra*
Magnolia acuminata

Morus nigra
Platanus occidentalis
Populus Bolleana
Quercus Robur, and vars.
 — *suber*
Robinia Pseud-acacia
Sambucus nigra
Tilia europææ
Ulmus alata
 — *campestris*
 — *montana*
Virgilia lutea

PRACTICAL FORESTRY.

GRAVELLY AND SANDY—cont.

Conifers.

Juniperus communis

— Sabina

Pinus austriaca

— halepensis

— laricio

Pinus Pinaster

— pumilio

— sylvestris

Taxus baccata

Thuia gigantea

Scrub in

X

CLAY.

Carpinus betulus

Castanea vesca

Cryptomeria elegans

— japonica

Gleditschia triacanthos

Quercus Ilex

— pannonica

— Robur

Thuia gigantea

— Lobbii

IRONSTONE AND COAL.

Acer Pseudo-platanus

Betula alba

Castanea vesca

Cerasus Padus

Cupressus Lawsoniana

Fraxinus excelsior

Juniperus communis

Larix europæa

— pendula

Pinus Cembra

— Montana

Quercus Robur

Thuia gigantea

Ulmus montana

Larch

osican Pine

austrian Pine

Douglas Fir (P. chalt)

Thuia gigantea

Abies nobilis

" ponderosa

" Sycamore

" Shonish chestnut

" Elm

" Beech

" Cedars

" Wellingtonias

" Cupressus Novaezofa

Gravel & Sand

Douglas Fir (Abies Douglasii)

Thuia gigantea

osican Pine

? Spruce?

chock soil

Thuia

austrian Pine

Scrub in

Cedars

Scrub in

CHAPTER VIII.

TREES FOR ECONOMIC PLANTING.

(1) **Coniferous Trees.**—Amongst the many conifers that have been introduced to this country during the last three-quarters of a century very few can, with any amount of confidence, be recommended as suitable for profitable planting. The following, so far as is known, are the only species to be recommended. They are not arranged according to their value for so doing.

The **Larch** (*Larix europæa*).—Both for and against the larch much has been written and said, particularly of late years; but, however much has been said in commendation of it, there can be no doubt that to overstate its value as a timber tree, as well as its exalted place in the economy of British forestry, would be a task of some difficulty. When we combine its great, almost peculiar, aptitude to suit itself to nearly all conditions of soils, altitudes, and diversities of climate, its long-established value as a timber tree, rapidity of growth, and ease of culture, it is clear that no other tree cultivated in this country can be ranked on a par with the larch. Unfortunately, however, of late years the larch has suffered much from disease, the predisposing causes of which may mainly be attributed to the variableness of our spring weather, and rapidly degenerating state of the tree—the latter chiefly brought about by an injudicious selection of seed. By far too little attention has been paid to this important matter, the result being that weakness and tenderness have got into the constitution of the tree, and it is thus unable to withstand even a few degrees of frost. So

weakened, blight, fungus, and ulceration find a footing, and thus the fell disease is generated about which so much has been said and written of late years. In my own opinion, strengthened by careful investigation and research, induced tenderness in the constitution of the larch is the primary cause of disease, cold winds and frost the destroying agents, and ulceration the direct consequence.

Were we to follow more closely nature's method of dealing with the cones and seeds of this—as well, indeed, as many other conifers—we should have less sickly and rapidly-degenerating trees in our woods, and far less cause for the constant wail regarding the decline of this noble and valuable timber-producing tree. In its native country, the Tyrol, the seeds of the larch are never scattered from the cones until March and April, after having been fully exposed, and their contents thoroughly matured by a winter's frost. A comparison of such seeds with those usually produced in this country, and from which our stock of plants is mainly raised from year to year, reveals marked differences, for not only are our home supplies of cones collected in November, before maturity is nearly attained, and when only partially, if at all, wintered, but these are kiln-dried, so that the immature cones may part with their seeds—a most pernicious practice. With such treatment there can be little wonder why our once healthy larch is fast becoming unhealthy, and gradually, but surely, degenerating, as the reports from almost every part of Great Britain too truly confirm. To further add to the evil, the large demand for larch seed by our nurserymen creates a rather keen competition for them to be supplied in time for early spring sowing, and so it is that, instead of the cones being allowed to winter on the trees, they are collected in the greatest quantity in the autumn or early winter, so as to be forward in time to meet the demand.

It is, likewise, well known that sickly trees, as if by a last effort of nature, and so as to propagate their kind, bear an unusually large quantity of seed; and, as these are, in nine cases out of ten, collected at so much per sack or bushel can it be wondered at that the bulk of our home-saved larch

seed is totally unfitted for reproductive purposes? Injury to the roots of the larch in transplanting is attended with most injurious results. For corroboration of above, it may be stated that natural or self-sown trees are, in this country, almost exempt from disease.

The variableness of our spring weather is, no doubt, one of the predisposing causes of disease, for, although no degree of cold experienced in this country can injure the tree when leafless, yet few are more sensitive when in young foliage.

The durability of the wood of the larch is well known, and this peculiarity is even noticeable when of only a few years' growth. As compared with Scotch and spruce firs, the wood of the larch is about doubly durable—a fence of the latter cut at from twenty to thirty years' growth lasted from seventeen to twenty years, while that of the spruce lasts about nine years, and the Scotch five years. This is referring directly to rails, not to posts, which decay in about half that time. For mining and railway purposes the durability of larch wood makes it much sought after, this being further enhanced by its extreme lightness, a cubic foot, when seasoned, weighing only 34 lbs. It takes a beautiful polish, works with great freedom, and, when fully seasoned, is not at all liable to twist or warp.

Substitutes for the larch have often been recommended, but, in the true sense of the word, none can be termed substitutes, except, indeed, in the narrowest sense, although, doubtless, some of those whose claims have been set forth might reflect one or more of its valuable qualities: but this is the widest limit of comparison.

The Corsican Pine (*Pinus laricio*).—This is, undoubtedly, one of the best all-round conifers that has found its way into the British Isles, and we predict that before long the number of trees to be found in woods and plantations will equal, if not exceed, that of any other introduced species. It is of very rapid growth, and well suited for planting, even in the most exposed and wind-swept situations; a non-fastidious subject as to soil, and a very valuable timber producer.

As to its adaptability for withstanding long-continued and

cold blasts at high altitudes, ample evidence can be adduced on many an English and Scotch estate where the pine has been introduced to the woodlands in such quantity as in certain places to form the ultimate or standing crop. In North Wales, on one of the Snowdon range of hills, I have planted the Corsican pine in great quantity. The plantation was, for the greater part, fully exposed to the dreaded south-westerly wind, which at times blows hard and long, and sweeps the hillsides with terrific fury; yet, under such unfavourable conditions, the Corsican pine has done remarkably well—in fact, proved itself to be well suited for planting at high altitudes on our English hillsides. Even at the highest point of the woodland in question, this pine has thriven in a manner that is quite surprising, and thrown its stoutest branches out into the very teeth of the blast, and that where hardly a hardwood tree could survive, and even the Scotch fir shrunk from the cold and almost unceasing storms. Other notable instances of how well the Corsican does on exposed ground and high altitudes might be pointed out—such as at Blair Athol, in Perthshire, at 700 ft., where it is thriving amazingly; and again in Yorkshire, in parts, one of the most barren and wind-swept of English counties, where it grows with a luxuriance that is almost unparalleled in any other part of Britain. The timber produced by the Corsican pine in this country is strong, tough, elastic, very resinous, and easily worked, and this is speaking of trees of fully fifty years' growth. It thrives well on sandy soil, some of the largest specimens of the tree in this country growing along the margin of a disused gravel-pit.

It may be said that the Corsican pine is perfectly hardy, peculiarly well suited for planting in exposed situations, a rapid and valuable timber-producer, a tree that is cheaply and easily raised from seed, and one of the most non-exacting conifers as regards choice of soil that could be named—all qualities of the highest value in a timber-producing tree, and that are rarely so well concentrated in any other species.

In France extensive plantations of the Corsican have been formed, while the Prussian Government has introduced it extensively into the State forests

The **Weymouth Pine** (*P. Strobus*), whether viewed in an ornamental or economic aspect, must be considered as another of the most valuable pines that have been introduced to this country. Admit, we must, that in certain situations the cultivation of this handsome tree has been attended with no very promising results; but then it should be remembered that, like most other trees, the Weymouth pine has its likes and dislikes of soil, as well, indeed, as aspect and altitude. That it has succeeded well, and produced an unusually large quantity of clean and firm wood in various parts of the country cannot be denied; but then in such places its peculiar wants have been attended to. At Gwydyr Castle, in North Wales, the tree succeeds admirably, specimens fully 90 ft. in height, straight as arrows, and branchless for three-fourths their length, and girthing fully 8 ft. at breast-high, being not uncommon. The soil is rocky *débris*, largely intermixed with vegetable refuse, fairly moist at all times, but without stagnant moisture.

On the western borders of Ross-shire, at Strathkyle, where the altitudes vary from 100 ft. to 1,200 ft., the Weymouth pine is making rapid progress. We do not wish it to be inferred that the Weymouth pine alone is suitable for planting at high altitudes and on exposed situations; but that it will grow rapidly and produce useful timber in partially-sheltered districts has been proved by those who have paid particular attention to the value of the newer-introduced conifers as profitable timber-producers in this country.

A comparison of the wood produced by the Weymouth pine in this country with that sent to the late Colonial and Indian Exhibition showed but slight differences, and nothing more than could naturally be expected between a mature and an only partially-developed tree.

The **Austrian Pine** (*P. austriaca*) is to be recommended for profitable planting in this country, and it is, likewise, one of the best shelter-producers that has ever been introduced. Perhaps, in this latter respect it is even more valuable than for the quantity and quality of timber it produces, for it may, with perfect safety, be planted either on the fully-exposed sea-shore or on the wild mountain side.

not to be used as Austrian pine but well on

at considerable altitudes. The timber of the Austrian produced in this country is certainly of no mean quality, for we have cut up several of the largest trees produced in England, and in all cases the firmness and weight of the planks have been surprising. Few soils come amiss to the Austrian, it thriving luxuriantly even on that of very poor description, and where few other pines could eke out an existence. On dry, calcareous soils it is quite at home, and covers vast plains of chalky ground in Lower Austria, where hardly anything else will grow, and has also been successfully planted in the barren, chalky plains of Champagne Pouilleuse, in France. In almost every part of the British Isles this pine has been planted in quantity, and in no single instance has dissatisfaction with its general character been expressed—a fact that speaks volumes in its favour.

The Cluster Pine (P. Pinaster).—Long experience has proved this pine to be a most valuable tree for sheltering purposes, particularly in maritime districts, though an almost worthless species as far as timber value is concerned.

This latter quality can, however, very well be dispensed with when we look at the great value of the tree for planting as a screen to others of a less hardy nature, and in positions where these could not otherwise survive. Many instances of its value in this way might be pointed out in England and Scotland, and also of the use to which it is applied in the reclaiming of sandy, seaside wastes. Few there are who do not know of the invaluable services rendered by this tree in fixing the drifting sands on the dunes of Gascony, as well as those of several British seaside coasts. In such instances as these the value of the timber produced by so admirable a seaside and shelter-producing tree as *P. Pinaster* was never taken into account, more than sufficient benefit being derived from the numerous other trees that, by its friendly aid, were permitted to grow on these exposed and wind-swept wastes. It grows and produces large quantities of timber when planted on almost pure sand—indeed, sandy or gravelly soil and a maritime situation would seem to be two of the conditions under which the *Pinaster* succeeds best. Of late years the *Pinaster* has been extensively used in the

formation of woods and plantations at the Cape of Good Hope, and the results have been highly satisfactory.

The **Scotch Pine** (*P. sylvestris*) must on no account be omitted from our list; as, certainly for planting in exposed situations, where few other trees could succeed, it is one of the best. Probably the principal reason why this tree has not been more generally cultivated, is on account of the almost valueless timber it produces, for, of late years, it has been a difficulty, unless in certain favoured districts, to get rid of it at a remunerative price. The finest quality of Scotch pine timber, such as that produced in some of the northern Scottish counties, no doubt, is even now fairly remunerative; but, generally speaking, that grown throughout Southern Scotland, England as a whole, and also Ireland is of so inferior a quality as hardly to fetch a remunerative price. No doubt, however, this pine will continue to be largely planted wherever shelter and ornament are of first importance: and rightly so, for few others are so well capable of withstanding cold, cutting blasts at high altitudes.

The **Douglas Fir** (*Pseudotsuga Douglasii*) is, in certain situations, a valuable timber-producing tree—indeed, as regards the actual production of timber in a given time, it is, perhaps, ahead of any other tree grown in this country. From measurements we have taken, the actual production of timber during fifty years was 240 ft., or nearly 5 ft. per year for half a century. In a plantation of the Douglas fir in Wales, planted twenty-two years, we found the average dimensions to be as follows: Height, 76 ft.; girth of stem at 24 ft., 4 ft.; cubic contents, fully 50 ft. The timber produced in this country is of excellent quality, being light but strong, works very readily, has a pleasant yellowish tinge, and takes on a good polish. That the Douglas fir is a tree that is eminently adapted for cultivation in this country is already well known; but to grow it in anything like a satisfactory way it must be planted in sheltered hollows, for extensive experience has long ago proved to us that it is ill-adapted for braving the storm, and that even at but few feet above the sea-level. Long ago we strongly advocated the

forming of plantations of *P. Douglasii* alone, or with some other tree of about equally rapid growth, for, when mixed up with the general run of our forest trees, the leader, on overtopping those of its neighbours, soon gets broken over, or otherwise presents an almost branchless, whip-handle-like appearance. We do not wish to say one word against this our favourite fir: but the truth must be told, and our own experience, gained principally on a low-lying seaside estate, and where the tree was annually planted by the thousand, is that *P. Douglasii* must occupy a sheltered situation if either ornament or utility be points of importance.

The **Giant Arborvitæ** (*Thuia gigantea*) is fast coming to the front as a British timber tree, and has already, at the hands of far-seeing planters, received a fair amount of attention. After a fair and impartial trial on our part, we have found it to be perfectly hardy, even at high altitudes, a fast grower and rapid timber-producer, a non-fastidious subject as regards the quality of soil in which it is planted, and one of the easiest managed and most accommodating of trees. The quality of timber produced in this country is such as to warrant us in speaking highly of it, it being of a desirable yellow colour, fine-grained, easily worked, remarkably durable, and light in proportion to its bulk. From the measurements of fully twenty-four specimens scattered over an English park, we have found that the average annual rate of growth is 22 in., but even this is exceeded by young trees.

The **Norway Spruce** (*Picea excelsa*).—Whether as a hardy, shelter-giving tree, or for the quantity of fairly good timber it produces, the common or Norway spruce must ever rank high in the list of useful trees that have been found suitable for culture in the British Isles. That it is a tree in every sense of the word admirably suited for extensive planting is acknowledged by all, it luxuriating at high altitudes, and where fully exposed to our worst winds, and at the same time producing a great quantity of timber that has been found of excellent quality and well suited for general constructive purposes. As a shelter tree few others can equal the spruce, and when planted along the outskirts of exposed plantations

the amount of warmth and protection it affords is quite surprising.

The **Silver Fir** (*Abies pectinata*) is another of those trees that have of late years fallen into disrepute, and this mainly owing to the increased importation of foreign timber. That it is an excellent and highly remunerative tree is unquestionable, and the very fact of its thriving luxuriantly on the soils where the larch declines to grow should make it, in this country at least, of great value as a forest tree.

With the most satisfactory results has the timber been used for railway sleepers—in fact they (the four sleepers laid experimentally) have stood the wear and tear quite equal to those of Baltic timber, alongside of which they were placed. For roofing purposes the wood has likewise attained great fame, it standing vicissitudes of dry and damp alternately better than almost any other home-grown timber.

The **Nootka Sound Cypress** (*Cupressus Nootkatensis*) will no doubt be found valuable for profitable planting. It grows with great freedom, produces good timber, and, so far, is almost exempt from disease or the attacks of insects.

Nordmann's Fir (*Abies Nordmanniana*), the **Redwood** (*Sequoia sempervirens*), and **Lambert's Cypress** (*Cupressus Lambertiana*), will, when more readily procured, enter into the composition of British woodlands, they all, at present, promising favourably.

The Conifers just treated of are about the only kinds that can, from our own personal experience, be recommended for profitable planting in the British Isles, and it is very questionable if any other of equal merit can be added to the list.

(2) **Hardwooded Trees**—Amongst the best hardwoods for economic planting, the oak, sycamore, and ash hold first rank; second in point of value come the elm, Spanish chestnut, and plane; following up with the birch beech, alder, poplar, willow, and similar trees.

Oak.—Than the oak, few trees are more profitable to cultivate, as it grows readily on most good soils, is fairly free from disease, and the timber realises a higher price generally than that of almost any other tree.

+ **Sycamore** comes, perhaps, second on the list, the demand for large timber being good and the price highly remunerative. It grows very freely, even at high levels, and produces a great amount of timber, which, even in a young state, meets with a ready market.

The **Ash** has always been a highly remunerative tree, and one the timber of which is in great demand, whether for local purposes or transferring to a distance. The number of uses to which the wood can be applied on the farm and estate generally will always assist in keeping up the price.

+ **Spanish Chestnut**.—In certain districts the Spanish chestnut is a remunerative forest tree, and, when well grown and of large size, the timber rarely remains long on hand.

X **Elm**, both English and Scotch, are extensively planted for the value of the timber produced. Both are valuable for the shelter they afford.

X **Beech** timber has increased in value of late, and in most districts it is fairly remunerative. The tree is also largely employed for planting on those chalky and calcareous soils where only a limited number of forest trees could succeed.

Alder and Birch for economic planting are about on a par, whether as regards timber value or the position in which they may be planted.

Willow and Poplar.—The same may also be said of these as they succeed in almost similar situations, and realise, in point of timber value, about the same amount.

Not only for the intrinsic worth of the timber, but for the value individually of the trees for planting where few others could succeed, will the alder, birch, poplar, and willow ever hold an exalted rank in British forestry.

Speaking in a truly economic sense, the above may be considered as about the principal trees than can be employed for profitable planting.

CHAPTER IX.

SEASIDE PLANTING.

Few persons other than those who have actually been engaged in the work have the remotest idea of the difficulties to be encountered in the formation of belts and plantations on exposed and wind-swept seaside ground. To plant young trees around many parts of the coast of the British Isles, particularly where wide stretches of open seaboard are to be dealt with, without first erecting a shelter-screen of some kind or other, is useless work, and only productive of the most unsatisfactory results.

That there are not a few districts, however, where such a preliminary would be needless is well known, all that is required in certain instances being, first of all, to prepare the ground, and, secondly, to suit the plants to the soil and situation, for that certain varieties of trees succeed better than others in certain soils and situations is a fact that is well known. From experience I have found out how useless it is to plant in a haphazard way, on the more exposed seaboards along the west coast, at least; whereas, by careful manipulation, I have been successful in getting up shelter where before it was deemed almost an impossibility. The chief consideration in seaside planting is unquestionably shelter, be it only of a temporary kind, for it may be noticed anywhere along our coast that, wherever the direct force of the hurricane is broken, there trees and shrubs are growing best. Another evil—a great one, too—with which the planter has to contend is the injurious effect caused to trees, but more particularly evergreen shrubs, by the saline particles which are driven and deposited with such force on the leaves and branches as

in many instances to give them the appearance of having been scorched or cut over when in full vigour by an untimely frost. Wind-shaking, although a minor evil, must also be carefully guarded against, so that at the outset it is well to have the trees, unless such as are of dwarf size, securely staked and tied, so as to obviate the dire results occasioned to the roots of newly-planted trees when the stems are allowed to rock to and fro with the wind.

Before commencing planting operations on the sandy and exposed sea-coast, the preliminary step is to erect a barrier of some kind, which will intercept the violence of the wind, and act as a screen or shelter to the young plants. For this purpose various kinds of erections are equally suitable, but that usually adopted, especially where loose sand alone is present, is a strong paling-fence thatched with brushwood. The posts should be at least 6 ft. above ground, and about 12 ft. apart, the paling-rails, two in number, being securely nailed to these at 2 ft. and 5 ft. from the ground; against this are placed spruce or gorse trimmings, these being 6 ft. long if possible, in an upright manner, and firmly tied to the cross-bars by means of binding wire or strong tarred rope. This may best be described as a dead fence, but it is, nevertheless, quite as valuable for the purpose required as a perfectly developed living hedge. By means of this a great advantage is gained and a favourable start for the newly-planted trees is secured. Then, compared with a stone wall, or, in fact, a wall of any kind, this screen-fence is greatly superior, the wind being broken up in passing through it, and, what is of as much value, also relieved of its saline particles, at least to a very considerable extent.

Where the shore is almost destitute of sand, and where certain kinds of vegetation subsist, I find it to be a capital plan to substitute for the dead fence just described that composed of turf and earth.

The raised mound should not be less than 5 ft. in height, and of sufficient width at top to allow of the planting of a double line of such plants as have been found most suitable for the wind-swept maritime situation in which they are to be used. For this purpose few plants equal, and certainly

none surpass, the sea buckthorn (*Hippophæ rhamnoides*), Tamarisk (*Tamarix gallica*), the common elder, hazel, white-thorn, and at least three species of willow—*Salix Caprea*, *S. helix*, and *S. alba*. Immediately behind this screen, pits of not less than 2 ft. in diameter and about 18 in. in depth may be formed, and it will be all the better if a length of time is allowed to elapse previous to their being planted. The bottom and side of each pit should, where found necessary, be loosened with a pick, and if the soil is found to be of very inferior quality, it will be well, more especially where such can be readily obtained, to add a spadeful or two from some adjoining field.

Planting should not be commenced before March or April, an early start at growth being much in favour of young trees that have but recently been transferred to the sea-coast. The plants to be used should not exceed, say, 18 in. in height, but should be of strong growth in proportion to their size, and supplied with an abundance of fibrous roots, lanky, ill-grown, and coddled plants having but a poor chance of succeeding under such adverse circumstances.

In planting keep the strongest roots seaward, and do not place the trees at a greater depth in the soil than they stood whilst in the nursery border, this latter being an oft-committed mistake that is productive of anything but favourable results. Immediately behind this raised mound of turf, or the dead fence of branches above described, the best trees for withstanding the first brunt of the sea-breeze are the sycamore, elm, and willow amongst hardwoods, and the Austrian and cluster pines (*Pinus austriaca* and *P. Pinaster*), to which might be added *P. laricio*, *P. sylvestris*, and *P. pumilio*, amongst conifers. These are all well tried subjects, and may be relied upon as peculiarly suited for doing battle with hard-blowing and long-continued storms on the sea-coast.

Regarding the merits of the cluster pine for seaside planting, it would be almost superfluous for me to speak; while the elm and sycamore send out their stout branches into the very teeth of the blast, and are known as peculiarly well suited for such situations.

The following list includes such trees and shrubs as have, from long experience, been found well suited for planting on cold and wind-swept shores, and the trees are arranged according to their value for so doing:—

Hardwoods.

The **Sycamore** (*Acer Pseudo-platanus*) is, without doubt, the most valuable tree of timber size that I have come across for planting in exposed seaside situations. It succeeds well, even at highwater mark, the stout, twiggy branches being thrown out into the very face of the blast. Even during winter, and in a leafless state, the amount of shelter afforded by this tree is quite surprising. Taking everything into consideration—its great hardihood, and suitability to various soils and situations, I consider the sycamore the most valuable of any tree that I have yet tried for seaside planting.

The **Elder** (*Sambucus nigra*) is, amongst small-growing trees, the best for planting in exposed seaside districts. Its powers of endurance are even greater than those of the sycamore, although the amount of shelter it affords is by no means so great. Where its branches are constantly exposed to the saline-laden breeze, and, its roots amongst almost pure sand, it grows and thrives in a manner that is quite surprising. With the greatest advantages have I used the elder as a wind-break on some of the most exposed and desolate coasts of the British Isles. Even where grown as a single specimen, it seems to disregard the angry blast and saline particles with which it is almost constantly pelted—a fact that may be verified, in not one, but several stations along the coast. Then, what tree is of readier culture than the elder, succeeds better in poor, sandy soils, or spreads about to an equal extent?

The **Norway Maple** (*Acer platanoides*) stands the first brunt of the sea-breeze in a most commendable way—indeed, it may be recommended as one of the most hardy and valuable trees for the purpose under consideration that could be named. On the western coast of England, and in a very exposed and wind-swept district, I have used it with the greatest success in the formation of plantations, it growing

rapidly and soon forming an excellent shelter to other less hardy kinds of trees. It is by no means particular as to soil, but succeeds all the better if this is fairly rich.

The **Winged Elm** (*Ulmus alata*).—From a long experience of this, at present, little-known tree, I have every confidence in recommending it as one of the most valuable trees for planting in cold, wind-tortured, and maritime districts that have yet found their way into this country. Where many of our hardiest trees are bent and shrinking from the blast, this elm stands nobly out, and seems to defy both winds and storm.

The **Huntingdon Willow** (*Salix alba*) and **Bedford Willow** (*S. Russelliana*), but particularly the former, are excellent trees for windy shores. In many places along the coast the Huntingdon willow may be seen in a most flourishing and happy condition, and that, too, where the surroundings are the reverse of favourable. It is a tree of quick growth, and will succeed well in any class of soil if it be not too damp. In one instance that came under my notice, the trees were planted on a promontory overhanging the sea and in such a situation that they were almost constantly subjected to rough-blowing winds coming in from the Irish Sea, and yet they have grown with the greatest freedom, and to-day look as healthy and happy as if planted in some sheltered inland situation.

The **Beam Tree** (*Pyrus Aria*) is another excellent small growing tree for planting in sites where, from cold saline blasts, few others could eke out even a miserable existence.

On the limestone cliffs of the Great Orme's Head this handsome and hardy tree grows in a most surprising way—indeed, with the exception of one or two species of willow, I question very much whether any other tree could exist under the trying circumstances. The hard and leathery leaves seem as if specially constructed for bearing storms, and, being plentifully produced, render a great amount of shelter to other trees.

The **Goat Willow** (*Salix Caprea*), for planting in almost pure sand on the sea-coast, is a most valuable small-growing tree, and then it is so hardy that, without the least risk of

harm, it may be planted at great altitudes, and in very exposed situations. In several of the maritime plantations that I have formed, this willow was used with remarkable success in the outer line or screen.

The **Aspen** (*Populus tremula*) is an excellent shore-tree, one that can withstand a great amount of rough usage, and as hardy and fast-growing a subject as could well be desired. In the formation of several exposed seaside woods on the west coast of England I planted the aspen largely, and, I may add, the results have been most satisfactory.

P. canadensis, **P. alba**, and **P. nigra** are likewise worthy of extended culture, for they succeed well by the seaside. They all stand the breeze from the sea, are perfectly hardy, and afford a great amount of shelter.

The **Mountain Ash** (*Pyrus Aucuparia*).—Although valueless, or nearly so, for the quantity of timber it produces, yet, as a hardy, free-growing tree, the mountain ash, or rowan tree, merits attention from planters of exposed seaside land. All along the coast of Great Britain this pretty tree may be found growing luxuriantly, and in such situations affording a great amount of shelter to other less hardy kinds of trees and shrubs. It may be planted without fear of harm, down even to high-water mark, and where the soil is of the poorest description, and is thus one of the most useful of trees for planting as shelter along the roughest and most wind-tortured parts of the coast.

The **Hoary Alder** (*Alnus incana*) and the **Common Alder** (*A. glutinosa*) can hardly be excelled for planting in wet portions of cold, wind-swept ground, and in the vicinity of the sea. Both trees grow with the greatest freedom, and are perfectly hardy, standing the first brunt of the saline blasts in a most commendable and praiseworthy manner.

I have found it to be a good plan where shelter is wanted on bare coast-tracts, if the quality of soil be at all suitable, to plant the alders pretty closely, and when they have attained to 15 ft. or 20 ft. in height, to cut every alternate one over at ground level. By so doing a number of stout shoots are thrown out early in the following spring, which, as they

grow with great rapidity, soon fill up the blanks occasioned by cutting over the young trees.

After these have had several years' growth the remaining half of the original crop should be cut over, and when all have started from the stools a first-class shelter is obtained. Of course, damp portions of the ground should be selected on which to plant the alder.

The **English Maple** (*Acer campestre*) can well hold its own as a tree for planting on exposed seaside grounds. It is one of the hardiest trees with which I am acquainted, growing on exposed hillsides and at considerable elevations in a way that seems to attract the attention of everyone.

Hedges or fringe fences of the native maple have succeeded amazingly in several maritime woods in which it was planted, and in places, too, where the wind blew loud and long.

The **Scotch Elm** (*Ulmus montana*) comes next on the list of such trees as I would recommend for the purpose under consideration. It affords plenty of shelter, growing, as it does, freely from the root-stock, in the way of sending up suckers, and is so hardy and proof against damage from storms that it may safely be planted in wind-swept districts by the seaside.

Birch (*Betula alba*) and **Ash** (*Fraxinus excelsior*) are other trees that repeated experiments have proved to be well suited for withstanding the ocean's blast and for planting in poor, rocky soils.

The **Turkey Oak** (*Quercus Cerris*), with just a small amount of shelter, will be found a most valuable tree for planting within the influence of the sea. It thrives well in very poor soils, and when in full leaf is capable of affording a great amount of shelter.

The **Evergreen Oak** (*Q. Ilex*) has proved itself to be peculiarly fitted for planting as shelter in exposed and maritime districts. In the formation of seaside plantations, but particularly where, from the frequency and force of the storms, few trees can succeed, I have planted the evergreen oak with the best success.

The trees just treated of have no equals, among such as have yet been introduced, for withstanding cold sea-

side winds, a trial of many other varieties only resulting in proving their unfitness for planting in such situations. Two or three others, such as the **English Oak**, **Hornbeam**, **Beech**, and **English Elm**, might be added to the list, but they can only be recommended for planting where at least partial shelter is afforded.

Coniferae.

Foremost amongst these I must, from long personal experience and a fair trial of several kinds under exactly similar conditions in every way, place the **Austrian Pine** (*Pinus austriaca*). It grows with unusual freedom, and affords a greater amount of shelter than any other tree with which I am at present acquainted.

That it will succeed well with the *P. Pinaster* when subjected to the sea-breeze, I am now fully convinced, while the amount of shelter it affords, and rapidity of growth, place it far ahead of that species for the purpose we are now considering. It may not succeed so well as the *Pinaster* when planted in pure sand, on the sea-coast, and this is the only point that can be adduced in favour of the latter species over *P. austriaca*. In the forming of many large woods along the coast of Northern England I used the Austrian pine in preference to many others, and happily, too, for it has succeeded in a surprising manner, trees of ten years' growth being fully 13 ft. in height, and nearly as much in diameter of branch spread. With such a screen as that afforded by the hardy Austrian, many half-tender trees can be planted farther inland; and this is the method of procedure that I have found to be most successful in getting up shelter along bare and fully-exposed parts of the shores of Western England and Scotland.

The **Cluster Pine** (*P. Pinaster*) and its smaller-growing variety *P. maritima* have a world-wide reputation for their suitability for planting on exposed seaside tracts of ground. That they are of great value for planting on sandy wastes is a fact that cannot be gainsaid—indeed, few other trees could succeed or eke out an existence in pure sand and where the roots come in contact with the salt water. A great drawback to this pine is its long tap-root and want of

fibrous roots ; it transplants with difficulty, but this, as in various other species of pine, may be greatly obviated by careful nursery management.

In my own opinion the typical tree is hardly equal to the variety *maritima* either for shelter or withstanding the sea-breeze.

The variety, too, is, if anything, the most valuable for shelter-giving, it having a much greater inclination to retain the lower branches intact.

X The **Corsican Pine** (*P. laricio*) quite equals the Austrian in its powers of withstanding long-continued and cold winds. That it does not succeed so well on the sea-coast is a fact of which, from repeated experiments, I am fully aware. The Corsican pine, too, is a valuable timber producer—a fact that is well worthy of consideration in extensive planting.

X In the **Giant Arborvitæ** (*Thuia gigantea*) we have another excellent addition to the list of trees that have been found suitable for planting on exposed maritime grounds. It grows with great rapidity, and I have never found even a solitary example of this tree having been uprooted or injured during the most severe storms. On the sea-coast of Wales I have used the giant arborvitæ largely in the formation of woods and plantations, and with great success. It transplants well, even when of large size, and is readily propagated.

Pinus montana may also be recommended for afforesting tracts of ground by the sea-coast. It is a tree of undoubted hardihood, withstanding cold and cutting winds in a worthy manner.

The **Scotch Pine** (*P. sylvestris*), though by no means equal to the above for planting by the seaside, must on no account be omitted from our list, for it is a hardy, fast-growing species, and one that can do battle with very severe and long-lasting storms. It should not be planted where it will meet the first brunt of the storm, but given a little shelter, such as that afforded by the above-named kinds. The varieties of pine just named may all be relied upon as peculiarly well fitted for the purpose under consideration

The **Large-fruited Cypress** (*Cupressus macrocarpa*) and **Pinus insignis** might have been added to the list, both being well suited for maritime planting—inland, however, they cannot be relied upon. *Pinus insignis* grows with unabated vigour on the wind-swept coast of the Isle of Anglesey, and stands the breeze in a most surprising and praiseworthy manner.

The **Atlantic Cedar** (*Cedrus atlantica*) and **Swiss Stone Pine** (*Pinus Cembra*) do fairly well as seaside trees.

Shrubs.

The **Sea Buckthorn** (*Hippophae rhamnoides*) is unquestionably the best all-round shrub for planting as a shelter by the sea-coast with which we are acquainted. To see it in several districts of Scotland, growing almost amongst pure sand, and where constantly exposed to fierce blasts, shows how valuable a shrub it is for exposed maritime situations. For affording shelter it is one of the best shrubs that I know of, the unusually twiggy branches sifting and dividing up the wind in a remarkable manner.

Tamarix gallica and **T. germanica** are two excellent seaside shrubs, and such as are well suited for planting on exposed places. They grow with great freedom, transplant well, and are readily propagated. Even in pure sand they seem quite at home, growing freely, and producing a rich abundance of their showy flowers. In very exposed parts of the coast, and when fully open to direct sea-blasts, we have frequently seen the tamarisk fully a dozen feet in height, and nearly as much in branch-spread. Though little known, *T. germanica* is a most valuable seaside shrub, of about 6 ft. in height, with small leaves, and spikes of conspicuous red flowers.

The **Box Thorn** (*Lycium europæum*) may be introduced without fear of harm to the seaside woods, for it is not only perfectly hardy in such situations, but it bears constant exposure to wind as well as any shrub I know of. Hedges of this plant have been formed in many maritime parts of England and Wales, the only support being a few stakes driven in here and there along the line of fence. It will grow in pure sand, and when lashed by the waves.

The **Snowberry** (*Symphoricarpos racemosus*) comes next on the list of shrubs that have been found suitable for the purpose under consideration. It is a plant of extraordinary hardihood, one that increases rapidly from the root-stock, and affords a fair amount of shelter.

The **Tree Mallow** (*Lavatera arborea*) can hardly be surpassed for shore planting, where it frequently attains to a height of 10 ft. It has been found of great utility in some of the islands along the coast of Scotland.

Spirea Adiantifolia is a fitting companion for the latter, it growing and flowering very freely in wind-swept gardens along the Scottish coast.

Griselinia littoralis has stood a severe test as to its capability for withstanding cold winds blowing in from the sea.

The **Dogwood** (*Cornus sanguinea*) and **Flowering Currant** (*Ribes sanguineum*) are, likewise, excellent seaside shrubs, of perfect hardihood and readily propagated.

The **Tree Purslane** (*Atriplex halimus*) is also a really valuable shrub that is totally indifferent to the salt spray, and which, from its dwarf, evergreen nature, and silvery-sealy leaves, is also more or less ornamental. It does not seem to mind either wind blowing direct from the sea, or whether the soil in which it is planted is of even fairly good quality.

The **Laurustinus** (*Viburnum tinus*).—Where the situation is not too exposed, this is a most valuable and ornamental shrub.

Lilacs of various species are well adapted for planting by the seaside, the two kinds most to be recommended being the **Common and Persian** (*Syringa vulgaris* and *S. Persica*).

The **Spanish Broom** (*Spartium junceum*) has been used with the greatest success all along the coast, it being perfectly hardy, and an excellent subject for cold, draughty positions.

The **Tree Groundsel** (*Baccharis halimifolia*) is not only a shrub of great beauty, but one that is perfectly hardy, and well adapted for planting by the seaside. It will thrive almost in pure sand, but it is all the better for a poor gravelly

loam, and seems to delight in the ozone of the seaside atmosphere.

Both the **Portugal Laurel** (*Prunus lusitanica*) and **Sweet-Bay** (*Laurus nobilis*) are valuable evergreen shrubs for seaside planting. They afford, from their large size and compact habit, a great amount of shelter.

The **Common Holly** (*Ilex aquifolium*) and its golden form both do well at the seaside, which may also be said of the **Common and Scotch Laburnums**. They may be used with best advantage wherever the direct force of the blast is broken up.

The **Common Gorse** (*Ulex europæus*) and the **Broom** (*Cytisus scoparius*) should on no account be omitted from our list of shrubs that are valuable for maritime wastes where the wind exerts its full power.

The above shrubs include all that can be recommended for planting along the sea coast, but where good shelter is afforded by the trees named in this chapter, a few others might be recommended for trial. These include the **Strawberry Tree** (*Arbutus unedo*) **Euonymus japonicus**, **Berberis Darwinii**, **Ligustrum Ovalifolium**, **Daphne Mezereon**, and **D. laureola**, **Ruscus aculeatus**, **Hypericum calycinum**, **Vinca major** and **V. minor**, and several kinds of **Thorn**.

The **Maram**, or **Sea Matweed** (*Psamma arenaria*) is one of the most useful grasses with which I am acquainted for binding shifting sands on the sea coast. Not only so, but by using it as a pioneer, the amount of shelter it affords renders other more difficult subjects by no means hard to cultivate. It usually attains to from 2 ft. to 2½ ft. in height, much depending on the situation, whether it is partially sheltered or fully exposed. The root-stock creeps widely, some specimens that have been followed up in the sand being of the amazing length of 35 yards. Amongst loose and drifting sand the running roots find what is most suitable for the welfare of the plant, and it is astonishing with what persistency they bind in an unusually short space of time these shifting hills of almost dust-dry sand. In planting, place the plants in parallel lines, about 16 in.

SEASIDE PLANTING.

apart, and at a distance of 12 in. from each other. Large plants may be subdivided to almost any extent. A garden line is stretched along the ground, a notch 10 in. deep taken out, the grass inserted therein and filled with sand, and afterwards firmly trodden. That the sea matweed is a most useful plant for fast gaining a footing on sandy tracts of sea coast, and thus allowing of following up with the shelter-giving trees, cannot be disputed.

The **Lyme-grass** (*Elymus arenarius*) is also valuable for growing in almost pure sand on the sea coast.

It is of tall, elegant growth, and is readily increased from root divisions.

The following trees and shrubs, alphabetically arranged, are recommended for seaside planting :—

Trees for the Sea-coast

Acer campestre	Pinus Pinaster maritima
—— creticum	Populus canadensis
—— Pseudo-platanus	—— nigra
Alnus glutinosa	Pyrus Aucuparia
—— incana	Quercus Ilex
Betula alba	—— Robur
Carpinus betulus	Salix alba
Cedrus atlantica	—— Caprea
Cupressus macrocarpa	—— Forsteriana
Fagus sylvatica	—— Russelliana
Fraxinus excelsior	Thuia gigantea
Pinus austriaca	Ulmus alata
—— laricio	—— campestris
—— montana	—— montana
—— Pinaster	

Shrubs for the Sea-coast.

Atriplex halimus	Lavatera arborea
Aucuba japonica	Lycium europæum
Cerasus lusitanica	Rhamnus frangula
—— Padus	Ribes sanguineum
Cytisus Laburnum	Rosa spinosissima
—— scoparius	Shepherdia argentea
Euonymus japonicus	Spiraea adiantifolia
—— europæus	Syringa persica
Fabiana imbricata	—— vulgaris
Griselinia littoralis	Symphoricarpos racemosus
Hippophaë rhamnoides	Tamarix gallica
Ilex Aquifolium	—— germanica
—— Aquifolium aurea	Ulex Europæus
Laurus nobilis	Viburnum tinus

Grasses.

Elymus arenarius	Psamma arenaria
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CHAPTER X.

TOWN PLANTING.

To those whose lot is cast in or near our more important centres of industry this subject is of vast importance, and one which, at the present time, occupies a large share of public attention.

The atmosphere of our larger towns and cities—London, Glasgow, Liverpool, Manchester, and Sheffield—is, it must be candidly admitted, impregnated to a far greater extent with noxious fumes and vapours than is that of any of the Continental towns—Paris, Brussels, or Berlin—where street tree planting would seem to be a matter of paramount importance, and, therefore, the difficulty of establishing many trees and shrubs is correspondingly increased.

Observations and experiments carried on during the last ten years in three of the largest towns in Britain—London, Glasgow, and Liverpool—a trial garden was for this express purpose instituted in one of the most smoky districts or East London—have clearly proved, however, that there are not a few trees and shrubs well suited for withstanding even the deleterious effects of the impurest of town atmospheres. Not for one moment do I wish it to be inferred that there are not certain districts—to wit, the environs of Lambeth potteries, and some of our huge chemical and other works—where, do what we will, vegetation, be it of whatever kind, will not succeed; but, as we recede from these centres of sickness and death, particular trees and shrubs flourish amazingly, and no better example can be pointed out than the healthy and rapid-growing specimens that adorn the

Thames Embankment, which are removed but a very short distance indeed from one of the barrenest and most miserable of the city suburbs—the pottery district.

That certain trees and shrubs succeed best in particular towns is another strange fact, for, curious as it may seem, the smoke-proof London plane is by no means the best tree for either Liverpool or Warrington, particularly the former town, where the sycamore has been found to be better adapted.

In the very centre of Sheffield the Canadian poplar has been found to be by far the most useful tree, while in some of the worst localities in the colliery districts the chestnut and variegated leaved sycamore are the greatest favourites. Even the rhododendron does well in the most smoky parts of Bury, Lancashire.

In the smoky and impure (chemically) atmosphere of Glasgow, the thorn and beam tree (*Pyrus*), as also several kinds of *Retinospora*, thrive amazingly, much better than they do in any of the large English towns. That certain trees succeed best in particular towns is, perhaps, readily explained by the conditions of soil and situation, as well as the particular industry of the inhabitants. Coal smoke from the multitudinous chimneys of our larger centres of industry is, no doubt, bad enough; but when we have to contend with an atmosphere largely impregnated with the outcome from chemicals, gas, or iron works, the difficulties to be encountered are great indeed.

Preparation of the Ground and Planting.—In order that success may crown the effort, it may truly be said that no work of the arboriculturist requires more skill and good management than the proper planting of trees alongside streets and avenues. The materials with which roads are usually made up are ill-fitted for sustaining a healthy condition in trees—at least, for any great length of time; and this is well known to those who have taken any interest in the matter—broken stones, clinkers, and gravel affording but small support to vegetation, be it of whatever kind, but particularly large-growing trees and shrubs. Many failures in street tree-planting from this very cause might be pointed

out, and in not a few cases the future result will certainly be discreditable to all concerned, simply because the work has not been properly done. In crowded streets and squares, where the air is vitiated with impurities, and the soil hard and often surcharged with gaseous matter, tree-planting is a different matter to what it is along the side of a field. In the latter case, it may be sufficient to open a small pit, insert the tree, and stake it; but in our large towns the case is totally different, for the soil, hard as iron, and composed mainly of clinkers and shingle, affords but little nourishment to a rapid-growing tree, and one that, moreover, has to do battle with the deleterious effects of an impure atmosphere. Another fruitful cause of failure in street-planting is placing the pavement above the roots, and in too close proximity to the stems.

The roots should always be allowed plenty of breathing-room, and to effect this a good-sized space should be railed off around each tree, and no pavement laid within it. In so doing, a double benefit is conferred, by allowing free access of rain to the roots, and avoiding the accumulation of noxious gases in the ground, which are inimical to the welfare of the trees. Where street trees are to be planted, a good-sized patch of ground—say, at least 6 ft. in diameter and 4 ft. in depth—should be thoroughly broken up, and if the soil is of inferior quality, which will assuredly be so in 90 per cent. of the pits, good fresh loam should be substituted. By undermining the sides of the pits a much larger receptacle for the roots will be formed, and this will not occasion so much of the footway on a pavement being torn up as if the pits were of equal diameter top and bottom.

The plants used should be such as have been specially prepared for the purpose by being frequently transplanted for some years previous to being placed in their final position. They should be stout, stocky, well-rooted, clean, and from 6 ft. to 9 ft. in height. In planting, spread the roots well out around the stem, and do not bury too deep, the mark visible on the stem as to how deep the trees stood in the nursery border being the best criterion to go by. As regards the best time to plant town trees opinions differ, but there

can be little doubt that spring is preferable, for the good reason that, as they start into growth at once, they are not so likely to suffer from smoke and other deleterious affections as if they remained during the winter in an inactive condition.

Staking the trees, so as to prevent rocking by the wind, and consequent damage to the roots, should be set about immediately planting is finished. These simple matters connected with the preparation of the ground, planting, and staking are so important in town planting that they should never be lost sight of, for, while they add but little to the cost, the advantage gained is very great.

Trees.

The Oriental or Common London Plane (*Platanus orientalis acerifolia*)—This variety of the oriental plane stands first in the category of select town trees. Not only does it grow vigorously in towns, but it is peculiarly well adapted for withstanding the smoke and other impurities of their atmosphere. Repeated experiments have clearly proved that in London this tree flourishes better than any other, and a visit to the Thames Embankment and several other of the urban districts will substantiate the statement ; while the fine old tree which still exists in Cheapside, and the equally beautiful specimen which has hardly room for perfect development in the Court of Stationers' Hall, Ludgate Hill, afford other examples of how well suited this handsome tree is for doing battle with the smoke and impurities of the great metropolis. As a diversity of opinion has existed about which variety of plane it is that grows with such vigour in and around London, it may be stated that, on a careful examination of a large number of specimens, the variety *P. O. acerifolia* was found not only more commonly distributed, but, likewise, better suited for town planting than the typical *P. orientalis*. This valuable variety is readily distinguished from the normal plant by the less deeply divided leaves, and from the American plane (*P. occidentalis*), with which it is not infrequently confounded, by the many fruit "balls" which are attached to each peduncle, the fertile

catkins of *P. occidentalis* being, for the greater part, produced singly.

But not only for its value as a town tree is the oriental plane much sought after, for the giant proportions to which it attains, coupled with the handsome, finely-cut leaves and easy habit of growth, render it one of our most desirable ornamental trees. Then it is of the easiest culture, succeeding extremely well in soils of very opposite qualities. Taking everything into consideration, we question much whether any other of our forest trees is of greater, or even equal, value with the plane for town planting.

The **Maidenhair Tree** (*Ginkgo biloba*).—A prolonged visit to the very worst smoke-infested slums of London has now quite convinced me that the maidenhair, or ginkgo, tree is one of the most valuable that can be planted in the impure atmosphere of a town garden. Few trees, I am fully aware, can compare with the one in question, for withstanding the deleterious effects produced on vegetation generally by coming in too close contact with the impurities of our great centres of industry. The ample-delicate green foliage betrays—even late in the season, and when about to be cast off—little evidence of the fierce struggle that must almost constantly go on between vegetation and the smoke and filth of our towns and cities. That the thick, leathery leaves, and strong constitution of the tree, play an important part in keeping it free from disease is clearly evident, while the fact of the leaves being renewed annually must go a long way towards casting off the sooty nodules which work such havoc on the tender foliage of most evergreen trees.

At no less than five places in and around the great metropolis—and such places, too, where one is almost stifled with the fumes from chimneys—this tree may be seen almost in as fresh a condition as those in the open country.

The **Ailantus**, or **Tree of Heaven** (*Ailantus glandulosa*) may be seen in a very flourishing condition in many of the largest centres of industry in Southern England. It has been largely planted in many Continental cities, and has proved itself one of the few trees that is capable of withstanding the impurities of a town atmosphere.

The **Black Italian Poplar** (*Populus monilifera*).—Next to the plane amongst forest trees I consider the black Italian, poplar to be most valuable for planting in smoky towns. As a proof of this there are to be seen numerous fine specimens of this tree in a flourishing condition, and clothed with the most healthy foliage, in some of our largest cities—to wit, London, Glasgow, Liverpool, and Manchester.

The **Canadian Poplar** (*P. canadensis*), and its variety, *P. C. nova*, are excellent trees for planting in smoky localities. The former succeeds admirably in the very centre of Sheffield, in the old parish churchyard, where for hundreds of yards away not a particle of living vegetation is to be seen. The variety *nova* is a very superior tree for street planting, it being far more ornamental, and of more rapid growth than the black Italian poplar, and equally reliable for retaining a healthy and flourishing condition under the adverse circumstances connected with a town atmosphere.

The **Abele Poplar** (*P. alba*) grows with great freedom when subjected to smoke and foul air. In the very heart of our largest towns it may be seen flourishing in a manner that is almost incredible.

The **Lombardy Poplar** (*P. fastigiata*) is another tree that has been planted with some success in and around many of our largest cities, but it cannot equal any of the foregoing for withstanding the baneful effects of a tainted atmosphere. In the outskirts of towns, where the air is purer than amid chimneys pouring forth their volumes of smoke, the Lombardy poplar succeeds fairly well, and imparts an air of grandeur that could hardly otherwise be obtained.

The **Cucumber Tree** (*Magnolia acuminata*).—Few planters are aware of how valuable this tree is for withstanding the germs and soot of large towns. Experiments have, however, resulted in this highly ornamental tree being added to the list.

The **Tulip Tree** (*Liriodendron tulipifera*).—Excellent examples are not wanting of how valuable a tree the present is for towns and streets. It seems to have a wonderful recuperative power, for, scorched, blackened, and encrusted as may appear the falling-off foliage, yet in the following spring

it again puts forth a garb of the freshest and richest greenery. The remarkable four-lobed, truncate leaves render the tree almost without an equal for ornamental planting, while its undoubted smoke-resisting qualities place it high in the rank of town trees.

The Indian Bean (*Catalpa bignonioides*).—For various reasons this fast-growing tree is to be recommended for planting in smoky localities. It grows with great vigour in many smoky centres of industry, is a tree of handsome proportions, and, when fully established, flowers freely.

A valuable trait in the character of the Indian bean is that, should accident befall it, and the stem get injured, numerous strong suckers are produced, which, as they grow with great rapidity, soon take the place of the original.

The Common Mulberry (*Morus nigra*) and the **white-fruited Mulberry** (*M. alba*) may be seen growing satisfactorily in several of the old gardens and nurseries of the metropolis, and where they are now buried alive, as might be said, in stones and mortar. That they are excellent town trees will be admitted by everyone who sees the fine specimens in Liverpool and Manchester.

The Honey Locust (*Gleditschia triacanthos*) is a very suitable subject for planting in smoky localities. In many of the worst smoke-infested parts of London and Manchester are seen goodly specimens of this handsome tree—not poor, miserable trees, but, from their great size, wealth of foliage, and general appearance, betokening perfect health amid their rather adverse surroundings.

The False Acacia (*Robinia Pseud-acacia*).—Almost by the hundred can the false acacia be seen in London and many other English towns, thus proving that it is one of the most valuable trees that we possess, for withstanding the injurious effects of an impure atmosphere.

What renders this acacia of greatest value as a town tree is that it retains its rich verdure till well on in autumn. The varieties known as **Decaisneana**, **microphylla**, **macrophylla**, **sophoræfolia**, and the upright-habited are most to be desired.

The White Beam Tree (*Pyrus Aria*).—In many of the con-

fined spaces in Glasgow the white beam tree grows luxuriously, and produces annually great quantities of its brightly-tinted berries.

The **Lime** (*Tilia europæa*).—Where the situation is not too confined, and where soot and smoke do not abound, the lime may, and does, succeed; but where used in the worst parts of the metropolis, it soon shows signs of distress, the tops of the branches dying off, and the whole tree sooner or later showing the fierce struggle it has to endure with smoke and fumes. As an avenue tree in the more airy and pure parts of a town, the lime has certainly few equals, its general contour and the pleasing shade it affords being points of special recommendation.

The **Sycamore** (*Acer Pseudo-platanus*).—This tree may be classed as amongst the most useful for planting in smoky towns.

In Warrington, where the noxious emanations from alkali and other chemical works are most disastrous in their effects on vegetation, the sycamore is one of the few trees that grow satisfactorily. Being a rapid and strong grower, it is thus seen to be, for a certain time at least, unaffected by its inimical surroundings. The variegated variety would seem from recent experiments, to be preferable and better adapted for smoky localities than the normal form.

The **Weeping Ash** (*Fraxinus excelsior pendula*) would seem to be superior to the common ash for planting in towns. It thrives satisfactorily in many of our largest centres of industry—to wit, London, Liverpool, Glasgow, and Manchester.

The **Horse Chestnut** (*Æsculus Hippocastanum*) may be seen in a fairly satisfactory way in many town parks, but only where it is not exposed to smoke and soot to any great extent. In confined spaces both it and the **English Elm** (*Ulmus campestris*) soon show signs of distress, the points of the branches gradually becoming unhealthy, and the trees ultimately dying off prematurely. Taking everything into consideration, neither of these trees can be recommended for planting in smoky districts. The **Birch**, **Walnut**, **Hornbeam**, and one or two kinds of **Willow** will succeed in the

less smoky parts of a town; but they are not to be recommended for planting where the air is constantly impregnated with soot and dust.

The **Mountain Ash**, or **Rowan Tree** (*Pyrus Aucuparia*) and **Bird Cherry** (*Cerasus Padus*) are both good town trees, and excellent examples of both may be seen in the back streets and slums of London.

Sophora japonica is well worthy of recommendation as a tree that is admirably suited for planting in towns. It is of large and rapid growth, with elegant dark green pinnate leaves. Being a native of China and Japan, it may not be perfectly hardy in the northern portions of the British Isles, but it succeeds well in Southern England, and thrives admirably in the most smoke-infested parts of London.

Thorns of various kinds succeed well in towns, but they must not be recommended for the most smoky and confined localities.

The **Tansy-leaved Thorn** (*Crataegus tanacetifolia*) is an excellent member of the family for town planting.

Shrubs.

Of these there is rather a long list of kinds that are suitable for planting in smoky localities.

Evidently deciduous species possess an advantage over evergreen kinds in the total annual renewal of their leaves, and hence it follows that, as with trees, deciduous shrubs should have the preference.

The following list includes only such kinds as have been proved suitable for town planting:

Osmanthus ilicifolius is one of the handsomest of evergreen shrubs, and also one of the few that succeed, in a satisfactory way, when subjected to the impurities of a town atmosphere. In the smokiest districts of both London and Liverpool it is unquestionably the best all-round shrub.

Ligustrum coriaceum is a fitting companion to the last, so far, at least, as its powers of withstanding the effects of an impure atmosphere are concerned. Being an evergreen, it is peculiarly well suited for planting in the town garden, where it grows with great freedom.

Aucuba japonica.—This well-known evergreen shrub is of great value for planting in urban districts, it being able to do battle with a more than ordinary amount of atmospheric impurities. For this reason it has been largely planted in town squares and gardens, in the most crowded and densely-populated parts.

Griselinia littoralis.—Although a little-known evergreen, this is well suited for town planting, experiments having proved it to be a most valuable addition to the limited number of shrubs suitable for such a place.

Hibiscus Syriacus is one of the few shrubs that can successfully battle with an impure atmosphere. It is a shrub which town residents should plant freely if they have a bit of ground that they want to look pretty.

The **Wayfaring Tree** (*Viburnum lantana*) does not receive that amount of attention which its merits entitle it to. It succeeds well in some of the most filthy and smoky districts of our largest cities.

The **Venetian Sumach** (*Rhus cotinus*) is a much-neglected shrub, but for general usefulness it can hardly be surpassed. It is peculiarly suitable for planting in cities.

The **Stag's Horn Sumach** (*Rhus typhina*) must, on no account, be omitted, as it is a plant of curious appearance and one that thrives well in soot and dirt.

Leycesteria formosa is a capital town plant; what may also be said of the **Flowering Currant** (*Ribes sanguineum*)—indeed, too much praise can hardly be bestowed on these shrubs for planting in the town garden and shrubbery.

Skirramia japonica and the **Snowy Mespilus** (*Amelanchier Botryapium*), too, succeed well in smoke-infested districts; and the various kinds of **Lilac**—particularly the Common and Persian—have few equals as town shrubs.

In the **Kentucky Coffee-Tree** (*Gymnocladus canadensis*), and **Bladder Senna** (*Colutea arborescens*) will be found two most useful shrubs for the town garden.

Phillyrea Vilmoriniana, **Forsythia viridissima**, and the **Strawberry Tree** (*Arbutus unedo*) are all more or less suitable for planting where the atmospheric conditions are not too affected by smoke and dust.

The **Double Furze** (*Ulex europæus flore pleno*) is one of our handsomest flowering-shrubs, and a good addition to such as are suitable for planting in town gardens and squares.

The **Spurge Laurel** (*Daphne laureola*) grows freely in many a town garden—indeed, it is no uncommon thing to see large and well-balanced specimens where smoke and filth are the order of the day.

Cotoneasters of various kinds succeed well as town plants, particular mention being made of *C. frigida*, *C. Simonsii*, and *C. vulgaris*.

Euonymus japonicus is another excellent shrub, being almost smoke-defying.

The double-flowered forms of *Prunus sinensis* and the equally ornamental *P. triloba* all succeed well as town plants; while the **Almonds** are quite as good.

Koelreuteria paniculata, the *Laurustinus* (*Viburnum tinus*), *Weigelia rosea*, *W. amabilis*, *Deutzia scabra*, the common *Green Box*, *Gum Cistus* (*C. ladaniferus*), *Mahonia aquifolia*, *M. Bealii*, and *M. japonica* are all more or less suitable for the town garden, but not for the most smoke-infested parts. The *Japan Quince* (*Cydonia japonica*), *Hypericum Nepalense*, and *Euonymus radicans* all do well when subjected to the town atmosphere.

Climbers.

Of shrubs suitable for covering walls, trellises, and arbors, and at the same time able to resist the dire influences of smoke and soot, there are a few valuable and well-tried kinds.

The **Virginian Creeper** (*Ampelopsis hederacea*) has few equals as a town plant, succeeding perfectly in the midst of our busiest centres of industry. Many instances could be pointed out where this handsome climber grows with the greatest freedom in the most impure and smoke-laden atmosphere, and when constantly in the foul air, heat, and dust.

The **Common Ivy** (*Hedera Helix*) is, perhaps, the most valuable of all climbing plants for using in smoke-infested localities. In some of the courts near Ludgate Hill, a district of London that is by no means free from smoke and

dust, the ivy climbs the houses to a height of 60 ft., and surprises one by its fresh appearance in such localities.

The **Evergreen, or Trumpet, Honeysuckle** (*Lonicera sempervirens*) is another shrub of great merit for town planting, as it thrives well in confined spaces, and where the atmosphere is very impure.

Cratægus Pyracantha is a most valuable wall shrub for the town garden. It is of free growth, stands smoke well, and is one of the handsomest berry-bearing plants in cultivation.

Jasminum nudiflorum needs little description, as it is one of our handsomest wall-plants. For smoky districts it is invaluable, blooming freely when flowers are scarce, and seeming to heed but little the impurities of a town atmosphere.

The **Vine** (*Vitis vinifera*) must not be omitted from our list, it being an excellent plant for withstanding soot, smoke, dust, and heat.

Coniferous Trees.

Few of these, if any, succeed in a satisfactory way, when constantly subjected to the impurities of a town atmosphere.

Where the conditions are at all favourable the **Austrian pine** (*Pinus austriaca*), **Thuiopsis Dolabrata**, **Toxodium distichum**, and **Cupressus Lawsonii** do fairly well, but they are not to be recommended for general town planting.

Retinospora plumosa aurea has stood for seven years in one of the most smoky districts of Glasgow, and at present looks almost as well as it did when brought from the country.

For convenience we have arranged the following list in an alphabetical manner, so that any one can see at once the kinds which are best suited for withstanding the deleterious effects of an impure atmosphere.

Town Trees.

Acer macrophyllum	Cerasus Padus
Acer Pseudo-platanus	Cratægus oxyacantha
Acer Pseudo-platanus variegata	Cratægus oxyacantha fl. pl.
Æsculus Hippocastanum	Cratægus tanacetifolia
Ailantus glandulosa	Fraxinus excelsior pendula
Alnus cordifolia	Gleditschia triacanthos
Betula alba	Ilex aquifolium
Carpinus betulus	Ilex Balearica
Catalpa bignonioides	Ilex Hodgsonii

PRACTICAL FORESTRY.

Town Trees—cont.

Juglans nigra
Juglans regia
Liriodendron tulipifera
Magnolia acuminata
Magnolia glauca
Morus alba
Morus nigra
Olea europæa
Populus canadensis
Populus fastigiata
Pyrus Aria
Pyrus Aucuparia
Pinus austriaca
Platanus orientalis
P. o. acerifolia

Populus alba
Quercus Ilex
Quercus Cerris
Retinospora plumosa aurea
Robinia Pseud-acacia
Robinia Pseud-acacia macrophylla
Robinia Pseud-acacia Decaisneana
Robinia viscosa
Salix fragilis
Salix purpurea
Sophora japonica
Taxodium distichum
Taxus baccata
Tilia europæa
Tilia argentea

Town Shrubs.

Amelanchier Botryapium
Ampelopsis virginica
Amygdalus nana
Arbutus Unedo
Aucuba japonica
Berberis aquifolia
Berberis vulgaris
Buxus Balearica
Buxus sempervirens
Cistus ladaniferus
Cistus laurifolius
Colutea arborescens
Cotoneaster frigida
Cotoneaster Simonsii
Cotoneaster thymifolia
Cotoneaster vulgaris
Cydonia japonica
Daphne laureola
Daphne mezereum
Daphne Pontica
Deutzia crenata
Deutzia gracilis
Euonymus japonicus
Forsythia suspensa
Forsythia viridissima
Griselinia littoralis
Gymnocladus canadensis

Hedera Helix
Hibiscus Syriacus
Hypericum calycinum
Hypericum Nepalense
Koeleria paniculata
Leycesteria formosa
Ligustrum coriaceum
Ligustrum ovalifolium
Osmanthus ilicifolius
Philadelphus Gordonianus
Philadelphus grandiflora
Phillyrea angustifolia
Phillyrea latifolia
Rhamnus frangula
Rhus cotinus
Ribes aureum
Ribes sanguineum
Ribes speciosum
Skimmia oblata
Syringa Josikœa
Syringa Persica
Syringa vulgaris
Ulex europæus, fl. pl.
Viburnum opulus
Weigelia rosea
Yucca gloriosa
Yucca recurva

CHAPTER XI.

PLANTING EXPOSED GROUND.

THERE are many difficulties to encounter in planting high-lying and exposed ground that one would never have to think about in low-lying and sheltered situations. Planting, for instance, should not be commenced until March, as, by so doing, the newly-inserted plants will be fresh and vigorous, and ready for an immediate start to growth, which would not be the case if they had been put out in autumn and subjected to the amount of twisting and shaking that is always the case on exposed ground.

The choice of trees, too, for planting on wind-swept ground is a matter of far more moment than is generally considered, for that there are certain species of trees peculiarly suitable for withstanding prolonged storms is well known to everyone who has had anything to do with the forming of woods and plantations at high altitudes. The size of trees planted has also much to do with the after-success of the woods, and it may be well at the outset to say that these should not exceed about 12 in. in height on the most favoured sites to about from 6 in. to 9 in. on the more exposed grounds. They should also be properly prepared by frequent careful transplanting for the situations they are intended to occupy, as it can hardly be expected that a young and immature tree can, after being brought from a probably sheltered lowland nursery—as nine-tenths of those in this country are—to a high piece of ground, where at times the wind blows with terrific fury, and where one can scarcely stand upright, have sufficient stamina to stand against such

odds and difference as must and do exist between the two points at present under consideration.

Sometimes it is well to trench over a piece of ground on partially-exposed land, and insert therein for a couple of years before the proposed plantation is to be formed, the young trees intended for planting out. This has a wonderful effect in hardening and inuring them to severe cold and a wind-swept situation. By forming a nursery of young trees by the sea-coast, I have known great success attend the formation of woods and plantations in maritime situations, and like results are sure to attend the planting out of trees in any uncongenial and unfavourable situation.

About the trees to be planted, and that are sufficiently hardy to withstand prolonged storms, we will now say a few words. In the outer line—or, rather lines—the Scotch, Austrian, and Corsican Pines (*Pinus sylvestris*, *P. austriaca*, and *P. laricio*) are of first value, they being able to stand against the storms of the hillside and produce a great amount of shelter to other less hardy kinds. It is often only necessary to make a wind-barrier, as it were—that is, plant well-tried evergreen kinds, from which shelter can be obtained, next the most windy position, then to follow up with other kinds that are second hardy in nature, and so on inwards; while, in the very centre of the plantation, almost any kind of tree can be used.

The Austrian Pine has been successfully planted at high altitudes, and in the most exposed situations, and on the Continent it has proved itself of great value for breezy sites and maritime situations.

The State forests are composed of not a few Austrian Pines, and they are greatly valued for the shelter and warmth they afford to other less hardy kinds of trees. If planted when young the best results are to be obtained, for, when removed of an older age, and the roots large and rampant of growth, it is with great difficulty that they can be got to keep upright.

The Corsican Pine is equally good with the latter for using where winds are of common occurrence, proving stout and strong, rooting well, and presenting a broad surface of

hardy evergreen foliage to the blast. It, too, is a good timber-producer, and, being well fitted for growing in patches close together, will yet be largely used for forest work in this country.

About the **Scotch Pine** it is, perhaps, needless to speak, for everyone who has travelled in Scotland, particularly the more exposed northern parts, must have made himself acquainted with the capabilities of this valuable native tree. It can grow and flourish almost anywhere—on pure gravel, on the rocky mountain-slope, or by the rushing brookside, and in all these positions it seems to feel quite happy and contented, as the beautiful silvery glaucous foliage, the upright, rampant growth, and the cheery cinnamon or terracotta bark clearly point out.

With these three excellent storm-resisting trees for an outer barrier almost any kind of planting can be engaged in, for the shelter they afford is amply sufficient to start away into rapid growth even our only second-class hardy kinds of trees. The **Sycamore** is an excellent tree for planting where the storms blow loud and long, it being able to withstand, and in a very commendable way, the first brunt of the hillside winds. It, too, is a good timber-producer the wood at all times being easily disposed of and at a very remunerative price.

The **Elder** and **Mountain Ash** are other valuable trees of small growth for planting on exposed ground, both flourishing apace even in very high and exposed woodlands.

In the **Scotch** or **Mountain Elm** (*Ulmus montana*) we have a first-class tree for planting as shelter, while the **Alder**, **Willows** of various kinds, and the **Hornbeam** should all receive attention in the formation of woodlands on exposed and storm-swept sites.

The **American Winged Elm** (*Ulmus alata*) has few equals for withstanding long-continued storms at high altitudes, for it sends out its cork-covered branches without fear of harm into the very teeth of the blast. I have noticed how well suited this elm is for planting on exposed, high-lying ground by the few examples that occur at considerable elevations in some of the screen-belts that have been

formed on the flanks of the Snowdon range of hills, and where the tree looks quite as healthy and happy as at lower elevations in a sheltered park.

The **Larch**, be it remembered, is a good tree for planting on exposed ground, for, though it gets twisted about and untidy of appearance, it has a wonderful recuperative nature, and will succeed well even when planted on the margins of exposed woodlands. By taking advantage of natural tree or shrub growth when forming plantations at high altitudes much good may be brought about. A young tree planted to the windward of a clump of gorse, broom, juniper, or birch has a much better chance of succeeding than another planted where it has no shelter from the worst winds of the particular district. These wild clumps of natural shrubs should be encouraged in every way, for they will not only give a great amount of shelter, but help to thicken up the plantations as well. In exposed woodlands it is a good plan to plant up the margins with such hardy wild shrubs as the gorse, broom, Quick, juniper, blackthorn, etc., all of which will afford a great amount of shelter to the young plants when newly inserted, and help them to start away freely.

The **Common Beech** is a good all-round tree for planting in exposed sites, but especially where the soil is poor, or, in other words, composed principally of chalk or gravel. Some of the highest grounds in several of the English counties are occupied by thriving beech plantations, they acting as landmarks for many miles around.

Both the **Huntingdon** and **Cornish Elms** are even preferable to the common English species for planting as shelter, they having been tried at high altitudes, and with a fair amount of success.

The **Oak** and **Ash** should both find places in high-lying and exposed woodlands, for, although they cannot be planted successfully along the margins, yet they thrive well where a little shelter is afforded, and where the soil is fairly deep and rich.

The **Birch** cannot be passed by in any list of trees for planting in exposed places; it thrives well at high altitudes,

and where but a small quantity of soil overlies the rock.

The **Wild and Bird Cherries** (*Cerasus vulgaris* and *C. Padus*) are excellent ornamental trees for exposed grounds, where they grow to a large size and flower freely. They can both subsist where but a small depth of soil is present.

About the pits for planting, they should be well prepared—that is, the soil loosened up and made free for the roots to run in, which will greatly help the trees to become quickly established—a point of great importance on exposed ground. The top turf may be chopped up and placed in the bottom of the pit, this serving, when decomposed, as manure to the roots, and assisting to promote vigorous growth. In planting place the best-rooted sides of the trees to the windward or most exposed site, and do not cover with the soil to a greater depth than what the plant stood whilst in the nursery border. On very exposed sites, and where the soil is thin, notch planting and inserting with the planting iron are to be recommended.

It will be well, at stated intervals, to examine young plantations formed on high-lying and exposed ground, to see that the plants do not get shaken about with the wind and holes formed around the stems. This latter is highly injurious to the welfare of the plants, the air passing down the stem side causing the roots to get dry to an inordinate degree.

Wind-swaying, where these holes have been formed around the stem, is also hurtful, as the tender roots get strained and barked, and ill fitted for maintaining a healthy condition of the young trees. The holes formed by swaying of the stems should be filled up with fine soil—not stones, as is sometimes the case—and a small piece of stiff, grassy turf tramped firmly against the stem on the side opposite that from which the worst winds may be expected.

Should rank vegetation, which is, however, rarely the case at high altitudes and on exposed ground, interfere with the growth of the young trees, it would be well to have such cut over and either burned or spread evenly over the ground

CHAPTER XII.

THE FORMATION AND MANAGEMENT OF GAME COVERTS.

WHEN we consider that on not a few estates in this country the value of the plantations as game coverts is well nigh of as much importance as that of the timber produced, it will be readily seen that the successful formation and management of these is a matter of no small moment to those entrusted with the work. As to whether game-rearing and forestry can be advantageously carried on in the same woods is, however, a question we by no means feel inclined to uphold, and from which, being apart from the subject-matter of the chapter, we will for the present stand aloof.

Game coverts may be divided into two kinds, natural and artificial—natural when the woods are kept sufficiently thin to admit of the free growth of bramble, bracken, or other rough vegetation; and artificial when the planting of such shrubs as are suitable for underwood is resorted to.

Natural game coverts, which, by most sportsmen, are considered superior to those artificially formed, can only exist where the plantations are kept well and regularly thinned, so as to admit abundance of both light and air—the two principal requisites for the successful growth of natural underwood. Generally speaking, the formation of natural coverts has seldom to be helped, although occasionally in such coverts we have found it necessary to assist Nature by the sowing of such seeds as those of gorse, broom, etc., in the thinner and more open portions of the woodlands. This may, however, be considered an exception to the rule, as

where the woods are kept sufficiently thin, spontaneous undergrowth is usually pretty abundant, and requires neither care nor management, beyond preventing its too free incursions along the margins of roads and shooting drives. Where, however, bare patches do occur, the sowing of seed may be relied upon as not only a speedy but most effectual method of increasing the cover. Where seeds are intended to be sown, the soil should be thoroughly prepared by a slight picking, after which it may be dug over, and all hard clods or lumps broken down, and the whole made smooth and fine with a rake. The seeds may be sown in spring, and afterwards covered over with hardwood branches as a preservative against the depredations of small birds and game.

The best natural game coverts are those composed of bramble, gorse, heath, hazel, blackthorn, elder, blaeberry bracken, or the stronger growing grasses, these being arranged according to merit, and each possessing some peculiar feature, specially recommending it for planting in certain soils, altitudes. or situations.

In the formation of artificial game-coverts, when not only shelter and protection for game are required, but ornamental effect as well, the judicious grouping of the different shrubs should never be lost sight of, more especially when the coverts are within the park or policy grounds, and visible from drives and roads. Formality and stiffness are so often the characteristics of the present style of shrub planting, that in many cases our woodlands seem utterly destitute of that variety of outline and contrast of light and shade so essential to picturesque beauty. In planting evergreen shrubs for the two-fold purpose of covert and ornament, the best method is to plant each variety in separate groups or clumps. No hard and fast lines can be laid down as to the distribution or number of plants to be used in the clumps, which, to a great extent, must depend on the size and shape of the ground as well as taste of the operator. They should, however, be placed at irregular distances apart, be irregular in size and outline, and with from a dozen to forty or fifty plants in each—bearing in mind that game of all kinds delight in small patches of shrubs with abundance of open

space around each, but detest, in a most marked manner, continuous masses or jungles of underwood.

In selecting sites for the various groups, be careful to choose the most open positions, avoiding as much as possible planting immediately under the spread of trees; and, if practicable, so arrange that in viewing the wood from any point the eye may not pass along a straight bare unplanted space, but become arrested by the various clumps in passing to the farther side.

Having arranged the positions of the various clumps, the pits should be opened of a size, and at a distance apart suitable for the plants intended to be used, taking care that they are sufficiently large to avoid cramping or bending of the roots, which in all cases should be spread out to their full extent. In making the pits, it is well to thoroughly loosen the soil in the bottom and sides with a pick, so as to give the tender rootlets a free course when starting into growth in spring. Should the soil be found of inferior quality, a few loads of leaf mould, road-scrapings, or loam from an adjoining field will be found to work wonders in the way, of giving the plants a start, and also by producing a strong, healthy growth. Drainage should also have been attended to previous to opening the pits, and all stagnant water or superfluous moisture removed by the formation of open drains.

In giving a list of the best evergreen shrubs for covert purposes, I would call attention particularly to the merits of laurel, box, privet, laurustinus, holly, and yew, as these have been very extensively used for underwood, and with the best possible results. As to which of the above shrubs should receive pre-eminence as an ornamental covert plant I cannot decide, each having some peculiar merit rendering it valuable in its own particular place. We will for the present, however, consider all alike in this respect, and briefly describe the value of each separately, beginning with the laurel.

The **Common** and **Colchic** laurels are amongst our best shrubs for underwood, and should be planted extensively; they are of free growth, bear cutting and pruning well, and

thrive under the shade and drip of other trees. For covert planting the Colchic is perhaps preferable to the normal form, as it is of a more dense and procumbent habit, perfectly hardy, and less liable to injury from hares and rabbits. The common laurel requires frequent and heavy pruning to keep it in bounds, as, if allowed to ramble at will, it soon becomes bare near the ground, and useless either as game covert or ornament. Five years ago we layered a great number of this plant that had through neglect become useless for the purpose intended, many being from 12 feet to over 20 feet in height, and with simply a tuft of foliage near the top. In layering, we sawed the stems half through near the ground, to assist in bending, and laid the plants flat on their sides, a couple of stout pegs being driven alongside, the crooked heads of which served to keep the plants in their procumbent position. A spadeful of soil was then placed on the top of each peg to assist the layer in rooting. The result at the present time is everything that could be desired, each stem having thrown up quantities of young shoots, and thus formed a jungle of underwood, which year by year will increase in value.

In planting the laurel for covert avoid overcrowding, as, being of quick growth, the plants, even although placed at a considerable distance apart, soon unite and form a continuous undergrowth. No rule can be laid down as to the distance which should be allowed between individual plants, this depending entirely on their size, as well as quality of the soil in which they are to be planted. We not unfrequently plant double thick, either for immediate effect, or to produce covert at once, and when the plants begin to encroach on each other every alternate one is removed, thus giving the remaining plants ample room for developing side branches and thereby inducing a dwarf-spreading habit. Having a tendency, especially when confined, to increase more in height than width, the laurel, after a few years growth, should have all the leading and straggling upper branches cut over, which will not only increase the under shoots but prevent the plants running up into tall, branchless poles.

The **Green Tree-Box** (*Buxus sempervirens*) forms a very pretty as well as desirable covert plant, and thrives well beneath the shade of deciduous trees. It is also of slow, dense growth, and well adapted for planting in various soils and situations, although preferring a light loam and shady position. Another recommendation is its immunity from the attacks of game, hares and rabbits having such an aversion to this plant that even during the most severe weather I cannot remember having seen it badly injured. Few plants suffer more from overcrowding than the box, and for this reason it should be planted at wide distances apart, the plants soon getting top-heavy and falling over of their own accord. Where the plants are not of large size, and immediate effect or covert is required, they may be planted pretty close and in a few years, when encroaching on each other, every alternate one may be removed. It is well adapted for transplanting, the almost solid mass of matted roots holding the ball of earth firmly together, thus rendering the plant one of our easiest as well as safest to remove.

The box would seem at one time to have been more abundant in our own land than it now is; thus, Boxley in Kent, Boxwell, in Gloucestershire, and Boxhill in Surrey, were named from the quantity of this plant which was formerly found in their neighbourhoods.

Privet, as a covert plant, has its advantages and disadvantages. On the one hand it is cheap, easily grown, and not at all fastidious about soil. When planted amongst trees it, however, generally assumes a loose, straggling habit, and as the shade increases it usually dies out altogether. Where the plantations are well-thinned and kept regularly so, privet, if a little care and trouble be expended on its cultivation, will succeed and form capital underwood. In planting privet the greatest care is necessary to prevent its being overdone. Close planting is always productive of the most unsatisfactory results, not only as regards the health of the plants, but management of the woods as well. Instead of filling up the whole ground, as is not unfrequently done, plant in small clumps, and these at wide distances apart, which will not only allow the privet to grow more healthy

and compact, but also admit of space for pruning and layering—two necessities for the successful cultivation of privet as underwood.

The layering of privet, which is a simple though effectual and inexpensive method of increase, is performed as follows:—cut off all the branches, except those intended for layering, these being laid flat on the ground equidistant around the main stem or root and kept fast by hooked pegs driven firmly down. A spadeful or two of soil should then be placed on the top of each peg, which will partly exclude air and hasten the formation of roots. The pegs may be made of any refuse branches—hard wood, such as ash or oak, being preferable—about 10 inches in length, one end being hooked for holding the branches in position, and the other sharply pointed for ease in driving. As several forms of privet have crept into circulation of late, it is well to be sure that none unless the true evergreen be used in the formation of game coverts. The oval-leaved privet, though a most desirable evergreen plant and well suited for ornamental hedges, is from its too luxuriant growth and upright form hardly to be commended for underwood; at least, its merits in this respect are inferior to those of the common form.

Aucuba Japonica and the *Laurestine* are two of our handsomest evergreen shrubs, but, unlike those already described, they will not succeed in the densest shade. In open places or along woodland drives they thrive well, and are excellent for variety and contrast. The *laurustinus* cannot, however, be considered as perfectly hardy in this country, for even in maritime situations where the air is to some extent ameliorated, it suffers severely from frost, and it is even, during severe winters, killed completely to the ground. It, however, springs very freely from the root, and in a few years quite regains its original size and luxuriance. From their bushy, well-furnished habit of growth both the above plants are excellent as game covert, more especially around the outskirts of woods and plantations. They should be allowed plenty of room for development of both root and branch, though they may, when necessary, be pruned with the greatest advantage.

Mahonia aquifolia and **Berberis Darwinii** are frequently recommended as covert plants and for using in similar situations with the laurel and box. Along the margins of plantations or in very open places they may and do succeed. but from practical experience of these plants we find them next to useless as underwood in shady positions. Where many thousands of covert plants are used annually, we have entirely discarded them from use unless in the most open situations. These plants are highly ornamental, both in foliage and flower, produce berries which are much sought after by game, are quite hardy, and not at all fastidious about soil—qualities which specially recommend them for extensive use in positions at all suited for their growth.

The barberry, more especially when planted out in rich soil, and when at all confined, is apt to lose the compact, branchy nature so recognisable a feature of the plant when allowed ample room in the nursery border, and to assume a more upright habit of growth, which is anything but desirable in underwood generally. To check this and keep the plant in bounds, frequent light prunings will have to be resorted to, and this had best be effected during dull, damp weather, as the barberry is not a good subject for the pruning shears. Neither the barberry nor mahonia are adapted for planting in very high or exposed situations—at least, where such has been tried the results have been anything but satisfactory, the plants soon presenting a miserable, half-starved appearance.

Both plants are readily propagated—the mahonia, when planted in loose soil and an open situation, soon covering a considerable space of ground, the running roots being especially active under such circumstances.

Rhododendron ponticum, although useful in an ornamental point of view, cannot be considered a first-class plant for game shelter. It has, however, several good qualities which recommend it for underwood, such as ease of culture, dwarf-spreading habit, and immunity from the attacks of game—indeed, in this latter respect, it is not equalled by any other plant, if we except one or two species of *Daphne*. It is seldom resorted to by pheasants, the bottom being not only damp, but such a tangled mass of branches that it is any-

thing but pleasant quarters for game. For ornamental effect along the outskirts of plantations, the rhododendron is invaluable, and is by no means so fastidious about soil as is generally supposed, peat being not at all an essential to its growth and successful cultivation. Few plants can be made to increase in like proportion with the rhododendron, and for this reason it should be planted in small patches; and when it is desirable to increase the cover, the outer branches may be pegged down or layered. This plant also bears pruning with impunity, so that old plants that have, through neglect, become lank and straggling, may without fear or risk be layered or pruned in with advantage.

The **Common Yew** and **Holly** cannot be too extensively used in the formation of game coverts, both being unrivalled for beauty and hardiness. They thrive in a great variety of soils, and beneath the densest shade of our woodland trees. In planting the yew it is well, however, to bear in mind that it is highly deleterious to stock that may browse upon its branches, and for this reason should never be planted along the outskirts of a wood, or in any position to which they have access.

The **St. John's Wort**, as a low-spreading shrub, is unsurpassed, and thrives best in a light sandy or peaty soil. It is readily propagated by division of the roots; and when planted out in small patches a foot or two apart, the creeping stems soon cover a considerable surface of ground, and form a dense evergreen mass, covered in summer with bright golden flowers.

Gaultheria Shallon, another plant of creeping habit, is, notwithstanding its many good qualities, seldom planted to any extent in our woodlands; but this may, to some extent at least, be accounted for by the high price of the plants, as well as the small size of those purchaseable from our nurserymen. Like most other North American plants, the *Gaultheria* prefers a rather damp, peaty soil, and is one of the few shrubs found to thrive in pine plantations. The berries, which are borne in great abundance, are greedily devoured by pheasants, and in their native country are not unfrequently used as food.

The **Butcher's Broom** is a fine glaucous green shrub, densely covered with sharp, prickly leaves, and invaluable for planting in shady places—indeed, in such positions it seems to be quite at home. There it flowers and fruits freely beneath half-standard rhododendrons where few other plants could exist, far less succeed. The twigs of this shrub were formerly used by butchers for sweeping their blocks ; hence the English name.

Some of the above plants, notably the **St. John's Wort** and **Gaultheria**, may be considered as carpet plants, which, in contradistinction to general underwood, may be classed as evergreens, which, from their low, procumbent mode of growth, are scarcely in the true sense of the word suited for game coverts. To clearly define the difference would, however, be no easy matter, and, even were it possible to do so, would in the end be productive of but little good, as the habits of different plants vary so much that what is used in one place for carpeting purposes might in another and more favourable situation be equally valuable for game covert. A good example of this will be found in the **St. John's Wort**, which, when planted out and allowed to ramble at will amongst bramble, privet, etc., forms a capital covert ; whereas, when used in open, airy situations—such as alongside shrubbery walks—soon forms a dense evergreen carpet, of so compact a growth as to be almost impenetrable even to ground game.

In addition to the above-named plants, the following are well adapted for giving shelter to game :—**Dogwood**, **Hazel Elder**, **Arbutus**, **Cotoneaster** of sorts, **Juniper** of sorts, *Pernettya mucronata*, *Rubus nutkanus*, *Taxus adpressa*, *Photinia serrulata*, *Kalmia latifolia*, *Garrya elliptica*, etc. These should be planted out in small groups—the more valuable kinds in the most conspicuous position, such as alongside or within view of woodland drives and shooting-roads.

Protection from Rabbits, etc.—It may seem somewhat absurd to speak of planting coverts, and then to protect them from the depredations of game ; but that this is highly necessary for the first two years, at least, is well known to all planters. Few of the shrubs treated of in this paper are

exempt from the attacks of hares and rabbits, more especially when in a young state and newly transferred from the nursery; and for this reason it is always found necessary to protect them in some way or other until fairly started into growth and beyond the reach of game. For this purpose wire netting is the cheapest and most effectual preservative with which I am acquainted. The netting should be about 4 feet in height, not more than $1\frac{1}{2}$ inch mesh, and inserted in the ground 4 inches, to prevent rabbits from working underneath. It may be fixed to posts driven firmly into the ground at a distance of 5 feet apart along the line of fence. This precaution against the depredations of game may not be necessary for all the clumps, but it is especially so for those of laurustinus, barberry, and laurel.

For the first two or three years after planting, the shrubs should be kept free of grass and weeds, which will encourage the plants to start into growth quicker and thrive much better than they can do if the ground is impoverished and light and air excluded by weeds.

CHAPTER XIII.

TREES SUITABLE FOR HEDGEROW AND FIELD PLANTING.

IN proceeding to consider the trees that are most suitable for hedgerow and field planting four important points should always be kept in view. (1) That the spread of branches is, comparatively speaking, small in proportion to the tree's height; (2) that the roots have a downward tendency, or do not ramify to too great an extent; (3) that the tree is well adapted for exposed situations and standing singly; and (4) that the timber value is such as to compensate in some degree for the cost of planting and after-management in the way of pruning, fencing, etc. Although but rarely do we find all these good qualities concentrated in one tree, still, with careful choice and good after-management, much may be done to produce the desired effect, even in trees of a partially opposite character.

That the wrong class of timber has been, and is even yet, too often planted in our hedgerows is painfully apparent to everyone who has paid attention to the subject—trees of wide-spreading habit in both root and branch occupying positions and doing irreparable damage, where, with proper selection, others of an unobtrusive nature could with advantage have taken their place. Timely and judicious pruning is of the utmost importance in the production of hedgerow timber: but to be productive of the best results, the work must be attended to early, and prosecuted at intervals, as by skilfully shortening the branches from time to time, the spread of root is likewise, to a great extent, prevented, thereby securing, as it were, a double benefit to the farmer.

Now, as to the most suitable trees for field and hedgerow planting, nothing in our opinion approaches the **Cornish Elm** (*Ulmus cornubiense*), a tree that, unfortunately, is far too seldom seen either as a standard or in our woodlands, and for which the propagator is greatly to blame, it not being offered in anything like sufficient quantity for the demand. As a park or fence tree this distinct and well-marked variety of the elm has much to recommend it—such as a narrow branch spread in proportion to the tree's height, suitability for exposed situations, and the very decided ornamental character it imparts to the landscape when properly placed.

The principal advantages of this tree for hedgerow or field planting are that no pruning is required to keep the branches in bounds, that the spread of branches is very small in proportion to the tree's height, that the roots do not approach too near the surface, or ramify to a great extent, so as to become injurious to crops in their immediate vicinity.

The **English Elm** (*Ulmus campestris*) is another tree of value for hedgerow planting, and is, perhaps, more commonly used for that purpose than any other. Like the Cornish variety, though in a very much less degree, it has an upward inclination, the ramification of its branches being narrow in proportion to its height, while as an ornamental tree and valuable timber producer it is held in high esteem.

As a shelter tree it is of great value, and as the branches, particularly the lower, seldom spread to a great extent, the injury caused to the adjoining crop is usually not very serious.

The **British Oak** (*Quercus Robur*) is of about equal value with the elm for hedgerow planting—indeed, by careful manipulation it is even superior to that tree, being, perhaps, less injurious to the herbage beneath it, while the roots have a greater downward tendency than those of the elm. As an ornamental tree and valuable timber-producer the oak requires no praise from us, these qualities having been well set off from the earliest date.

It bears pruning with impunity, so that all ungainly or far-spreading branches can be cut back or foreshortened at

pleasure ; while those near the ground, and that in any way interfere with the fence or crop, can, by judicious management, be altogether removed. Several of the fastigate forms of the oak are equally, if not better, suited for hedgerow planting.

The **Lombardy Poplar** (*Populus fastigiata*).—Although of but little value as a timber-producer, yet, as an ornamental tree of singular habit and appearance, the Lombardy poplar is almost unique amongst our hardy deciduous trees.

When planted in judiciously-arranged clumps in the corners of fields, or hedgerows, this poplar produces a most pleasing effect in the landscape : and, being of close, fastigate growth, is not in the least injurious to crops in its immediate vicinity. No tree is, however, more readily misplaced than the one in question ; and in planting it is well to avoid the prevalent mistake of placing in lines, squares, round or oval forms, or even in single specimens, these methods being highly objectionable and devoid of good taste—that is, if we desire to preserve in the landscape a natural appearance.

The **Sycamore** (*Acer Pseudo-platanus*), as a standard tree, either in field or fence, is worthy of attention, not only for its well-known ornamental character, but great value of wood produced, in this latter respect being, perhaps, second to none. As a farmer's tree it is, also, not one of the worst ; for, although the branches incline to spread, still, by careful manipulation in the way of pruning, this may be corrected without doing injury to too great an extent to the ornamental qualities of the tree. For imparting both shade and shelter to farm stock the sycamore may be used with the best advantage. Few trees produce such valuable timber when grown singly or in clumps in the corners of fields and paddocks as the sycamore, and no other repays so fully the damage it occasions to fences and the surrounding ground.

The **Hornbeam** (*Carpinus betulus*), for exposed situations and poor soils, has few, if any, equals. The roots do not run near the surface, but, like those of the oak, derive sustenance at a considerable distance from the surface, which, combined with its somewhat upright inclination of growth

and hardy nature, renders it well adapted for hedgerow or field planting, where shelter, combined with effect, are required.

The **Lime** (*Tilia Europæa*), although one of our most ornamental trees, can hardly be recommended as suitable for situations in which the underlying herbage is at stake. For this latter reason alone, however, can it be omitted from our list, and, as it bears pruning well, and does not to any great extent impoverish the adjoining ground, and is at all times a pleasing object in the landscape, it will be seen that the evil done by shade is, in a great degree, compensated for.

Amongst coniferous trees, if we except the **Larch** and **Scotch Fir**, few are at all suitable for the end in question. The larch is a much-neglected fence and park tree, this being attributable to an erroneous impression that it is of too stiff and cold an appearance, either for standing singly or giving effect to the landscape. Nothing can, however, be farther from the facts, as, when placed so that its fine form is seen to advantage, few deciduous trees are more picturesque than the larch, or offer a better contrast to the ordinary run of our forest trees. It also occasions less damage to the undergrowing herbage than most trees, while, at the same time, it enriches the soil to a great extent by the annual shedding of its leaves.

The **Scotch Fir**, especially for shelter-giving purposes, has much to recommend it for being extensively planted as stock-shelter in the corners of exposed fields.

As it usually rises to a great height without branches, it cannot be considered as extremely injurious to its surroundings, although the shallow-running roots can hardly be spoken of as non-injurious to the greensward.

Planting and Fencing.—Whether for planting in the hedgerow or singly in the fields, good, strong, well-rooted specimens should always be used—indeed, it is well when a home nursery is on the estate to have these specially prepared, by frequent transplantings for a few years previous to their final planting out. The nursery management will require both care and experience, so that trees with strong, fibrous roots equally distributed around the stem may be produced

lanky, ill-grown, and ill-rooted plants having but a poor chance of succeeding under the circumstances. From 8 ft. to 10 ft. will be found the most suitable size for the purpose under consideration. The pits for their reception should be opened of sufficient size to admit the roots without cramping or bending, the bottom and sides being made loose and free with a pick—all the better if the pits have been opened for some time previous to planting, the winter frosts having a beneficial effect in clearing and pulverising the soil.

This is, however, seldom convenient, as, if in the field, they become filled in, and trampled on by cattle, while gaps in the fences occasioned by these cannot well remain open for any length of time.

The better plan—at least, we have found it so—is to open the pits, plant the trees, and have these fenced in on the same day, as by this method no part of the work has ever to be done a second time everything being finished up as the work proceeds. In planting, be careful to spread the roots out in an even manner around the stem, as, by so doing, the tree is not only more firmly fixed in the ground, but is enabled to collect food from all quarters.

Fencing should follow up at once the work of planting, as, if the young trees are allowed to remain unprotected for any length of time, they get badly injured by the farm stock. The fences may be of any desired kind, but, as they are only required for a few years, a simple erection made of small larch poles about 8 ft. long, driven firmly into the ground in a circle around it, say, 18 in. from the stem, and made fast to hoops of wood at top, and halfway up, will be found to be sufficient. Wooden erections are, perhaps, preferable to those made of iron for fencing hedgerow trees, as they seldom require renewing, for by the time the fence has decayed the trees will, in most cases, be out of harm's way.

Pruning and After-Management.—For at least the first ten years after planting, careful and regular pruning of hedgerow and field timber should in all cases be attended to, bearing in mind that timely attention in this way will alone obviate the necessity for heavy prunings at any future stage of the tree's growth.

Early and judicious pruning is necessary to the trees in question; for it is well known that if branches are allowed to ramify at will, greater injury to the underlying herbage must be committed than where timely pruning and shortening of all straggling branches has been attended to.

Early summer pruning, say, in the month of June, is to be recommended, as at that time, owing to the active circulation of the sap, the wounds heal up much quicker than when the operation is performed at any other season of the year. The pruning should be performed by a person who is thoroughly conversant with the work, haphazard cutting and hewing, by an inexperienced hand, and at any season, being most injurious. If the young trees have been well cared for whilst in the nursery border, little or no attention will afterwards be required—at least for a number of years.

The main object in pruning both hedgerow and field trees is to develop a valuable main stem which is only to diverge into branches at a given height from the ground, and to prevent the overgrowth of straggling branches farther up, so as to maintain a symmetrical and rather fastigate head.

CHAPTER XIV.

THE MANAGEMENT OF COPPICE WOOD.

ALTHOUGH coppice wood has deteriorated considerably in value during the past few years, yet in certain districts and on suitable soils growing it at the present day is, commercially, almost as profitable as timber. Unfortunately, however, the uses to which coppice wood are in the main applied are much localised, and which, with the bulky nature of the commodity, will to a very considerable extent restrict its sale to the localities in which it is used. Thus in Kent and Sussex hop poles find a ready market, pea and bean stakes in the gardening districts around London, crate wood in the neighbourhood of potteries, willow and ash in basket-making localities, and faggot wood wherever kilns abound, or in the environs of populous districts generally. It will, therefore, be seen that next to the question of soil the most important is that of local demand, so that in forming a coppice plantation only such underwood should be used as there is a demand for in the particular district. Coppice wood may either be grown alone or in company with large standard trees, but the latter must at all times be kept sufficiently thin, so as not to overshadow and kill out the undergrowth. There are advantages, too, in the employing of standards in the protection they afford to the young shoots in spring, as also in the amount realised for the periodical thinnings to which they may be subjected. For this purpose the oak is to be recommended, but such wide-spreading trees as the ash, elm, and beech, which produce so dense a shade as to kill out all vegetation

that might spring up beneath them, are to be avoided. Generally where the health and vigour of the coppice wood are points of first consideration, it will not be advisable to allow the standard trees to occupy altogether more than about one-fifth of the wooded area; and even then the lower branches should be pruned off, so that the effects of shade will be mitigated as much as possible. As to the woods which coppice most freely, the ash, Spanish chestnut, oak, and hazel occupy the first rank, at least in a profitable sense, the elm, willow, beech, birch, hornbeam, alder, and sycamore occupying a second, but, as before stated, the nature of the soil, and less so the altitude and exposure, have everything to do with the particular species that will succeed best. Thus ash will do well where the soil is moist and loamy, the Spanish chestnut in sandy or gravelly districts, for rich plains and hollows the oak will be most remunerative, the alder and willow in marshy ground, and where bare and exposed, the birch, hazel, beech, and hornbeam will succeed best.

The preparation of the land and planting for coppice are similar in all respects to that adopted for the growing of an ordinary timber crop. Where the ground is too wet, draining should be judiciously engaged in, while trenching, although expensive at first, is amply compensated for in the increased growth and vigour of the underwood. The pits for planting may be made from $3\frac{1}{2}$ feet to 4 feet apart, and, if the ground was previously trenched, of sufficient size to hold the roots without undue cramping. It is always well to keep the stools tolerably close together, as the shoots take a more erect habit and are straighter and more valuable than when allowed too much space and side room. Two years after being planted, or at the end of the second autumn, the young trees, excepting such as it may be thought advisable to leave as standards, should be cut over near ground level. This cutting is a most important operation, and should only be practised by skilled workmen, with tools of the best description and well sharpened. The cut should be clean and directed upwards, all splitting of the stems and tearing of the bark being assiduously guarded

against as conducive to decay and early death of the stools. After four years' growth the shoots should be thinned out, leaving, say, four on each stool, and these preferably the strongest, the work being carried out at any time from November to the end of March, but not during frost. Upon the kind of wood grown and uses for which it is designed will depend very much the length of rotation pursued, for while Osiers might profitably be cut at the end of the second year, ash, oak, and chestnut would not usually, even on the best quality of soil, be felled sooner than from ten to twelve years, and the poorer classes of coppice wood, especially on light soil, at from twelve to sixteen years. It should be remembered, however, that the duration of the stool is usually proportionate to the length of the rotation adopted, and with good management on fair soil the best class of coppice wood has a duration of nearly a century. In felling the coppice wood it is always advisable to cut as near the ground level as possible, the shoots sent up having the advantage of rooting in the ground and so extending the area of the stool, the system of allowing the stools, by careless cutting, to rise in some instances several feet from the ground being averse to the best management. A sharp billhook should be used for all smaller shoots, a light well-ground axe for those from 3 to say 6 inches in diameter, and the cross-cut saw for all over that size.

The coppice wood is usually sorted out after being cut down, the best poles being laid aside for the use of the hop grower, the next size for pit props or fencing as the demand may be, and so on until every pole has been arranged according to what it may be intended for, the lop and branches being bound into faggots for fire or oven-lighting. Great care is necessary to avoid damage to the stools when removing the fall, which is not usually done until just before the young buds are shooting out, and consequently at the time when injury is most easily brought about. The trampling of horses and passage of wheels are most injurious while the browsing of cattle should be carefully guarded against. Good roads are always a great advantage in a coppice plantation, and to these as much of the produce as

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possible should be carried for loading, thus avoiding damage to the stools.

Although the growth of coppice wood has its disadvantages particularly in park scenery, yet it is valuable in this way that should the crop, from local circumstances, not be found remunerative, the plantation can at any time be converted into a standing wood by allowing the best and strongest shoots from the stools to form the permanent crop.

No 2 coppice Woods on estate -
in 1915-16 underwood - Is it more profitable
To form permanent Woods -

Domes wood plant Douglas Fir etc
sheltered spots also Thuja plicata
Corsican Pine & noble Timber -

Austrian good on chalk -
Thuja plicata good on chalk -

<u>Chalk</u> -	<u>Thuja plicata</u>	gravel
	Corsican	Douglas
	Deodar	Scotch
	Larch	Corsican
	Sycamore	clay
	ash	Thuja
		Deodar

CHAPTER XV.

ORNAMENTAL PLANTING.

IN ornamental planting one of the principal things to bear in mind is to allow sufficient space for each of the permanent standards to develop its true and natural character. Instead, therefore, of planting indiscriminately and in a haphazard way, as, unfortunately, is so often done, have a fixed idea, and only plant on a regular and well-matured plan. Should the individual standards be considered stiff or unsightly for the first few years, a good plan is to fill up between with small-growing trees and shrubs, these for removal as necessity demands, but always before damage to the permanent specimens, by too close contact, has been brought about. The habit of the tree and the size to which it will ultimately attain are points that should never be lost sight of in ornamental planting. Far too often the mistake is made of planting specimen trees near roads and buildings, or, quite as bad, too closely to each other. This is a most unfortunate mistake, as it sooner or later necessitates the sacrifice of specimens when their full beauty is probably developed.

In the case of both hardwooded and coniferous, the latter in particular, the trees are planted when young and small, and ample room is supposed to be given to them; but, as they grow up and near perfect development, the spread of branches soon points out that a great mistake had been made in the space of ground allotted, and that the ultimate size to which the particular specimen would attain had never, at the time of planting, been duly considered. There is little

left then to be done but either to put up with crowding and ill-formed specimens, or to attempt their removal to more suitable quarters. The latter, in the case of trees that have been left undisturbed for many years, and when tap and side roots have been sent down to a great depth for safe anchorage, is quite out of the question, the only remaining way out of the evil being to sacrifice the specimen by having it stubbed out and removed. In any case, in the event of one tree encroaching too closely on another, no time should be lost in deciding which is to be removed, for, if they crowd into and interfere with each other, the branches on that side will get thin and die off, and the plant will thus lose the uniformity of appearance on which its whole beauty depends. Should crowding of specimen trees be permitted for even a few years, partial disfiguration of the trees will have been brought about, and it will take years of careful management to restore them to their original beauty.

In order to plant with any degree of certainty as to future results, it is absolutely necessary to become first of all well acquainted with the nature and habit of every tree planted, as also the properties and peculiarities of the various soils, and aspect and position of the ground to be planted.

Probably no other branch of forestry requires sound judgment and correct ideas to such an extent as the laying-out of parks and grounds, or, in other words, landscape and ornamental planting—and this knowledge can only be attained by perseverance, investigation, and study.

In selecting sites for the various trees, it will be well to bear in mind that certain species are better suited than others for planting in exposed places, for using in particular soils, and for inserting in either dry or damp ground.

By the lake or pond side the **Deciduous Cypress** (*Taxodium distichum*), the **Bhoton Pine** (*Pinus excelsa*), the beautiful cut-leaved **Imperial Alder** (*Alnus glutinosa imperialis*), the **Golden and Purple Willows** may all be planted with the best chances of success; whereas none of these would thrive well on dry or sandy soils. Should chalk or calcareous soil crop up, we have good subjects in the **Fern-leaved Beech** (*Fagus sylvatica asplenifolia*), the **Cephalonian**

and **Spanish Silver Firs** (*Abies cephalonica* and *A. Pinsapo*), and many of the **Pyrus** family ; while, where only a small quantity of loam over-lies the gravel, the **Scotch and Cluster Pines** (*Pinus sylvestris* and *P. Pinaster*), the pretty and far from common **Manna Ash** (*Fraxinus Ornus*), and many others may be successfully planted. In good, rich soil, and where the position is fairly sheltered, there are no end of ornamental trees, both hardwooded and coniferous, that may be planted. Some of the **Magnolias**, but particularly *Magnolia stellata*, *M. acuminata*, and *M. Umbrella*, should find a place, while the **Juneberry** (*Amelanchier canadensis*), the **Cornelian Cherry** (*Cornus Mas*), and various **Thorns** should not be neglected. In exposed places plant clumps of the **Corsican** and **Austrian Pines** (*Pinus laricio* and *P. austriaca*), following up with the hardy **Spruces** and **Cypresses**. Such dainty conifers as the **Japanese Cryptomeria** (*C. japonica*), the **Elegant Cryptomeria** (*C. elegans*), *Fitzroya patagonica*, **Prince Albert's Fir** (*Tsuga Mertensiana*), and **Umbrella Pine** (*Sciadopitys verticillata*) must have cosy corners and good soil to show their beauty to perfection.

Pitting and Planting.—The pits for the reception of ornamental trees should be well formed: that is, be made of sufficiently large size for the specimens to be planted—indeed, it is always preferable to dig out the pits of a greater size than they are required, thus allowing of a quantity of broken-up soil being placed beneath and around the roots. In any case, have the bottom and side of each pit thoroughly broken up, and should the soil be found to be of inferior quality it is best to substitute that of a more desirable kind and such as is known to be suitable for the wants of the particular specimen. In removing large specimen trees great care should be exercised—first, that the roots are uninjured, if at all, in a very small degree ; second, that a good ball of earth is attached ; and, third, that replanting is delayed as short a time as possible. Have the pit for the reception of the tree dug out and prepared before the specimen is lifted. Lift carefully by undermining the roots, and digging out a deep trench at a reasonable distance from the stems

the distance from the stem to be regulated by the root-spread, size of the specimen, etc. So as to avoid falling apart, the ball of earth should be bound with a strong mat or tarpaulin, the ends being made fast around the stem.

A stout low-wheeled truck has been found a most convenient appliance for removing the specimen; but in the case of large and heavy trees the common timber wheels, or janker, may be found of great service. The truck to which we refer should be specially made and of the following dimensions:—Length, 5 ft.; width, 3 ft.; and on wheels 1 ft. 3 in. in diameter, these being placed so as to be below the level of the body, thus doing away with the inconvenience of coming in contact with the load when that is either longer or broader than the specified dimensions. The framework should be of stout oak, and the bottom 3 in. thick boarding. The timber wheels, or janker, being an adjunct of forest appliances, is always at hand, and does away with the necessity of procuring any of the elaborate and costly carriages usually recommended for transplanting large trees and shrubs. The tree being placed in the pit opened for its reception, the roots should be spread out and the soil replaced and trampled firmly, and afterwards well watered.

Staking the Trees.—Next to careful planting and watering a matter of the most vital importance—but one that, unfortunately, is too often lost sight of—is the efficient staking or otherwise securing of large transplanted trees. The great strain and consequent damage to the roots of large transplants when allowed to rock about with every gust of wind is not only highly injurious, but, in viewing the matter from a point of neatness, few things in forestry have a more unsightly or neglected appearance than trees almost blown over by the wind. Various are the methods usually adopted in staking and tying newly transplanted trees, which, as no hard-and-fast lines can be laid down, as a rule, must to a great extent depend on the size of the trees and the exposure of the positions in which they are planted. It may be that when growing in a low-lying, sheltered valley, trees of even

10 ft. in height may be perfectly safe without stake or tie of any kind, whereas others of similar or even smaller size, growing in an open position and exposed to the prevailing winds of the district, will require a mooring of the most secure description, and adjusted in the most efficient manner. For trees and shrubs up to 6 ft. in height, a strong, sharp-pointed stake should be driven firmly into the ground, within about 9 in. of the main stem, and on the most exposed side. The stake should be fully 7 ft. long, and driven, not perpendicularly, but with the head slightly inclined from the tree, and in the direction from which the prevailing winds usually blow. A strong ligature of some kind, such as tarred rope or thick matting, is then placed around the stem of the tree requiring support, at about 4 ft. from the ground, and made fast to the stake at a similar height.

By crossing the tie between the tree and stake a more efficient job is performed, as there is then less room for the tree to work in when rocking with the wind. It will thus be seen that the nearer to the stem of the tree the stake is placed, the greater will the power of resistance be.

When the trees and shrubs are from 8 ft. in height and upwards, but especially in the case of evergreen species, stronger moorings than that just described will have to be resorted to, and the following plan we have found suitable for almost any emergency. A strong band of leather, or several strands of tarred rope, are placed loosely around the stem of the tree to be staked, and at, say, three-quarters of its height. Three wires—ordinary fencing wire does well—are then joined to this collar, two on the most exposed side and one on the other, and made fast to stout stakes driven firmly into the ground, at a distance from the main stem proportionate to the tree's height. In the case of very large trees, or those that have been reinstated from a fallen position; double wires are used in a manner similar to that just described, the collar, however, being unusually strong. The advantages of double wires are extra strength, and that they can be twisted at any time to the tightness required.

The above may be considered the two principal ways of

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staking large transplants, but occasionally cases will crop up in which other methods may require to be resorted to, but such are peculiar cases, and must be dealt with in a peculiar manner.

Included in the following lists will be found a selection of the best trees for ornamental planting.

Ornamental Flowering Trees.

<i>Æsculus Hippocastanum</i>	<i>Gleditschia triacanthos</i>
——— <i>glabra</i>	<i>Halesia tetraptera</i>
<i>Amelanchier canadensis</i>	<i>Koelreuteria paniculata</i>
——— <i>vulgaris</i>	<i>Laburnum Adami</i>
<i>Catalpa bignonioides</i>	——— <i>alpinum</i>
——— <i>speciosa</i>	——— <i>vulgare</i> (in var.)
<i>Cercis canadensis</i>	<i>Liriodendron tulipifera</i>
——— <i>Silicquastrum</i>	<i>Magnolia</i> (in var.)
<i>Cornus Mas</i>	<i>Paulownia imperialis</i>
——— <i>Nuttalii</i>	<i>Prunus</i> (all)
<i>Cratægus</i> (nearly all)	<i>Pyrus</i> (nearly all)
<i>Fraxinus Ornus</i>	<i>Robinia</i> (all)
——— <i>Mariesii</i>	

Cut-leaved Trees.

<i>Acer platanoides</i> (several)	<i>Liquidambar styraciflua</i>
——— <i>polymorphum</i> (several)	<i>Pyrus Aucuparia quercifolia</i>
<i>Alnus glutinosa imperialis</i>	<i>Tilia europæa laciniata</i>
——— <i>laciniata</i>	<i>Salisburia adiantifolia</i>
<i>Betula alba laciniata</i>	<i>Quercus Robur asplenifolia</i>
<i>Castanea vesca dissecta</i>	——— <i>filicifolia</i>
<i>Fagus sylvatica asple nifolia</i>	——— <i>heterophylla</i>
——— <i>quercifolia</i>	——— <i>pectinata</i>

Weeping Trees.

<i>Betula alba pendula</i>	<i>Pyrus Aucuparia pendula</i>
——— <i>Bonamy's</i>	<i>Salix Babylonica crispa</i>
——— <i>Young's</i>	——— <i>Caprea pendula</i>
<i>Corylus Avellana pendula</i>	<i>Sophora Japonica pendula</i>
<i>Fraxinus excelsior</i>	<i>Tilia europæa pendula</i>
——— <i>pendula</i>	<i>Ulmus montana pendula</i>
<i>Gleditschia triacanthos</i>	——— <i>Camperdown</i>
——— <i>pendula</i>	<i>Juglans regia pendula</i>
<i>Populus grandidentata</i>	<i>Planera Richardii pendula</i>
——— <i>pendula</i>	<i>Robinia Pseud-acacia pendula</i>
——— <i>canescens pendula</i>	<i>Quercus Robur pendula</i>

Trees with Autumn-tinted Foliage.

<i>Acer rubrum</i>	<i>Acer saccharinum</i>
——— <i>dasy carpum</i>	<i>Betula populifolia</i>
——— <i>Peunsylvanicum</i>	<i>Celtis occidentalis</i>
——— <i>spicatum</i>	<i>Fagus sylvatica purpurea</i>

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Trees with Autumn-tinted Foliage.—continued.

Gymnocladus canadensis
 Liriodendron tulipifera
 Liquidambar styraciflua
 Pyrus arbutifolia
 Ptelea trifoliata
 Prunus Cerasifera Pissardii

Quercus coccinea
 ——— rubra
 ——— nigra
 ——— tinctoria
 ——— palustris
 Ulmus Americana

Trees and Shrubs with Ornamental Fruit.

Berberis vulgaris
 Cydonia Maulei
 Cratægus (nearly all)
 Colutea arborescens
 ——— cruenta
 Cotoneaster (many)
 Euonymus latifolius
 Hippophœa rhamnoides
 Lycium europæum

Rosa rugosa
 ——— lucida
 ——— villosa
 ——— cinnamomea
 ——— spinosissima
 Skimmia japonica
 ——— Fortunei
 Symphoricarpus racemosus
 Pyrus (of sorts)

CHAPTER XVI.

SHRUBS FOR CARPETING IN SHADE.

THE list of small growing or carpeting shrubs that have been found to succeed when planted beneath the shade and drip of forest trees is by no means a long one, and as the clothing of such bare places is oft-times a point of the greatest importance, particularly in park management, the following notes may prove useful.

The common Ivy is well known to be one of the best evergreen carpets for shade planting with which we are acquainted. It runs about and roots freely, soon covering a large space of ground with its neat, deep-green foliage. Propagation is brought about either by means of cuttings or suckers, and is simple and inexpensive.

The Periwinkles (*Vinca major* and *V minor*) are well adapted for planting beneath our larger trees, and where, unless the shade is very dense, they succeed admirably, soon forming large breadths of evergreen carpet. They are rapidly increased by layering, but when once established they soon spread about unheeded.

The St. John's Wort (*Hypericum calycinum*) can also be confidently recommended for planting as a ground covering beneath our larger trees. It runs about readily, and if occasionally cut over shoots out all the more freely and thickly.

The Mezereon and Spurge Laurel (*Daphne Mezereum* and *D. Laureola*) are excellent, medium-sized shrubs for planting in shady positions, where they not only succeed well, but flower freely. They are both increased by layering.

Euonymus Radicans Variegata is a useful, dwarf-growing shrub for planting in the shade, and succeeds well in smoky localities.

The Butcher's Broom (*Ruscus aculeatus*) grows with great freedom beneath the densest shade of our forest trees, and being an evergreen is to be recommended for such situations.

Gaultheria Shallon and **G. Procumbens** may also be recommended for planting where the shade is not too dense; they both flower and fruit freely, and are of neat procumbent growth.

The Common Ling or Heather, Blackberry (*Vaccinium*), and **Andromeda Catesbœi** all succeed well in the shade of coniferous trees, particularly if the soil be inclined to peat.

It frequently happens that the soil beneath large trees is thoroughly exhausted, and that the small, fibrous rootlets are so abundant as to render planting almost impossible. Under such conditions it is advisable to first pick up gently the soil, without disturbing the larger roots, and add a top dressing of, say, three inches or four inches of good soil. This will give the young plants a start and allow of their becoming strong and established before the existing roots rob the ground of its nourishment.

CHAPTER XVII.

OSIER-CULTURE.

Selecting and Preparing the Ground.—There are not a few persons who consider that, in order to cultivate willows successfully, any neglected, damp piece of ground, and that which is unsuited for other crops, may be utilised, and the cuttings simply stuck in without ground-preparation of any kind. This is, however, a great mistake, as experience has long ago demonstrated that, in order to make osier-cultivation at all profitable, a low, level, and, naturally, rather moist situation must be chosen, and the soil should be deep, well drained, and thoroughly prepared.

Thoroughly drain the ground first, then steam-plough or trench the soil to a depth of about 18 in., removing carefully all weeds, but particularly such troublesome kinds as the bindweed, couch grass, and dock.

It is always preferable to take a crop of potatoes first from the land intended to be laid down for osier-culture, as it not only sweetens and enriches the soil, but allows of all obnoxious weeds being dispensed with. Where, however, it is not practicable to crop the land first with potatoes, the soil should be well and roughly broken up and left so for a year, or for a winter, at least, before being planted with the osiers. The best time to plant is from October to the middle of March.

Planting the Sets.—The sets, or cuttings, should be about 15 in. long, and formed of well-ripened rods, of one year's growth, and the straightest and cleanest portion of the rod only used. Three or four buds should, if possible,

be on the top end of each set. In planting, insert the cuttings from 9 to 12 in. into the ground, leaving 3 in. above soil, which forms the stool that bears the future crops.

It is well to exercise great caution whilst inserting the cuttings, as, if the work has been delayed till the sap is rising, the bark readily strips away from the wood, and this is very objectionable, as the plants in such a state usually die. The sets may be placed about 15 in. apart, and the rows, which, for convenience, should be lined off straight, about 30 in. from each other. Of course, a great deal as regards distances will depend on the quality of the soil and particular kind of willow being planted, but these are good average distances. For basket-making, etc., the best kinds of osiers to use are the golden brown Spaniard, long-skinned plum, Sussex new kind, and white osier; but there are others. A good basket-willow, be it of whatever kind, should, when green, twist from end to end without breaking. It is well to bear in mind that, in order to have the greatest profits on willow-culture, only the very best kinds should be planted—indeed, a judicious selection should, next to preparing the ground, be one of the main considerations. For the first year, at least, after being formed, osier-beds must be carefully attended to in the way of cleaning and weeding. Hoeing will be found the most convenient method of getting rid of weeds, but, in the case of bindweed, hand-picking around and amongst the sets will have to be resorted to.

Cutting the Osiers.—This must be done while the crop is dormant, or not later than the middle of February, but not during frost, which will injure and kill off parts of the stool. The cutting is done by means of a rod-hook, which much resembles a miniature sickle, and this should always be kept sharp, so that the cuts made may be clean. Tie the rods together when dry, in bundles of three or four sizes, and either house or stack them.

It should be borne in mind that rods are readily spoiled by being tied up and stacked whilst in a wet state, as they are very soon heated, which makes them brittle and utterly valueless for the purpose intended. What is known in

England as “bolting” is simply taking a number of osiers, of as nearly a size as possible, and laying them on a twisted wand, at the same time keeping the butts all one way, and level, then drawing them tightly together—not, however, to such an extent as to injure the bark—with a rope and two levers, and finishing off by tying the wand. The wand should be at 14 in. from the butts. A bolt of rods should measure 40 in. round the band.

In forming a willow bed, the following short rules should be observed :—

(1) Willows will not succeed well in peaty, sandy, or water logged soils ; rich, well-drained loam, that can be flooded at will, is the most suitable.

(2) Trench or plough, and thoroughly clean and pulverise the ground before planting.

(3) Plant only the best kinds, studying soil and market, and avoid a mixed crop.

(4) From November to March insert the cuttings about 9 in. deep, avoiding such as are bark-chafed, and tramp firmly.

(5) Keep the beds clean and free from weeds.

(6) Cut the crop close to the ground ; pollard willows soon decay, and in that state harbour injurious insects.

Taken as a whole, osier-culture is not now a very profitable undertaking, foreign supplies being sent into the English markets at a cheaper rate than they can be produced in this country.

Mr. Scaling, the well-known cultivator of osiers, and author of several works dealing with the cultivation and marketing of this produce, writes as follows :—“ I am sorry to say that, since my report to the Highland and Agricultural Society was written, osier cultivation has ceased to pay, from the same causes that wheat growing has ceased to pay—viz., foreign imports, aided by railway preferential rates, which enable a French, Belgian, or Dutch grower to deliver his produce into the large inland towns of England at a lower rate per ton than a grower can from the centre of the railway system. The wisdom of this policy of self-extinction will some day be called in question. Meantime, I abstain

from comment. I may, however, remark that to peel, sort, and prepare a ton of osiers (the average produce of an acre when peeled for market) costs the home grower about £8. The foreign grower can do it for about £3, an advantage of about £5 per acre. Indeed, I would not, under the disadvantages we are placed, advise anyone to plant osiers. The cost of peeling osiers has been materially increased since the School Board rules were so strictly enforced—in fact, the cost has been nearly doubled."

CHAPTER XVIII.

THINNING PLANTATIONS.

IN the successful rearing of timber trees for profit there is, perhaps, no other branch of more importance than a good knowledge of the art of thinning, and, at the same time, one on which so great a diversity of opinion exists.

Thinning plantations, be they old or young, must always be subject to great modification, according to the nature of the trees and soil, or ultimate design of the plantation being operated upon, and is a matter requiring great tact, forethought, and discrimination, and that can only be acquired by long experience and by those having a good insight into the peculiarities and properties of our general forest trees.

The same rule as regards thinning will not apply to, say, fir, hardwood, and mixed plantations; and far less will it hold good in the case of an ornamental and a profitable wood. No universal rule can, however, be laid down for thinning, but general principles can be given that will be sufficient for the guidance of those who have to undertake such work.

In thinning any plantation two very important points are well to be borne in mind—first, cut away all diseased and dying trees; second, study the relationship of trees and soil, and act in accordance. To be more explicit, we might say that, in the first case, the removing of all dead and dying trees is a necessity, and, being done, one can proceed with greater certainty in the disposal of the standards to be left. In the second case, by suiting the trees to the soil, at least as far as possible, great good is accomplished, and an instance

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of this that came under our own observation lately will be given as an example. Fully half of a plantation 130 acres in extent was planted with larch, the remainder being composed of oak and Spanish chestnut, placed at regular

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distances apart throughout the whole extent of the wood. Now, the soil was gravelly for a considerable distance down, and, consequently, fairly well suited for the chestnut and the oak, but just the reverse for the larch, which, on such a

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soil, generally becomes "pumped," or rotten at the core. In thinning this particular plantation, it would have been very unwise to cut away the chestnut and the oak and leave the larch, and this had to some extent happened before the proper system of management and adaptability of soil to tree was thought of. Larch may look healthy enough, unfortunately, and show but small indications of disease, even when growing on gravel, for from 20 to 30 years of age, so that it is with difficulty that the inexperienced become aware of the pending doom that usually awaits the larch when planted on such a soil. This example is merely given to point out how carefully thinning should be gone about, and that in all cases it is wise policy to study soil in relation to the future crop of timber before an axe is laid to the tree.

At the outset of these remarks on thinning plantations it should be distinctly borne in mind that there are two chief objects for which trees may be grown, each requiring a special mode of management, in order that the best results may be obtained.

The first is the management of trees in a purely economical sense or with a view to profit; the second, their management with a view to ornament. There is also a third object that is well worthy of consideration, and that is the growing of timber in one and the same wood, both for ornament and utility combined, and this is very frequently the case with woodlands that are visible from park roads and drives, with strips bounding parks or pleasure-grounds, and on small properties.

To produce ornamental trees of natural appearance is by no means difficult, as by allowing the individual specimens ample room for branch development, the desired effect is gradually brought about. Far greater difficulty, however, attends the production of the greatest quantity of the most valuable trees on a given space of ground. Here many questions of the greatest moment, and on which great difference of opinion exists, crop up: such as at what age thinning should be commenced, to what extent should it be engaged in, what time should elapse between each thinning and which trees should be removed.

Anyone at all interested in the management of our woods and plantations must have noticed that trees having an abundance of room and light on all sides make comparatively short and thick trunks that are well furnished with branches; whereas such as are grown up in a circumscribed space and amongst others are tall and straight, with clean, well-formed trunks destitute of branches for the greater part of their height. All species, or nearly all, are governed by the same laws, that is to say, those that have the least room laterally, within, of course, certain prescribed limits, which will be described hereafter, produce the tallest, cleanest, and straightest trunks, and *vice versa*.

The influence of light has not, in this country at least, been sufficiently taken into account in the rearing of timber, but it has everything to do in directing the growth of trees, and should be a most important factor in the hands of the forester. Thus, if it be allowed in excess, as when the trees stand far apart, the growth of lateral shoots and large branches will be greatly induced, the result being short and thick boles, that are rough and knotty, and ill-adapted for constructive purposes. On the other hand, by keeping the trees thick on the ground, light is, to a greater or less extent, excluded, and the trees grow tall, straight, and branchless for the greater part of their height, and are of the greatest economic value. But here another and very important question crops up. To what extent in a wood, managed solely for the value of the timber it produces, will it be profitable to thin? In dealing with this, two distinct bearings should be kept in mind—the first, that too small a quantity of branches, and consequently leaves, must, to a greater or less extent, check the growth of the trees, and so diminish the production of timber; and, second, that by having too large a quantity, the value of the timber is greatly reduced in consequence, and the number of trees to the acre much diminished as well.

There is, therefore, a medium between these two, and by adopting which, the greatest quantity of the most valuable timber will be produced; although, at the same time, it is astonishing, when looked at from a physiological point of view, what a small quantity of foliage is required to keep a

plantation tree in a healthy, growing condition, and to produce a trunk of useful dimensions. This may, however, be explained as follows: that the almost entire absence of large limbs and branches, which in some cases would amount to one-fifth the total bulk of the tree, renders the amount of sap, and consequently of leaves, required proportionately less, the nutriment being mainly elaborated in the building of the trunk.

Independently altogether of the forests of northern Europe, Canada, etc., which have grown up naturally, I might give many examples in our own country—the native Fir forests in the Highlands of Scotland, the valuable Beech woods on the Chiltern Hills, and a few Larch plantations in Yorkshire and Bedfordshire—where trees averaging 70 feet in height, growing at from 4 to 6 yards apart, and with only a tuft of foliage atop, may be seen. It is only, however, by long and careful study and attention to different trees at different stages of their growth that any idea can be formed of the amount of branches and foliage required for preparing the sap that will be necessary for the profitable yearly increase of the trunk until maturity is arrived at.

The questions now to be dealt with in growing timber for purely economical purposes are: 1. At what age should thinning be commenced? 2. To what extent should it be engaged in? 3. What time should elapse between each thinning? And 4. Which trees should be removed?

At the outset, it may be well to mention, that in so far as any of the above questions are concerned, no hard-and-fast line can be laid down as to the universal management of plantations, each tract of wood, and even different parts of the same wood, according to the particular species of tree, quality of soil, altitude, and exposure, being dealt with on its own peculiar footing. Many serious mistakes have been committed, and irreparable damage done, by treating every plantation alike and according to the rule-of-thumb method. Upon the manner in which thinning is performed, much of the ultimate success of a plantation will depend, and it is a matter requiring great tact, forethought, and discrimination, and that can only be acquired by long experience, and an intimate knowledge of trees and their surroundings.

The quality as well as quantity of timber produced should be carefully considered in the management of every plantation. In dealing with the following questions regarding thinning, it may be well to state that the average plantation will alone form the basis of remarks.

1. *At what age should thinning be commenced?*—The necessity of thinning, few practical arboriculturists will care to deny, and that whether the plantation be composed of coniferous or hard-wooded trees. It is the abuse of the practice that, in this country at least, is so to be condemned, and I entirely dissent from those who consider that a coniferous plantation should be left to Nature, or, in other words, should thin itself. The argument that the natural forests of America, the source from which we derive the finest and best quality of timber, thinned themselves, is often quoted; but it should also be remembered that the conditions of such forests are widely different from those of our own, and that the waste of timber is immense, great quantities being destroyed in procuring what is required. Although, however, we cannot adopt all the details of Nature's practice, we can and we should admit the correctness of the principle on which she acts, and by studying this we learn much, and it is by acquiring a knowledge of her economy, and where and when to apply assistance, that the point of the whole argument rests. Natural regeneration, unless in a limited number of cases, and particularly with our least valuable classes of timber, is never, in this country, likely to supersede artificial planting, and it has been conclusively proved in the Forest of Dean, that with our most valuable timber-producing tree, the Oak, the latter system is most to be encouraged.

No thinning of young trees should take place until a complete ground shade has been established; and it is most important for the welfare of the plantation, that a complete overhead foliage covering be brought about at as early a date as possible after planting. At what age this may take place will entirely depend on the size of the plants used and distance at which they were inserted in the ground, less so on the quality of soil and other considerations. At a short

period after a complete leaf canopy has been established, the individual trees begin to press against each other, and later on a struggle for existence commences, the stronger specimens gaining the supremacy over the weaker. Here it must be borne in mind that hard-wooded trees require proportionately more room for their healthy development than coniferous kinds, while length and clearness of stem, produced by a due proportion of shade, is an object of prime importance. It might, as some suppose, do little harm, to let the struggle for existence go on unchecked, but there can be no question that for several reasons it is wise policy to allow the stronger trees every chance of succeeding, and to cut away the weaker. The object should be to provide for the trees left standing that amount of room or growing space best suited for bringing about the particular conditions aimed at, and in thinning, it must be the aim of the forester to arrive at the happy mean—neither over nor underdoing the work, the former in particular. But while over crowding is not to be tolerated, the danger of suddenly exposing the trees to currents of air, to which they have hitherto been unaccustomed, must be carefully guarded against, and it should be distinctly borne in mind that to thin trees in an abrupt manner is one of the greatest mistakes that it is possible to fall into.

Statistics compiled from a healthy Larch plantation, growing on fair soil, and in a moderately sheltered position in southern England, will now be given, and from which a good idea of the age and size can be formed of the period when thinning should be commenced. The trees when planted were 2 ft. high, and pitted at 3 ft. apart. In four years the outer branches began to touch each other, and in six years from time of planting the average height of trees was 7 ft. 10 in., and the shade occasioned had killed out most of the grassy undergrowth. At this period of growth, the disproportion in the size of the trees was, as is usually the case, considerable, and left no doubt about which to remove when the first thinning took place. Two years afterwards, or in eight years from time of planting, thinning was first engaged in, the taller trees at that time averaging nearly

11 ft. in height, but many of the suppressed and weakly were little more than half that size.¹

2. *To what extent should thinning be engaged in?*—In following up the latter case, the tallest and healthiest trees were reserved; all distorted, sickly, and stunted specimens being removed; but in the case of two or more proportionately small trees growing in close proximity, the most promising was left, and the others cut away, thus avoiding gaps in the plantation. At the first thinning it will be found quite impossible to leave the trees anything like regular over the ground, although this should be studied as much as possible, and bare spaces are to be carefully guarded against. With the vigorous growth of the trees, and the interlacing of branches previous to the first thinning, no great openings will require to be made, and nothing more than will be canopied over during the next two years.

3. *What time should elapse between each thinning?*—This can only be correctly defined after a careful inspection of the particular wood. Generally speaking, after the first thinning, when the trees were eight years old, the lower branches gradually began to give way, and as the trees increased in height, this became more and more apparent, and formed a good guide as to the time which should elapse before the second thinning might profitably be engaged in. The intervals between the various thinnings should for the first thirty years in the case of Larch—and, indeed, most other trees—be comparatively short, and longer with advance of age; but heavy thinnings must be carefully avoided, and especially if the best class of coniferous timber is to be produced.

A well-managed Larch plantation of twenty years' growth should have the trees branchless for about one-half of their height, which is, of course, brought about by crowding, and at forty years three-fourths of the trunk should be clear of branches.

I have purposely abstained from giving the number of feet apart at which trees ought to stand at various stages of their growth, and the number of thinnings they require, as being calculated to mislead.

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4. *Which trees should be removed* need cause little or no anxiety, as the dead, dying, diseased, and badly-formed will naturally receive first attention

In thinning the following short rules should be observed :—

1. Thin not at all until the undergrowing vegetation has been completely killed out by the overhead foliage, the golden rule of silviculture being to keep the sunshine off the ground until near the end of the trees' career.

2. Thinning should be performed in such a manner as not to reduce the value of the crop, but so as to tend to the production of the greatest quantity of the most valuable timber in the shortest possible space of time.

3. By thinning allow of sufficient light and air to prevent the trees becoming drawn up and lanky, but avoid too much space, which induces the growth of side branches and detracts from the value of the timber.

4. Keep up the number of trees to the highest possible pitch until they are tall, straight, and clean, and thin gradually.

5. The danger of suddenly exposing the trees to currents of cold air to which they have hitherto been unaccustomed must be carefully guarded against, and it is a serious mistake to thin in an abrupt or unequal manner.

6. In thinning remove all dead and dying trees first, then the distorted and stunted, the best grown and healthiest being preserved for the permanent crop.

7. Hardwooded trees require proportionately more space for development than conifers, and the annual rings in the timber of the latter should be narrow in proportion to those of the former, good quality of hardwooded timber being indicated by broad annual rings, but with coniferous wood the reverse is the case.

8. Thinning should be commenced at the central or most sheltered point of a plantation, or section of same, so that the outer intact boundary may continue to form a barrier to cold winds, which might prove injurious to trees that had hitherto stood in close order.

9. In economic forestry timber trees should be cut down when they have arrived at maturity or ceased to grow. With

coniferous trees this generally occurs at from seventy to ninety years ; but with hardwoods, excepting the ash and chestnut, which are of most value, say, up to fifty years' growth, the period may be greatly extended.

10. Thinning is usually performed in autumn and early winter, but it may be well to remember that at the latter period the lowest percentage of moisture (about 47 per cent.) is present, and the timber consequently of the greatest value for constructive purposes.

CHAPTER XIX.

TREE-PRUNING.

More nonsense has been written on tree-pruning and more injury done to woods and plantations by its practice than perhaps any other operation in the whole range of forest management. Where tress are grown for profit, they will, if properly managed, prune themselves, and where for ornament the natural outline is far better than any of the contortions and symmetrical shapes that have been recommended by various writers on the subject.

A broken or dead branch may be removed, a rival leading shoot cut away, or an ungainly limb amputated, but here all pruning should cease, the practice being wholly wrong and unreasonable, and without one recommendation that could be adduced in its favour. In an economic way the finest plantations of either coniferous or hard-wooded trees in this country are those where the individual specimens are growing so thickly together that the branches are killed outright for fully one half of their height. Here the stems will be straight and clean, and the timber when converted free from the knots and warping that are so characteristic either of standard specimens or such as have been grown too thinly on the ground.

Everyone knows that an Oak growing alone or along the margins of a wood is in nine cases out of ten branched almost to the ground, and the bole in consequence rough and ill-fitted for any particular constructive purpose, and the same may be said of every other tree, be it hard-wooded or coniferous. Larch and Scotch Fir trees growing along the

margins of plantations are rough and knotty, and sell at a considerably lower figure when compared with those further in, where the branches have been killed back gradually as the trees increased in size.

The same thing is markedly the case in young woods of ash, oak, and chestnut, where they have been grown sufficiently thick on the ground to kill off the lower branches, and also to cause the trees to rise straight, clean, and tapering. It is a well-known fact, too, that the timber of trees so grown is far more elastic and realises a much higher price than that of the same age, but grown under conditions where pruning might have been a necessity. A case of this kind came under my own notice only a short time ago in which one-half of a plantation of hard-wooded trees realised fully one-fourth more than the remaining half. It came about in this way. Both ends and a large patch in the centre of the wood had been thinned out severely for the purpose of planting game covert. The trees, standing thinly on the ground, branched out and soon covered the open spaces where underwood had been planted. In thinning the whole plantation the trees on these particular parts were very rough and knotty, and bore no comparison to those where they had been left moderately thick on the ground, and in consequence of which the boles were straight, clean, and tapering. This case has special features, inasmuch as the trees over the whole area were growing under exactly similar conditions as to soil, shelter, etc., and were of the same age and species.

Great and irreparable damage has been done to woods and plantations in this country by too heavy thinnings, by commencing the thinning at too early a period, and by adopting the book method of leaving the trees at measured distances apart and a stated number to the acre according to the age of the plantation. Such rules can never be expected to work satisfactorily, the size of trees depending so much on the character of the soil, exposure of the woodland, and other peculiarities of the particular district in which they are planted.

Timely and judicious thinning should never be neglected,

but it is the over-thinning, whereby branches and knotty trunks are produced and the supposed need for pruning follows, that I wish to deprecate and entirely dissent from. Grow your timber trees so thickly on the ground that the stems are induced to become straight, clean, and branchless for the greater part of their height, and on no account admit sufficient light and air to cause the lower branches to be retained intact, or, in other words, at all times retain an unbroken leaf canopy. The necessity for pruning will then be entirely done away with, and a more valuable class of timber produced. The losses sustained through injudicious planting and the unnecessary and ruinous practice of pruning have taught a lesson that is fraught with good for the tree planter of the future.

There are a few cases, however, where pruning is quite justifiable, and where the abuse of a system should furnish no argument against its legitimate use. Hedgerow and field timber, for the sake of the live fences, the grass, or the grain crop in the vicinity, may require attention in the way of judicious pruning, but this has been fully dealt with in the chapter under "Hedgerow and Field Timber," and need not be repeated here.

Again, pruning is often a necessity where standard trees are grown in conjunction with coppice wood, as by shortening of the lower branches the undergrowth in consequence becomes much improved.

Pruning Live Branches.—In and around London, as well as many other large centres of industry, the hacking and hewing, pruning we cannot call it, to which trees are subjected is barbarous in the extreme, and calls for the strongest denunciation. To annually prune and elbow in such noble forest trees as the lime and plane, in order that the restricted growth may render them suitable for the cramped positions in which they have been unwisely planted, is little short of vandalism. The lime and plane, perhaps, suffer most in this way, for as soon as they have overgrown the allotted space an annual system of pruning back the branches is resorted to, the result being great mop-headed protuberances at the points

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where amputation took place, which not only rob the tree of its graceful natural appearance, but render it susceptible to disease and insect pests. There is no need to specialise cases where this most objectionable system is carried out, for a walk around our squares and gardens will unfortunately reveal how prevalent mal-treatment of trees in the way of pruning is effected. There might be some excuse for planting our noblest forest trees in cramped and unsuitable positions were there no other species of smaller growth that would take their place, but the various species of *Pyrus*, *Cratægus*, dwarf *Acacia*, *Mulberry*, *Catalpa* and *Sumach* surely give us sufficient scope for choosing trees of restricted growth for confined positions and so do away with the barbarous system of pruning which the employing of large growing species necessitates.

Even in the case of dwarf avenues and screens it is quite unnecessary to use such large growing trees as the lime and plane where pruning must oft be resorted to, for an avenue or screen of thorn or mulberry the beam tree or mountain ash would all be more suitable, and in the end far more natural and artistic in appearance.

To sum up in a few words my contention is that no tree should be planted in a position where, in order to keep it within due bounds, a systematic clipping and pruning has to be resorted to.

Pruning Dead Wood.—Opinions differ greatly as to whether or not dead branches should be removed from park and woodland trees. It is, however, mainly a matter of taste, and on which point two of the largest owners of woodlands in this country hold distinctly opposite opinions, though at the same time it cannot be denied that the careful removal of all dead and dying wood from a tree is highly beneficial. Pruning should, however, only be extended to such trees as are in a fairly healthy condition, with well-developed heads, and which contain only a moderate quantity of dead wood, there being many fine old specimens that would be rendered unsightly in the extreme and receive no benefit from removal of the dead and dying timber, but this has direct reference to trees standing singly throughout the park, and not to specimens in the woodland.

In many of our parks and woodlands at the present time there exists an undue quantity of dead and dying wood, which may be attributed to natural decay, the quality of the soil, and in some instances to long-standing neglect in the matter of non-attention to wounds which have been caused by wind-broken limbs and branches. Such trees would be greatly improved, both in health and appearance, by judicious removal of the dead branches and attention to old wounds in order to prevent the ingress of water, the decay of many branches being directly attributable to this cause. That an undue quantity of dead wood will induce injurious insect pests, such as the goat and wood leopard moths, which attack healthy trees, is well known, and was exemplified in one of our London parks recently where numerous young thorns and various species of *Pyrus* were injured by the latter. In removing dead branches they should be cut well back into the living wood in order to induce a fresh start to growth at the point where amputation took place. The removal of large dead limbs from old specimen trees is an operation that requires a great amount of skill, and should only be entrusted to those who have had practical experience of pruning in its various phases. As before stated, the removal of dead wood is merely a matter of sentiment, though of its practical utility there can be no doubt, and in all cases where the stag-headed trees are conspicuous the removal of the dead wood is to be recommended.

How and when to prune.—The latter part of May or beginning of June is undoubtedly the best season for pruning the majority of hardwooded trees, as during that time the motion of the sap is most vigorous, and in consequence the wounds caused by amputation heal quickest. There are a few exceptions—the birch, sycamore, and maple—where, on account of profuse bleeding, pruning had best be postponed till after full foliage has been attained.

Much mischief has been done by the pruning knife, and more by the handbill and saw when placed in the hands of inexperienced workmen—a fact that is apparent to any interested person who visits various parts of the country.

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When conducted with care, on sound principles, the effect of pruning on the class of timber referred to is highly beneficial, whereas, when done in a haphazard way and by an inexperienced hand, it is often attended with great danger and grave results.

In cutting or foreshortening small branches, a sharp pocket-knife will be found most convenient, but when large limbs have to be removed the pruning saw should be brought into request. The branch to be removed, especially if of large size and weighty, should first be cut through at any convenient distance from the main stem, thus preventing splitting and tearing of the bark, after which the stump may be neatly sawn through as close to the bole of the tree as possible. Undercutting by a few draughts of the saw will here also go far in preventing tearing of the wood and bark. So as to render the saw-cut smooth and prevent water lodging on the surface, the face and edge should be neatly dressed with an adze or sharp pruning knife, and then painted with tar. When cutting over an upright-growing branch, such as in pollarding trees, &c., never cut on the horizontal, but always in a sloping direction, so that the rain may pass off quickly.

CHAPTER XX.

TREES AND SOIL.

There cannot be a doubt that many of the failures in tree planting can be directly attributed to errors in judgment in the selection of particular species to the wrong classes of soil. We have good examples of how certain trees and shrubs affect particular classes of soil in the common Rhododendron, and most of the so-called American peat plants, none of which can for long survive in that of a chalky or calcareous formation, while the cluster and Aleppo Pines (*Pinus Pinaster*, and *P. Halepensis*) succeed best in almost pure sand on the sea coast.

Again, we generally associate the Scotch Pine, Larch, and Mountain Ash with poor, gravelly soils or rocky ground, the Ash with that of the best quality, which may also be said of the Walnut, while the Beech and Pyrus do best in that of a calcareous formation. The Willow and Alder frequent damp soil; in fact, that of a water-logged character does not come amiss to either, while the various species of Poplar revel in that of almost a similar, perhaps drier nature.

Amongst the later introduced Conifers the same law with reference to soil holds good, and many failures by not planting the Umbrella Pine (*Sciadopitys Verticillata*) in dampish peat, and placing Menzies Fir (*Picea Menziesii*) on dry gravelly soils have been brought about. These are only a few of the many instances that could be pointed out in which trees have become unhealthy, or died out altogether when planted in unsuitable soils and situations. The Larch will not remain long healthy when planted in gravelly soils—heart rot or “pumping” being brought about at an early age, and many examples of such could be pointed out in almost every part of the country where the tree is extensively cultivated. But it would only be superfluous to multiply examples, and it is wise on the part of the planter to consider well the species of trees that have been found to succeed best when planted in particular classes of soil.

The following is a brief summary of the trees that have been found best suited for the soils with which they are associated in the list :—

Acacia.—Rich soil gravelly.

Alder.—Rich, damp soil, in proximity to water.

Ash.—Alluvial deposit, or rich yellow loam.

Beech.—Gravelly or chalky loam.

Birch.—Poor upland slopes and light soils.

Cherry.—Rich, dampish vegetable soil.

Chestnut.—Deep, rich sandy or gravelly loam.

Chestnut (horse)—Good firm loam; dampish.

Elm (English).—Deep, dry loam.

Elm (Scotch).—Upland rocky soils.

Hazel.—Good loam, on chalk preferable.

Hornbeam.—Poor clayey soils.

Lime.—Firm, well-drained loam.

Maple (English).—Loam on chalk.

Maple (Sugar).—Deep, sandy soil.

Mountain Ash.—Rocky soils and gravelly loam.

Oak.—Deep, rich and rather stiff loam.

Poplar.—Preferably a moist rich soil.

Sycamore.—Rich, open loamy soils and alluvial deposit.

Walnut.—Rich, wheat soil.

Willow.—Dampish and fairly good soils.

Coniferous Trees.

Douglas Fir.—Rich gravel or sandy soil.

Larch.—Fairly rich loam, in upland or rocky situation.

Pine (Scotch)—Light and poor gravelly soils.

Pine (Austrian).—Calcareous formation.

Pine (Corsican).—Loam on deep gravel.

Pine (Cluster or Pinaster).—Deep sand on the sea coast.

Silver Fir.—Good, rich loam.

Thuja Gigantea.—Fairly rich soil of almost every description.

Thujopsis Borealis.—Gravelly or sandy loam; in sheltered situations.

It must be borne in mind that perhaps every species above enumerated will succeed in other soils than those recommended, but with a wide and intimate knowledge of the individual kinds and their requirements we may conclude that for general planting the above instructions as to soil are well worthy of attention.

CHAPTER XXI.

BARKING OAK.

THE period of bark stripping and harvesting is one of the most anxious seasons of the year with the forester, as the quality of the bark is so largely dependent upon the weather during the time that intervenes between the stripping and stacking, or delivery, as well as upon the carrying-out of the work at the proper time, to secure easy and expeditious peeling. In most cases the time when the bud is just expanding into leaf is that which gives the greatest weight of bark of the best quality, and with the smallest amount of labour. By deferring the work, even for a few days, there is often a loss in weight amounting to as much as 10 per cent., and a great deterioration in quality.

Even in the most favoured situations it is seldom that the season for stripping extends beyond twenty-eight days. The advantages of early stripping are so well known that any comment on the subject is unnecessary; suffice it to say that, immediately the bark commences to "run" freely, no time should be lost in making a start, and the work should be prosecuted with vigour and dispatch until completed.

The proper time to commence barking cannot, however, be fixed with any amount of certainty, much depending on the season, whether early or late, as well as district of the country in which the operation is to be performed. During ordinary seasons, and in most parts of England, bark-stripping commences during the third week in April, and continues for about a month, or until such time as the trees are in full

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leafage, whereas in some parts of Scotland, especially the north, the operation is frequently nearly a month later. No mistake can, however, arise as to the right time to start barking in any locality, as in all cases the period when the bud is first bursting into leaf will be found the proper time for felling to insure easy stripping and the best quality of bark. As the season of bark-stripping is, therefore, of short duration, every preparation should be made beforehand—trees marked and numbered, tools in readiness, and squads arranged—so that an early start may be made, as, by deferring the work beyond the time stated above, there is not

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only a perceptible loss in weight, but considerable deterioration in the quality of bark as well.

Elaborate directions regarding the arrangements of squads and tools to be used are unnecessary, as almost every district has its own peculiarities in this way. The tools generally in use are heavy axes and the cross-cut saw for felling, hand-bills and saws for pruning, peeling-irons or chisels for removing the bark, scrapers for removing moss, and light wooden mallets for beating refractory bark or such as cannot be removed by the peeling-irons alone.

Previous to felling the trees a man or stout lad is sent before, who removes the bark from the root upwards for a distance of 2 ft. or 3 ft., which not only prevents its being injured when laying in and felling the tree, but is convenient for after-stripping as well. When the stools are intended for reproduction great care is necessary to avoid tearing or loosening the bark from the roots. After being thus prepared the trees are felled in the usual manner, those under 6 in. in diameter being cut with the axe ; above that size it is found economy of time and timber to fell with the cross-cut saw. Following in the rear of the cutters should be a squad of men, to clear the trunk and larger limbs of all branches down to 1 in. in diameter, leaving the limbs to be peeled as part of the tree.

Heavy timber and large branches are usually peeled where they fall, but it will be found convenient to have the smaller trees and branches carried out to some clear space adjoining the stacking ground, and peeled while one end is supported by means of two forked sticks placed against each other. When the bark of small branches cannot readily be removed by the peeling-iron, a smooth, flat stone is brought into use, beside which the peeler sits, and with one hand holds the branch on the stone, moving it along from one end to the opposite, at the same time applying the mallet with the other hand until the bark becomes loosened from the wood. Here it may be well to caution against a too frequent use of the mallet, which should never be brought into request when the bark can be otherwise removed from the wood, as all hammering and beating not only diminishes the quantity of tannin, but has a tendency to blacken the fleshy part of the bark and cause rapid decay in a bad season. The body, or trunk bark is removed in lengths of from 30 in. to 36 in., and in as large pieces as possible.

A dry, open, and airy situation, convenient to the work, but without the wood, should be selected on which to harvest the bark, and rather than do so in a sheltered, humid spot, it should be carted to some distance off. The drying racks, or ranges, may be fully 2 ft. high, drooping somewhat to one side, and formed of forked sticks driven firmly in the ground,

while stout rods are placed transversely upon these. It should also be arranged, not only to throw the rain off, but so that the ends of the bark may be facing the prevailing wind, thereby insuring a current of air through and beneath the mass. After being carted or carried to the drying-ground the small bark is spread out loosely on the stage to a depth of about 6 in., and thatched or covered over with the larger pieces as a means of protection against rain. Each day's bark should be cleared up, and put on the range the same evening, and oftener, if found necessary, during damp, showery weather, keeping the white, or fleshy part downwards and using the larger pieces as covers to run off the rain.

During favourable weather the bark will be ready for stacking in about a fortnight from the time it was placed on the stage, but should close, damp weather intervene, it may be found necessary to turn the bark occasionally, thus adding to the length of time required in harvesting. It should, however, be remembered that the less turning the bark receives after being placed on the stage the better will the quality be. Well-seasoned bark has the fleshy side of a creamy colour, whereas such as has been exposed to the sun or rain is of a dull brown, wanting in tannin matter, and, consequently, deficient in value.

As soon as the bark is thoroughly dry and ready for stacking, which may readily be told by its breaking freely across rather than bending or yielding to pressure, it should be secured in a shed, ricked, or delivered to the tanner.

In stacking bark the rick should not be made too wide—say about 9 ft.—but well hearted, so that the side pieces may have a good fall or declivity outwards to throw off the rain. The rick may be of any length, according to the quantity of bark on hand, and of a height proportionate to the width. The largest pieces of bark should be reserved for thatching the rick, this being covered over by a tarpaulin or waterproof cloth of some kind. In some cases the bark is chipped previous to being sold, but, as this necessitates having a large shed at command, the system is not generally adopted.

There are, however, several advantages accruing from this method, not the least of which is that the bark may be chopped up as it is removed from the drying-stands, thus saving the expense of stacking. Chopping the bark can also be done by the workmen during wet weather, and when not otherwise engaged.

In computing the quantity of bark before stripping, we have found the following data fairly reliable:—

(1) A well-balanced tree with a good head will yield about 6 cwt. of bark for every ton of measurable timber, if branches down to an inch in diameter are peeled.

(2) Hedgerow trees usually yield about a ton of bark to every three tons of timber.

(3) Trees growing in close woodland are usually thin barked, the yield being about a ton of bark to every $4\frac{1}{2}$ tons of timber.

(4) Oak poles will average five tons of timber to a ton of bark.

Tall, clean stems, as when the poles are grown thickly together, with small heads, give the smallest yield in proportion to the quantity of timber, and short stems with spreading heads the largest.

Profit and Loss of Barking Oak.—At the highest price now obtained for the best class of oak bark, viz.:—£4 10s. per ton, the profit, after paying expenses of stripping, &c., is indeed small, and brings it within the pale of discussion whether should the price of bark go on decreasing, it is wise to have it removed. For industrial purposes it must be admitted that the quality of the oak timber is materially affected by the season at which the tree is cut down, viz.:—when the tree contains the largest quantity of sap.

The main question, however, to be carefully considered is whether or not the average market price of the bark is commensurate with the expenses of production, adding thereto that proportion of the value of the timber lost by the deterioration of the sapwood. The total cost of production has been carefully gone into, with the following result per ton:—

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	£	s.	d.
Labour, peeling, and harvesting ...	1	10	0
Cartage to railway station, including loading (this is the average from six districts)	0	7	6
Loss on four months delay in selling the timber, which, but for the bark, would have been felled in winter at 5 %	0	5	0
Customary terms of payment, less 2½ %	0	2	0
Superintendence, etc.	0	1	6
	<hr/>		
	£2	6	0

This leaves a seeming profit of £2 4s. per ton of bark, or about fully 3½d. per cube foot, there being on an average 150 feet to the ton.

It has been carefully estimated that there is a loss of fully 12 per cent. of wood, caused by felling the oak during the barking season, or, in other words, the proportion of sapwood to the whole tree is about 14 per cent., which, for the majority of purposes to which oak timber is applied, is rendered by the peeling of little or no value.

We will say, however, that two per cent. can be profitably utilised, which leaves us with a net loss of 12 per cent. on the whole tree.

The average price of the best oak is 2s. per foot, 12 per cent. of which is as nearly as possible 3d. per foot, or £1 17s. 6d. per ton of bark to 150 feet of wood.

This, with the £2 6s., cost of production, brings the total to £4 3s. 6d., leaving a balance to the good of 6s. 6d. per ton—a profit utterly incommensurate with the great risk involved.

CHAPTER XXII.

THE MANUFACTURE OF CHARCOAL.

IN the preparation of charcoal two different methods are usually employed—one, that of piling the wood in a heap, covering with turf, and setting on fire; the other, by placing the wood in an iron cylinder set in brickwork, and surrounded with fire. The former method is that generally adopted, and will be described first:—

A piece of ground, sheltered from the prevailing winds, and in a position to which easy access with wood can be obtained, is set apart for the charcoal-making. The wood is carted in at any time when obtainable and when it is convenient to spare horse-labour from other parts of the forest work, and consists of all kinds of hardwoods in size, if possible, not under 2 in. in diameter. Principally fire-wood and rather rough and unsaleable timber are used for this purpose. The wood is sawn into pieces 2 ft. long, and these again split, if required, to about 4 in. square, and when a sufficient quantity has been cut up for two pits, the building of these is then proceeded with.

Here it may be necessary to state that it is much better to burn two pits at the same time, as both can be attended to during the charring process as conveniently as one, and do not necessitate the men sitting up at night for each separately. The pits are usually made of conical shape, 21 ft. in diameter, and about 9 ft. in height, the mode of construction being as follows: A strong stake is driven firmly into the ground, and left protruding about 12 in.:

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around this are placed small pieces of dry ash of a similar size, and standing as close to the upright stake as possible, around this being placed another layer in the same manner, and so on, until a circle 4 ft. in diameter is obtained.

A circle 1 ft. in diameter, and having the top of the stake driven into the ground as a centre, is next made by placing the wood horizontally on the upright pieces, and side by side, repeating the same by laying other pieces on these in a similar manner, until the pit is of the required height ; the wood used here being dry pieces of ash, 24 inches long, but split rather smaller than the ordinary size. This forms a sort of chimney by means of which the pits are fired. Out-

SECTION OF CHARCOAL PIT.

side, the wood is placed on end and reclining inwards, this method being continued until the pits are of the required size.

When completed, the pits are covered with newly-cut turf, the grassy side being placed innermost, beginning at the base and working towards the top, each line of turf overlapping the previous one by a few inches, the circular hole or chimney being left open for firing. The turfs are cut about 1 ft. in width, and any length convenient, the quantity required for two pits being about seven cartloads. Before turfing the top half of each pit they are carefully examined, and any crevices between the pieces of wood packed full of

small bits of turf and sawdust to exclude the air. They are next fired by dropping a couple of shovelfuls of burning wood and some pieces of dry pine or ash into the opening left at the top; the top turf is then put on, which effectually shuts up the chimney, after which the process of charring commences. The smoke is first seen issuing from the lower half of each pit, where sawdust has not been used, and, ultimately, all over. Constant attention is required day and night during the period of burning, and especially so should the weather be stormy, as the wind, striking constantly on a particular part of the pit, causes that side to burn very rapidly and fall into a hole. Should this occur, the hole must at once be filled up with rough logs, which have been set aside for the purpose when splitting the wood, and recovered with turf. When the weather is mild the pits burn uniformly all over, require but little attention, and produce the finest charcoal.

The time required in burning varies from seven to nine days, according to the state of the weather, dry and mild requiring the longest period. As the charring proceeds the turfs gradually disappear, and only a slight covering of burnt earth remains, after which, and having become cool, the pits are ready for being opened, when it is found they are reduced to about half their original size.

The charcoal is extracted by means of a rake resembling a light drag, but having much finer teeth, and after becoming quite cold, is stored away until required for use.

Kiln-burning.—The kiln is made of brick, one course being sufficient if bands of iron be added to strengthen the brickwork. It is usually conical in shape, 24 ft. in diameter, with an equal height, and holds about forty cords of wood. The wall of the kiln is carried up nearly straight for about 6 ft., when it is gradually drawn in and made a blunt cone shape. A plate of iron is fastened on the top in the manner of a stone to an arch. Three-inch hoop-iron bands, about an eighth of an inch thick, are placed around the kiln and drawn together by means of screw-bolts and nuts. At the base, and near the top, are double sheet-iron doors, by which it is filled with wood or emptied of charcoal. The time

THE MANUFACTURE OF CHARCOAL.

required to fill, burn, and empty is about three weeks. **Pit-burning**, for estate purposes, is, however, most commonly pursued, and has this advantage—that the charcoal can be made at any place where timber is being felled, without extra expense, save that of the cartage of the charcoal, whereas in using the kiln or retort the wood must, in most cases, be conveyed to the place where it is erected.

Comparative value of woods for charcoal making.—Amongst home-grown timber, oak, ash, and beech are generally preferred for charcoal making, but the following table will show pretty correctly the proportionate relative values of the various descriptions of wood for gunpowder charcoal :

						Per Cent.
Rhamnus frangula contains	...	...	...	...	...	27
Laburnum	...	...	...	...	...	25
Boxwood	...	...	...	...	...	24
Sweet Chestnut	...	...	...	...	...	23
Oak	...	...	...	...	...	22
Holly	...	...	...	...	...	20
Walnut	...	...	...	...	...	20
Beech	...	...	...	...	...	19
Sycamore	...	...	...	...	...	19
Elm	...	...	...	...	...	19
Willow	...	...	...	...	...	18
Poplar	...	...	...	...	...	18
Birch	...	...	...	...	...	17
Alder	...	...	...	...	...	17
Ash	...	...	...	...	...	17
Hazel	...	...	...	...	...	17
Mountain Ash	...	...	...	...	...	17
Scotch fir	...	...	...	...	...	16
Larch	...	...	...	...	...	16

Uses of Charcoal.—The uses of charcoal for estate purposes are very numerous, for horticultural, agricultural, and other departments. From remote antiquity charcoal has been used as a fuel, and for many purposes it is still unsurpassed. It is by far the cleanest solid fuel known ;

it burns steadily, gives out a great amount of heat, and lasts well. On account of its smokelessness it is invaluable for cookery, and it is also admirably suited for use in greenhouse and other stoves. It is not adapted for heating apartments on account of the poisonous gas (carbonic oxide) produced in its combustion, and the danger, most apparent when the charcoal is burnt in an open *chauffeur*, is not obviated by using it in a stove, as carbonic oxide has the power of diffusing through red-hot iron.

In gardening charcoal is largely used for potting purposes for vine borders, and for flower beds; and in the form of dust it is the best material for packing bulbs for transmission to a distance.

Perhaps the most important of the uses to which charcoal can be put about a house or estate is that depending on its extraordinary power of absorbing gasses. It is a perfect deodorant, a preservative of food and all animal substances and a valuable disinfectant. The gasses most readily absorbed by charcoal are those which are most prejudicial to health and which are most frequently produced by putrefactive changes.

In the pores of the charcoal they are destroyed by union with the oxygen condensed from the air. The fact of its being absolutely non-poisonous and perfectly odourless puts it before all other disinfectants.

CHAPTER XXIII

UTILISING WASTE FOREST-PRODUCE.

THAT the production of timber, in common with trades in general, has of late years been rendered far less remunerative than was formerly the case, owing principally to keen foreign competition, is a fact that is now well known, even to the most casual observer. In face of this it behoves us to ask ourselves the question: Do we utilise to the fullest extent the by-products of the forest and woodland, and so diminish waste, and, at the same time, add to the general revenue of the forest department? By waste produce, or by-products, is meant anything other than wood not in the condition in which it is generally used, and includes bark, charcoal, firewood, house and kiln fagots, tar, wood-spirit, turpentine, sawdust, wood-ashes, leaf-soil, etc. That much may be done, both in the economy of production and utilisation of waste produce, is well known to those in charge of woods and forests in every part of the country; and where the by-products cannot well be utilised in any of the above-named ways, it would be better, perhaps, to reduce them to ashes; for, by so doing, insect and fungus life are lessened, and a valuable manure is obtained, particularly rich in potash, whether for grass land or certain farm and garden crops.

The forest by-products of Great Britain and Ireland are, in the main, applied in the four following ways:—

- (1.) Firewood.
- (2.) Charcoal, for heating purposes, etc.
- (3.) Bark for tanning.
- (4.) Fagots, for house and kiln purposes.

Although the British forester has usually little or nothing to do with what we might term the volatile products of the forest—tar, pitch, turpentine, rosin, wood-spirit, acetic acid, etc.—nor, indeed, with paper-pulp, still, it may not be out of place to briefly point out the minor uses to which waste timber and by-products generally are applied.

Tar, which at present is largely imported from the Baltic ports and Southern United States, is obtainable principally from three species of *Pinus*: *P. palustris*, *P. Pinaster*, and *P. sylvestris*.

Pitch is simply tar deprived of the volatile oils, which is brought about by boiling.

Turpentine comes from incisions made in the stems of some of the pines, principally *Pinus palustris*, *P. sylvestris*, and *P. tæda*.

The common silver fir (*Abies pectinata*) produces the famous Strasburg turpentine, while the larch is the source of the Venice turpentine of commerce.

In New England the whole of the younger sapling pines—stem, branches, bark, and leaves—are made into paste-board, while in other countries the lime and poplar are converted into paper-pulp of great value. That the great and ever-increasing demand for paper of all qualities will yet cause a corresponding demand for the material used in producing it cannot be doubted. From the sap of the larch and Scotch firs “coniferin” is obtained, while “rubber,” a valuable product for mixing with gutta-percha, which is very durable, is got from the bark of the common birch by distillation. The value of gorse as a food for horses and sheep is well known even in this country, while in Italy poplar leaves have long been used as cattle-food, and ground fir-needles in Styria for the same purpose.

Dried leaves make excellent litter, and they are valuable as manure; and sawdust, though without manurial value, absorbs liquid manure, and is thus used as an excellent top-dressing. Leaf-mould, too, is well known for its many uses in the garden, as also for top-dressing and mixing with other poorer soils in the making of composts for planting. These are some of the many uses to which the minor by-products

of the forest and woodland are applied, but, as these hardly come within the scope of the forester, special attention will be devoted to the major by-products—firewood, charcoal, bark, and fagots—with which the British forester is most intimately associated.

(1.) **Firewood.**—Never, perhaps, was the subject of English firewood more worthy of consideration than at the present, when timber, speaking generally, is almost a drug on the market, and numbers of unsaleable trees are to be found on almost every averaged-sized estate throughout the country. Many persons—and, perhaps, rightly, too, will maintain that, particularly in districts where coal is abundant, it is very questionable whether there is any advantage to be obtained from burning wood. We have satisfied ourselves that even could wood be procured at less than its present price—firewood price—it is quite as expensive as coal, as sold nowadays in most of our large towns. No doubt, on many large estates where there is a superfluity of unsaleable wood, it would be utter folly not to have it converted into firewood, more particularly as such work gives employment to the woodmen when the inclemency of the weather puts a stop to general outdoor work. But this of itself, is no proof that the firewood when prepared and ready for the grate is not as expensive as coal; for, when the rent of ground on which the wood was grown, the cost of felling, and converting into firewood are considered, it will be found that firewood is nearly as costly as household coal of ordinary quality.

What will it cost to prepare a ton of firewood? is a question that is not very readily answered, the cost of labour in various parts of the country varying so much. In England, generally speaking, the cutting up and stacking of a cord of fairly clean firewood—that is, when large knotty pieces, which require the mallet and wedge for their manipulation, are excluded—cost from 5s. to 6s. Then, how many cords of wood will make a ton of firewood? is another question that is more readily asked than answered, for the difference in weight between equal-sized logs of, say, yew and birch is considerable. For all practical purposes, how-

ever, we may state that about one-and-a-half cords of wood go to the ton of firewood, thus making the cost of preparing and housing the latter about 10s. The lowest price at which we have sold a ton weight fresh cut was 8s., but 10s. is nearer the usual price, or about one-half of what is generally obtained for firewood. The cartage of this ton of wood cannot be less than 3s. Much depends upon distance, no doubt, but it is usually delivered within a radius of two miles for the price quoted.

The whole matter, therefore, stands something like this: Lowest cost of a ton of wood, 8s.; cutting same into firewood and stacking, 8s.; cost of delivery, 3s.—total, 19s.

It will thus be seen that the difference in price between a ton of firewood and one of coal is inconsiderable, and everyone knows which of the two as fuel lasts the longest and imparts the greatest amount of heat.

Of course, where the firewood is cut up during wet weather by the estate workmen and consumed on the estate, the matter will stand somewhat differently, the two principal items, the cost of preparing and cutting—both of which can be done as by-work—being considerably diminished. Then, in districts where the firewood cannot readily be sold, and would only rot in the woods, it is wise policy to have it cut into firewood, not only for the saving of the coal bill, but for the health of the plantations as well.

In mining districts, or on the outskirts of large towns, there is usually little difficulty in getting rid of all surplus wood for firing and other purposes, but it is in thinly-populated, outlying parts of the country, and where the cost of transit is excessive, that the actual difference between a ton of coal and one of firewood has to be considered.

(2.) **Charcoal.**—The chief uses of charcoal in this country are in the manufacture of gun and blasting powders, for heating hall-stoves, cooking, boiling preserves, the smelting of iron, and as a filtering and deodorising agent. It, likewise, occupies an important place in the making of black paint, ink, ivory and lamp black, and as a horticultural requisite in the packing of bulbs and for potting purposes. In the manufacture of gunpowder, for which a highly-inflammable quality

is required, the three principal woods used are the dogwood (*Cornus frangula*), the white willow (*Salix alba*), and the common alder (*Alnus glutinosa*), though not infrequently the hazel, chestnut, and our native *Rhamnus catharticus* are substituted.

Charcoal produced from the dogwood is, however, preferred to any other, it forming a very explosive powder, used for military small-arms and for sporting purposes. For this purpose the dogwood is cut when an inch in diameter, and, if possible, when not more than of ten years' growth.

Although iron cylinders or retorts are more economical in the making of charcoal, yet for various reasons the primitive method of pit-burning is to be recommended for general estate purposes. The manufacture of charcoal in this way having received due attention elsewhere in this book, it need not be repeated here. It should be remembered that small wood is more profitable for charcoal-making than that of too large size, not only because the former requires little or no cutting and splitting, but for the main reason that it can be procured at less cost, and produces more charcoal, weight for weight. Even at the present low price of charcoal—about 10d. per bushel—there is a fair profit attached to the making of it, as will be seen from the following figures, which may be taken as a fair standard. A cord of ordinary mixed wood, which should measure, after being stacked, 12 ft. long, 3 ft. wide, and 3 ft. high, will usually, when properly burned, yield 35 bushels of charcoal, and this, at the low price of 10d., will be 29s. 2d. for the produce of the cord of wood. The cost of cutting this cord of wood, which is always performed by contract, will be at the least 5s., and that of burning 7s.; thus leaving a clear profit of 17s. 2d. per cord for the wood.

Even roots are made into charcoal, and we have seen whole woods grubbed up free of expense, only giving the roots for the labour; but such work is usually performed during the winter, when labour is at a discount. Pinewood is not nearly so valuable for charcoal-making as hardwood, but the former is not infrequently made to realise a profit of from 8s. to 10s. per cord of wood.

(3). **Bark.**—In the past the annual home supply of bark was estimated at about 300,000 tons, but, in addition to this, some 30,000 tons were imported from the Continent; but of late years, with chemical substitutes, the amount is much less. For tanning purposes, oak and, occasionally, larch bark are those principally in use in this country, though both willow and alder are largely used for the same purpose in various countries, principally Russia. Although not at present a valuable product, still, that a small margin of profit, even at the present low price, will accrue through careful and judicious management, is a fact of which we are fully convinced. It is, perhaps, not so well known as it ought to be that of our two varieties of oak, *Quercus Robur pedunculata* and *Q. R. sessiliflora*—the former contains 15 and the latter only 13 per cent. of tannin. The branches, too, down to an inch in diameter, contain a relatively higher proportion of tannin than the bark of the stem.

The stripping and harvesting of oak bark having received a separate paper, nothing further need be said of these here.

(4.) **Fagots.**—These are made of the smaller branches or spray, the remains of charcoal-wood, etc., and tied into bundles similar in size to a sheaf of wheat. They are either left lying on the ground or standing upright in threes or fours together for a few days after being made, and previous to being stacked, which they always are for about six months before being used. In thinning a woodland the fagots are usually bound up by contract at 4s. 6d. per hundred, unless when the wood is exceptionally rough and crooked, when another shilling is added. When stacked and dry they realise about 16s. per hundred in the wood, thus giving a clear profit of 11s. 6d., when we deduct 4s. 6d., for binding, per hundred.

In England the demand for these fagots is considerable, they being used either for kiln purposes, or, when chopped up into smaller bundles, for fire-lighting. These latter are about 9 in. long, and half that in diameter, and are bound tightly round the centre by tarred rope. They sell readily at 2s. 6d. per hundred.

This is a good and profitable way of getting rid of all superfluous spray and branches. Brush or kiln fagots,

which are largely used for brick-burning, consist of all refuse woodland scrub, and when tied up and dry can be sold at from 5s. to 6s. per hundred for the brickkilns. They are made by contract at 2s. 6d. per hundred. By the utilising of this otherwise waste-product, every twig and shrub is carefully gathered together, and the woodlands are thus kept in a neat and healthy condition.

Minor Products.—In addition to firewood, charcoal, fagots, etc., which may be considered as the main by-products of the forest and woodland, there are other minor products, such as are to be met with largely where coppice-wood is grown to any extent, and which will repay the cost of singling out from amongst the above. These may include flower-stakes, tool-handles, walking-sticks, barrel-hoops, chisel-rods, etc., all of which sell readily in various parts of the country.

In cutting the coppice-wood, the longest and straightest poles are selected for hop-stakes, the next size for bean-stakes, pea-boughs, etc., and so on until every part of the wood is utilised.

Leaf-soil, too, sells readily at 5s. per cart-load—indeed, near large towns the demand for this and peat often exceeds the supply. In all cases it may not be wise policy to remove this valuable soil from the woodlands, even at the high price offered.

Half-decayed leaves, too, are much sought after where market gardening is largely carried on, they being used in the forming of forcing-beds, and for preserving plants and roots from severe frost.

CHAPTER XXIV.

HEDGES, THEIR FORMATION AND MANAGEMENT.

STRICTLY speaking, hedges are divided into two distinct kinds—useful and ornamental—the former being employed for keeping farm-stock in bounds, and the latter in the subdivision of gardens and for lawn and park purposes generally. Where the fences are intended for protective purposes, either the thorn, beech, hornbeam, or holly are the plants usually employed, while for ornamental garden sub-divisions almost any shrub may be used, the choice of which will lie with the operator.

Amongst all the trees and shrubs that have been found suitable for the climate of Britain, none equals the common whitethorn, or Quick, for hedge-formation, where strength and shelter are points of first consideration. The beech certainly can thrive better on exposed and high-lying ground and where the soil is poor and thin, but it never forms so durable a protection against farm-stock as the thorn.

When properly treated the thorn is a fast grower, and as a fence plant it is ornamental, smooth, stubborn, and long lived. It is also not at all subject to disease, and is very readily propagated. Few soils come amiss to the thorn—that is, if they are not overcharged with moisture, but it delights in a rich hazelly loam.

(1.) **Plantation Hedges.**—Preparing of the Ground and Planting.—Thorough preparation of the ground where live fences are formed should take precedence of all other operations—indeed, nothing can repay the planter more

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satisfactorily than the previous suiting of the land, in the way of draining and trenching, to the plants intended to be inserted.

In all cases we have found it pay well to have the ground trenched to the depth of 2 ft., and about 3 ft. in width, and a quantity of manure incorporated at the same time. If this can be done some months before planting the thorns or other fence plants so much the better, as it gives time for

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the loosely-upturned soil to get mellowed and sweetened, as also for the manure to get well decomposed. In all cases it may not be necessary to apply manure, but, where the soil is at all poor, the adding of a quantity of well-rotted manure has a wonderful effect in stimulating the quick into active and strong growth. The vigour and rapidity assumed by a hedge, when the soil has been well worked and manured, over that otherwise treated is somewhat

remarkable, and in all cases amply pays for the increased labour and expense bestowed on the fence.

It is well to plant rather above than below the general ground level, so that in trenching the soil a slight mound may be raised along the intended line of fence, which will not only materially assist in keeping the plants from excessive moisture, but aid in the cleaning and general management of the hedge. Where superfluous moisture is present in the soil the hedge-and-ditch system is to be recommended, which consists in digging out a ditch parallel by the line on which it is intended to place the fence. It should be 3 ft. deep, 5 ft. wide at top, and 1 ft. at bottom, and the soil removed in so doing is thrown upon that side where the hedge is to be planted, thus forming a mound, or rather ridge, on which the plants are to be placed.

In wet soils such a ditch is indispensable, but, under ordinary circumstances, it is to be condemned, and for the simple reasons that it is expensive and rather against than in favour of the free growth of the fence.

Thorn or Quick.—The best time to plant the whitethorn is just after the fall of the leaf in the autumn; but the operation is usually extended from that time until early spring, though in the latter case perhaps with less satisfactory results.

In selecting the plants a great amount of care is necessary, as well, indeed, as in the lifting and after-planting. Four-year-old plants are best suited for hedge-formation, and they should be stout of growth and well-rooted. The size of the plants is of more importance than the age, and those with stems as thick as one's finger are to be preferred to others of greater height, but lank and small of stem. Frequent transplanting whilst in the nursery-border should have been paid attention to, as then the roots are bushy and fibrous and well suited for planting out permanently.

Great damage is usually done to thorn plants by careless lifting, and, worse still, by bundling the plants in hundreds ready for the planter. This should never be tolerated, as it is quite evident that, when tied up in bundles and covered

over with soil, the plants in the centre of each bundle get dust-dry and fall a prey to the searching winds of spring.

Plants should in all cases, where it is possible, be lifted and replanted within the week, but, much better still—and this is readily effected where a home nursery is on the estate—on the same or the following day.

In planting, stretch a line along the centre of the prepared ground, and close to the line take out a perpendicular trench with the spade of sufficient size to allow of the roots of the plants being spread out to their full extent. From 6 in. to 8 in. will be found a convenient distance apart to place the thorns, and they should not be planted deeper than they stood whilst in the nursery border, which will readily be seen by the mark on the stems. A small quantity of fine soil should now be placed next the roots, and this firmly trodden, the remainder of the soil being added afterwards. Dibbling the plants is sometimes recommended, but, in our own opinion, it is a dangerous practice and to be avoided, the roots necessarily being thus confined to small space and placed in an unnatural position. Planting in single line is also preferable to inserting in double line, as, by the former method, the strongest and most durable fences have been formed. Some planters cut back the young plants to within 2 in. of the ground, and the practice, although not readily reconciled with physiological principles, is to be recommended. It is unquestionable that headed-back thorns shoot out with greater vigour, and become thicker, than such as have been left untouched, but the fact that they are then greedily devoured by ground game has somewhat caused the practice to fall into disuse, at least where game is abundant and the cost of fencing cannot be entertained.

The **Beech**, as a hedge-plant, must not be despised, it being a rapid grower on most soils, and soon forming a very valuable fence. In rich soils it retains a great proportion of its leaves during winter, and is, therefore, an excellent shelter-plant. It, however, wants the rigidity of the thorn, and for that reason is not very suitable for planting where farm stock have access. It may be planted in a manner

similar to that recommended for the thorn, only the individual plants should stand farther apart.

The **Hornbeam** makes a good live fence, and will grow readily in any fairly good soil and not too exposed ground. It may be treated similarly to the beech.

Privet—both the common and oval-leaved—have been largely used, along with other plants, in the formation of hedges, for which they are peculiarly suitable. They, however, want stiffness, so as to be able to cope against farm stock, and for this reason are principally used in ornamental garden sub-divisions.

Gorse or Furze.—Strikingly beautiful as well as useful hedges may be formed of the gorse. It is well adapted for planting on light dry or sandy soils, or on the top of a dyke or sunk fence.

Seed sowing is to be recommended in the formation of gorse fences, and after preparing and well working the soil, 1lb. of seed to every 100 lineal yards will be found sufficient for sowing down. It should be remembered that in order to keep the fence full and bushy pruning should take place immediately after flowering and before seeds are produced.

By cutting over the hedge at ground level every third year great good will be brought about.

(2.) **Ornamental Hedges.**—**Holly.**—This makes an excellent ornamental fence, and it is occasionally used for plantation purposes, though rarely. The ground should be thoroughly prepared, and, if necessary, enriched by a dressing of strong loam, and the plants inserted in May.

Yew.—For purposes similar to the latter, the yew is generally in use. It may be planted at any time, but should be kept well watered until it has become established.

Laurustinus.—As a flowering hedge for garden or lawn purposes few shrubs are of greater value than the laurustinus, particularly in maritime districts. In severe winters it suffers, though generally fresh growths are sent up from the rootstock. Pruning should be carefully done, so that the flowering shoots are not cut away.

Box.—Very neat and serviceable garden fences are made of this plant. It grows freely, and stands pruning well.

Rosa rugosa and **R. rubiginosa** (Sweet Briar).—Both these species of rose have come greatly into favour for garden subdivisions, for which they are peculiarly suitable. They make charming hedges, are of easy growth, and stand pruning with impunity. Of course, where they are wanted to flower great care in pruning is necessary.

Laurel.—Both the common and Colchic laurels make fairly good hedges, but they are apt to get gappy by portions dying out. This can, however, easily be remedied by substituting others instead. They bear trimming well.

Aucuba japonica forms a useful and ornamental hedge, stands pruning well, and lasts for a long time.

Berberis Darwinii and **B. stenophylla** are both highly ornamental hedge shrubs, and when not pruned too severely flower with great freedom. Shortening the long shoots with a pocket knife is best.

Cleaning and Pruning.—An annual cleaning of the ground alongside hedges must never be neglected, weeds robbing the soil of its nourishment, choking the young plants, and to a great extent, preventing the free access of rain to the roots of the hedge plants. The common hoe is, for this purpose, to be recommended, and any weeds that cannot be got at around the stems must be removed by the hand. Ivy, elder, and honeysuckle should all be treated as weeds, for they are highly injurious to hedges, be these young or old.

Very little, if any, pruning or switching should be done till the third year after the fence has been formed, and then only the longer twigs cut back, so as to get by degrees a general uniformity of shape. The switching-knife is alone to be recommended for pruning fences, shears never making a clean cut, and pressing and loosening the bark at the point where amputation took place. A well-sharpened switching-knife in the hands of a dexterous hedger turns out beautiful and commendable work.

Unless it be an annual cleaning and trimming, a well formed hedge should require but little attention for many years. Should it, however, when old, begin to show signs of distress and become gappy, a top-dressing of rich farm-

yard manure will go a great way towards throwing fresh energy into the plants. This should be applied in winter, and lightly forked in the following spring, and before growth has commenced. Should gaps occur by reason of deaths in the old plants, these should be removed, and others of young growth substituted, the soil at the same time being dug out and other fresh from a field or roadside used instead. Great care should be exercised that the roots of living plants are not injured whilst removing the dead and substituting the live specimens. Specially-prepared plants that are unusually stout and bushy should alone be used in hedge-repairing.

CHAPTER XXV.

FENCING PLANTATIONS.

BEFORE commencing to plant almost any piece of ground, it is absolutely necessary to have it securely fenced against the inroads of farm stock. Many different methods of fencing are adopted throughout the country, each one, no doubt, possessing peculiar advantages according to the circumstances in which it may happen to be required.

In hilly districts where stones are abundant, very efficient fences of such may be made, turf dykes on high-lying grounds where stones are not readily procured, and iron or wood wherever fancy dictates.

The term “dead fence” may be applied to these in contradistinction to “live fence” or hedge, to which the previous chapter is devoted.

To describe even a tenth part of the various fences nowadays erected would be a by no means easy task, but typical examples of each kind will be explained.

(1) **Stone Walls.**—These make capital fences, but are at first rather expensive, and unless well-built require a good deal of attention in the way of repairing breaches. They possess a great advantage over most other plantation fences in the amount of shelter afforded to the young trees. Two

methods of building are usually adopted; first, where stones are abundant, the entire wall may be of these; and, second

so as to be economical, the wall is built a certain height and wires placed a-top.

The dry stone wall, as this is usually termed, is built without mortar, with the exception of the cope-stone, which in all cases should be bedded in and pointed with lime.

From 4 ft. to 5 ft. is the usual height, the foundation being from 22 in. to 24 in. wide, and 14 in. across beneath the cope-stone, the latter being about 10 in. high and placed on edge. Great care is necessary in building to see that the "throughs" or binding-stones are placed in position as on this depends mainly the efficiency of the fence. Where wires are used a-top, the wall need only be 3 ft. high 22 in. wide at base, and 12 in. under the cope-stone. The latter are bedded in mortar, and an extra large stone is placed every 6 ft. apart for receiving the iron standard, to which the wires are attached. Slate slabs, where these are readily procured, may be used for a similar purpose to the iron standards, but they are built firmly into the wall, and reach from the base of the foundation. Two, and sometimes three wires, are used a-top of the wall.

(2.) **Slate Fences.**—These are commonly in use throughout Wales, in fact, wherever slate quarries are worked. When well erected and of fairly regular-sized slates this fence is certainly not to be despised, and it may be considered as practically indestructible. The expenses incurred for keeping these fences in repair are also very little, as they seldom become damaged, and when an upright chances to get broken, another whole one can easily be substituted, and without interfering with any other portion of the fence. The size of slate pale, or slab, as usually termed, is 5 ft. long, 4 in. to 6 in. wide, and about 1 in. in thickness. In erecting the fence a trench is cut about 12 in. wide and 8 in. deep, care being taken that the trench is cut perpendicular, so as to insure the pales standing in a similar position. These are placed upright in the trench, about 3 in. apart, with their flat side close to the perpendicular cut and the soil replaced in the trench and made firm with a rammer.

A double wire is then tightly interlaced about 3 in. from

FENCING PLANTATIONS.

the top of the pales, and given a double twist between each thereby insuring great stability by uniting the fence and keeping the pales at equal distance apart. The straining-posts are also of slate, 6 ft. long, 6 in. wide, and 3 in. thick.

SLATE FENCES.

(3.) **Turf Dykes.**—These were formerly much used in moorland and outlying districts, where stones are not abundant, and where, from the nature of the soil and situation, hedges

would not succeed. They are, at best, troublesome fences to keep in repair, and require some adjunct either in the way of wires a-top, or to be planted with gorse or other suitable shrubs. One advantage is the great amount of shelter they afford to the young plants, while they are, comparatively speaking, cheap of erection. There are several methods of building turf dykes, the best being to cut or pare the turf 3 in. in thickness and in one or more lengths to suit the width of the dyke, and of a convenient breadth: they are laid cross-wise one above the other. Both sides of the dyke should be built at once, giving the necessary batter as the work proceeds, and the grassy surface of the turf placed to the outside. The dyke is usually made 3 ft. in height, 3 ft. wide, and drawn gradually in to 12 in. at top. A two-rail fence surmounts the dyke, bringing the total height to $4\frac{1}{2}$ ft. or 5 ft. Sometimes a ditch is cut alongside the dyke 3 ft. wide about $2\frac{1}{2}$ ft. deep, and 9 in. wide at bottom, which prevents the farm stock getting at and damaging it, the soil removed being used in forming the fence. By sowing gorse and broom seeds on top of the dyke an excellent shelter fence is obtained.

(4.) **Wood Fences.**—These are common on almost every

SAWN WOOD FENCE.

estate throughout the country, especially such as are well wooded, and, owing to the low prices obtainable for home

grown timber, it is well that such should be employed as widely as possible. The rustic appearance of wooden fences is also much preferred by many owners of property to those erected either of stone or iron.

Wooden fences are, therefore, sure to be largely employed when the appearance of the property and not too-exacting financial results are points of importance.

There are many forms of wooden fences adopted, these varying chiefly according to the particular use to which they are applied; and the following descriptions are only of such kinds as are generally in use for woods and plantations. Here it might be well to mention that only matured and seasoned timber should be used in fencing, the cost of erection, whether of good or inferior wood, being alike, and everyone knows which will last longest.

A good strong fence is erected as follows:—Posts, 5 ft. 9 in. long, 4 in. broad, and $2\frac{1}{2}$ in. thick; bars or rails, 9 ft. long, by $3\frac{1}{2}$ in. by $1\frac{1}{2}$ in. Four holes are mortised in to the posts for the reception of the bars, the ends of which are so formed as to overlap each other tightly. The fence is usually 4 ft. high, and so as to strengthen the horizontal bars a stake is driven into the ground midway between the larger posts, and to which the rails are securely nailed. In some cases the posts are not mortised, so that the bars require to be attached by nails.

For park clumps, particularly where a substantial and neat fence to keep back horses, cattle, or deer is required, the following, though rather expensive at first, is largely employed. The entire fence is made of oak or Spanish chestnut as shown on following page.

Posts 7 ft. long, 6 in. by 4 in., and run out with the circular saw. Rails triangular, about $3\frac{1}{2}$ in. to the side. The uprights are rent from oak or chestnut trees of straight grain, and are usually about $\frac{3}{16}$ of an in. thick, and 5 ft. high. At 6 ft. apart the posts are erected, the rails being mortised into these, and the rent uprights fastened at about 2 in. apart by patent rose rails to the horizontal rails. A fence of this kind, when properly erected, will last for forty years, especially if the butts of the posts were charred previous to being inserted in the ground.

FENCING PLANTATIONS.

Rustic fences for small tree clumps may be of almost any design, but the following is cheap and easily erected. It is formed of larch posts 6 ft. long, and about $4\frac{1}{2}$ in. diameter, driven into the ground at 6 ft. apart. Two flat or rounded rails about 3 in. by $1\frac{1}{4}$ in. are nailed horizontally to these, the lower at 9 in. from the ground and the other flush with the top of the posts, which when driven are at 4 ft. from ground level. The uprights are also of larch, split up the centre and nailed on the horizontal bars at 2 in. apart. They extend above the top rail for 7 in., and so as to be unclimbable are sharply pointed.

(5.) **Wire Fences.**—These may be erected either with iron or wooden standards and straining posts. The form most commonly in use for enclosing woods is that with wooden posts and strainers, these being made of mature and

WIRE FENCE WITH WOODEN POSTS.

thoroughly seasoned larch or oak. The strainers are 7 ft. long and 6 in. square, or, if round, about 7 in. in diameter, while the intermediate posts are $5\frac{1}{2}$ ft. long, and $3\frac{1}{2}$ in. by 3 in., or, if round, $3\frac{1}{2}$ in. diameter at smallest end. The strainers should be fitted into the ground at 150 yards apart, and the posts driven firmly at 6 ft. from each other. At every sharp curve along the line of fence a stout post, say 5 in in diameter

should be used. So as to make a stout fence proof against cattle and sheep, six wires should be used, the two top No. 6, and the others No. 7 gauge, the distance between each, beginning at the top, being 8, 7, 6, $5\frac{1}{2}$, and 5 in., the lower

TOOLS FOR FENCING.

being 5 in. from the ground. Brackets for straining the wires should be attached to each of the strainers, these having the advantage over the older system of using the straining machine in that the wires can be loosened or

tightened at will, when repairs are found necessary. The tops of the posts should be rounded off or sawn on angle so as to prevent the lodgment of water. Iron and wire fences combined are now commonly in use, and there are so many excellent systems that it would be invidious to recommend one kind more than another.

Iron box fencing, which consists of standards with double pronged feet for fixing in the ground and round or flat horizontal bars run through them, has been largely used and looks neat, as well as, if properly erected, very efficient. Wrought iron hurdles are sometimes used for fencing park clumps, and they possess at least this advantage, that they can be lifted at any time and re-erected readily should it be found necessary to remove them from one place to another.

(7.) **Tree-guards.**—These may either be erected of wood or iron, the former is, however, preferred on most large estates and will receive first attention. For large trees whose branches sweep the greensward an elaborate structure is required, which may take the form of almost any of those described under wooden fencing. That entirely formed of oak is to be recommended, or split larch for uprights, with oak posts and rails may be considered more rustic in appearance. In any case the guard should be sufficiently high and wide to prevent cattle and horses reaching over to damage the branches.

When the trees are destitute of branches for a considerable distance up the stem, say 8 ft. or 10 ft., a very neat and efficient guard is made as follows:—Procure a number of larch, oak, or Spanish chestnut poles, 7 ft. high, and about $2\frac{1}{2}$ in. diameter at small end. Thread these on wires by boring holes in the poles at 2 ft. and 5 ft. from the butt end, keeping each couple separate by 3-in.-long pieces of the same size of pole, also threaded on the wires. These can be formed on the level, and when sufficient to embrace the tree have been got together, the whole may be lifted up and placed in position closely around the trunk. Another method is to bind the poles together with fencing wire, giving a double twist between each, thus keeping them at a suitable distance apart.

When a more elaborate fence or guard is required four posts 7 ft. long, 4 in. square, and sawn from crooked oak branches, are used. The posts are quite straight for 5 ft. in length, the upper 2 ft. being inclined outwards

TREE GUARDS.

which not only gives the guard a neat appearance, but is a great preventive against the encroachments of farm stock. The posts are inserted nearly 2 ft. in the ground, and so as

to form a square around the stem of $4\frac{1}{2}$ ft. to the side. Four bars, each 3 in. wide by 1 in., are nailed horizontally on the straight portions of the posts, and at equal distances apart from where the angle occurs downwards; upwards from that three hoop-iron rails are nailed in a similar manner, the top one being one inch below the level of the crown of the posts. Iron has a light and neat appearance when used for the top bars, but wood is often substituted. Another cheap and neat tree-guard for using with the rarer trees, where cattle has not access is made as follows:—Palings 3 ft. long, 2 in. wide, by $\frac{3}{8}$ in. thick. are sawn out and pointed. They are driven into the ground round the tree to be protected, the tops sloping outwards and $1\frac{1}{2}$ in. apart. Stout tying wire is then interlaced at two heights from the ground.

Oak or chestnut bark placed loosely around clean-stemmed young trees, will prevent damage by ground game.

CHAPTER XXV I.

BRITISH TIMBER AND SOME OF ITS USES.

THE following is a brief account of a few of the many uses to which home-grown timber may be applied.

Oak has long been associated with our national defence as the chief element in ship-building, but although iron and steel have, to a great extent, taken its place, yet for barges and small boats, the timber is still largely used. Wagons for railway mineral traffic are largely made of oak, while the builder finds in it his best material for the strong frames of domes, spires, and roofs of public buildings. It is also used for the bottoms of carts and wagons, cart-wheel spokes, fencing, furniture-making, railway "sprags," charcoal, etc.

Ash timber is largely used by agricultural implement-makers, it possessing great elasticity and bearing considerable cross-strain. It is the best wood for shafts of all kinds, for tool handles, wooden rakes, and is largely used by furniture makers.

Beech wood is the chief constituent in the making of cane-bottomed chairs, and is largely employed for the handles of joiners', carpenters', and other wood-worker's tools. For gun stocks, saddle-trees for heavy harness, wheel-felloes, and bobbins it is largely employed. When of large size and clean growth it is used for calendar machines, and for engineering purposes in spinning and bleaching districts. It makes excellent charcoal.

Sycamore timber is peculiarly white and smooth and free from grain, which makes it valuable. It is used for curtain rings, churns, butter prints, backs of violins, founders'

patterns, cutting boards, and in the making of wooden vessels and furniture. For calendar machines and in cotton and jute factories it is much employed.

Elm wood is extensively used for the boarding and flooring of carts and wagons, in coffin making, for the framework and foundations of bridges, naves for wheels, and the keels of boats and ships. It makes strong furniture, and is often substituted for ash in making agricultural implements.

Chestnut (Spanish) timber more nearly approaches that of oak than any other species, and when stained is not only substituted for it but the walnut as well. For piano sides it is largely used, as also for rafters in open-roof churches, for furniture and cabinet work, ship-fittings, sign-boards, and post and rail fencing.

Lime.—The wood is white and very fine of grain and used for carved work, sounding boards for musical instruments, wagon breaks, packing boxes, toys, domestic utensils, and for shoemakers' and saddlers' cutting boards. Charcoal for gunpowder is made from this wood.

Birch wood is largely used for turnery work, thread bobbins, clog soles, shoe pegs, furniture making, hatters' blocks, in the manufacture of brushes, and in toy making.

Alder is used extensively for clog-soles, barrel staves, mill-bobbins, and occasionally in furniture making. It makes excellent charcoal for cooking and heating, as well as that used in the manufacture of gunpowder.

Horse Chestnut.—The timber is largely used for packing boxes, moulding patterns for castings, cutting boards, manufacture of brushes, and other common uses.

Poplar wood is wooly and teraceous, and for this reason is made into the bottoms of stone carts and barrows. It is well adapted for making packing cases, railway breaks, weather boarding, and for purposes where lightness is of greater importance than durability. The Abele, or white Poplar, produces perhaps the most valuable timber of any of the numerous species.

Hornbeam timber for cogs in mill gearing is well-known, also in "bushing" for saw-mill rollers, and for skittle pins.

Willow is famous for the production of the best class of cricket bats, and makes good charcoal.

Apple and **Cherry** wood, when of large size, are used for cabinet purposes, and stained in imitation of other woods. For veneers, golf clubs, bowls, etc., they are of value, as also for weaving shuttles.

Holly is used by mathematical instrument makers, for fancy turnery and inlaid work, and is often sold as ebony when "ebonized."

Yew wood is valuable when employed for veneering.

Walnut timber is much in demand for gun and rifle stocks, for the best classes of furniture, and for veneering purposes.

Maple is employed in the turning of bowls, for toys, and "bird's eye" Maple for furniture.

Larch.—The wood of this tree is largely used for fencing boat building, permanent staging, and pit wood.

Scotch, Spruce, and Silver Fir may all be classed under the same heading, being of about equal value and applicable for similar purposes. For sleepers and pit wood, boarding under slates, heading for barrels, stores, soap boxes, temporary fencing, also into planking for lead works, and all erections of a temporary kind.

CHAPTER XXVII.

BLASTING AND BURNING TREE ROOTS.

BLASTING by gunpowder or dynamite is not only the most expeditious but cheapest method of clearing away stumps and large logs. In doing so great care must be exercised to bore the hole in the right place and not to use too much explosive. For blasting powder the hole should be $1\frac{1}{2}$ in. in diameter, and should penetrate to the centre of the stump. It should not be too low down, lest the bottom should blow out and the force be expended in shattering the ground instead of the stump or log. In selecting the spot to bore for the powder, insure an equal thickness of wood all round, and even splitting of the log

BLASTING AND BURNING TREE ROOTS.

will be the result. The following is a good way of putting in the powder :—For large stumps of from 2 ft. to 4 ft. in diameter about $3\frac{1}{2}$ in. depth of coarse blasting powder should be inserted in a hole $1\frac{1}{2}$ in. in diameter. The end of the fuse should be put into the centre of the powder, and left protruding for 15 inches outside the hole, this being filled with dry sand, which is consolidated or packed around the fuse by means of a coarse iron wire.

The outside end of the fuse should be teased out and lighted with a match, and as it will require over a minute for the fire to reach the powder time is given for the finding of a place of safety.

Burning Tree Stumps.—With a 2-inch auger bore a vertical hole in the centre of the stump from the top towards the bottom. In the side of the stump, near ground-level, bore a horizontal hole towards the centre, so as to open into the bottom of the vertical hole, drop some fire down the vertical hole, and the draught of air entering by the horizontal hole will, like the draught of a chimney, maintain the combustion of the fire in the centre, which slowly spreads and ultimately burns away the stump.

Another and equally simple method of destroying stumps of trees is as follows:—In autumn bore a hole 2 in. in diameter and 18 in. deep, put in $1\frac{1}{2}$ oz. of saltpetre, fill with water, and plug up close. During the following spring put in the same hole half a gill of kerosene oil and then light. The stump will smoulder away without blazing, down to every part of the roots.

CHAPTER XXVIII.

TIMBER MEASURING.

To those who are not practically acquainted with the measuring of home-grown timber the following brief remarks in elucidation of the subject will be useful. It may, however, be well to mention that timber-measuring is rather a vexed question, some following what is known as Hoppus's system, and others advocating that of Horton. As the former is that generally in practice amongst timber merchants in this country, and consequently of greatest value to the forester, it will be followed up here.

Regarding the timber-measurer's equipment it may first be necessary to say a few words. This consists of a 66 ft. Chesterman's tape-line, or instead of this a 5 ft. wooden rod, standard girt-strap, scribe knife, and bent piece of iron, with eye at end for drawing the girt-strap beneath such trees as the arm cannot readily pass under.

A piece of thin whipcord or string is frequently used for girthing timber, but as the elasticity of this varies greatly, and has in many instances led to dispute, a much fairer plan, and one that is liable to no abuse is to use the 12 ft. girt strap, upon which every inch in length is reckoned $\frac{1}{4}$. The proper quarter girth can, on this strap be seen at a glance, and by adopting it the usual trickery to which the string and rule is liable is quite done away with.

For entering measurements the most convenient book is that 9 in. by 4 in., with stiff pasteboard covers, ruled with

horizontal lines, and divided into four vertical columns. To measure proceed as follows :—Mark a number with the scribe on the butt end of the tree, and enter a similar number in the first column of the book, which will serve not only to identify the particular log, but prevent any risk of measuring twice. Should the taper throughout the whole length of the tree be tolerably gradual, set down the length in the second column of the book, opposite the number already entered. At exactly one-half of the length of the portion measured take the girth by passing the girt-strap tightly around the stem. Put this down on the third column on the same horizontal line as the number and length. Should, however, as frequently happens, the trunk taper not be fairly uniform throughout the entire length, several measurements may require to be taken.

As example, a tree may be 36 ft. in length, running of regular taper for perhaps 12 ft., after which it branches out, reducing the size of the remaining part very considerably for, say another 12 ft., where it again branches and leaves the last 12 ft. of a relatively small size. With such a tree it would be quite impossible to obtain anything like a correct measurement by taking only one length and girth. The difficulty is, however, readily got over by first measuring the lower 12 ft., then the second, and third, giving the respective lengths and girths in the same vertical columns as already described.

The measurement of these trees, in so far at least as the field work is concerned, is now completed, the contents being made up at leisure, by referring to "Hoppus's Measurer"—a book with which every forester should be supplied. By squaring the quarter girth in inches, multiplying by the length in feet, and dividing by 144, the same result will be obtained. This is, however, a tedious method, especially where large numbers of trees have to be dealt with, and should only be adopted when Hoppus is not at hand.

By committing to memory the following short table of quarter girths much time in calculating and consulting authorities will be saved.

TIMBER MEASURING.

6-inch quarter-girth will give contents equal to $\frac{1}{4}$ the entire length in feet.

7	„	„	„	$\frac{1}{3}$
8 $\frac{1}{2}$	„	„	„	$\frac{1}{2}$
10	„	„	„	$\frac{2}{3}$
12	„	„	„	
13	„	„	„	1 $\frac{1}{4}$
14 $\frac{3}{4}$	„	„	„	1 $\frac{1}{2}$
16	„	„	„	1 $\frac{3}{4}$
17	„	„	„	2
19	„	„	„	2 $\frac{1}{2}$
21	„	„	„	3
22 $\frac{1}{2}$	„	„	„	3 $\frac{1}{2}$
24	„	„	„	4
27	„	„	„	5
29 $\frac{1}{2}$	„	„	„	6
31 $\frac{3}{4}$	„	„	„	7
34	„	„	„	8
36	„	„	„	9

The sliding rule is useful for determining contents.

The proper allowance to be made for bark is half-an-inch for oak and elm under 12 inches girth, and an inch for all beyond, but it is quite impossible to fix upon any one uniform scale that will meet even the majority of circumstances. Trees growing in exposed situations will frequently have bark almost double the thickness of those of a similar size in the woodland. My plan has always been to allow for the bark of each tree at the time of measurement.

Measuring Standing Timber.—For this a pliable pole 18 ft. long, marked in feet, and the girt-strap already referred to are the necessary equipment. In estimating the number of feet of timber upon a large area, it is not always necessary to measure each tree separately, particularly when the whole plantation is composed of one species, and the individual trees are of about the same age and size, as by multiplying the number of specimens by the average content per tree, a very just calculation will be arrived at. Great care in the selec-

tion, and considerable judgment in taking the average will, however, be required.

When each tree is to be measured separately two assistants will be required, one to carry the 18-ft. pole, and the other the girting-strap. Sometimes, when the timber is of great height, jointed bamboos are used, and a light ladder brought into request.

In going to work, the man with the pole declares the height of the tree, and the one with the tape the quarter-girth.

Measuring the height of trees.—There are several methods of ascertaining the heights of trees, but the two following are, perhaps, the most simple and the appliances inexpensive :—

No. 1.—Take three laths, such as bricklayers use for tiling, and nail them in the shape of the frame; $a a$ must be of equal length; a and b being placed on the ground, the eye must follow up the larger lath $d d$ until it is in a line with e , the top of the tree or object you wish to measure.

The frame must be placed as level with the bottom of the tree as possible. Should the ground be very uneven you must give and take accordingly.

It will be seen that b to c is the same length as b to e .

No. 2.—Suspend the triangle between the thumb and forefinger of the left hand, knuckles down, upon the point $a a$, allowing it to swing freely. The edge $b c$ will then fall perpendicularly, and $c d$ will be horizontal. The remaining edge $d b$ will then lie at the angle of 45° to the horizon. On this edge are two sights, e and f . Look through e until f is aligned with the tree-top, advancing or retiring till the sights point exactly to it.

Then, if the observer's feet are level with the tree root, the height of the tree is the distance from his feet to the root, plus the height of the eye from the ground.

TIMBER MEASURING.

CHAPTER XXIX

LEVELLING.

IN the carrying out of drainage operations in connection with the formation of new plantations, but particularly where the land is nearly level, one of the most necessary implements is the spirit-level or theodolite. There are many other operations, as well as in connection with draining, where the level and a knowledge of its working are all-important for the forester. Thus in the formation of roads and paths, levelling of ground inequalities, lake and pond forming, etc., the level will be found an almost indispensable instrument—in fact it cannot well be done without.

FIG. 1.

SPIRIT LEVEL.

Of levelling instruments there are various descriptions, but the simplest of any is the ordinary spirit-level, it being cheap, easily carried about in the pocket, and when erected

b g, *c l*, and *d n*, are inserted in a column headed *Foresights*, and the heights *a e*, *b h*, *c k*, and *d n* in a collateral column headed *Backsights*. The difference between the sums of the numbers in these two columns will be equal to the height of one extremity (*a*) of the line, above the other (*d*). When a number of levels have to be taken in succession it will be found a saving of time to use the Surveyor's level or theodolite instead of the ordinary spirit level illustrated on previous page.

With regard to the use of the instrument as shown in Fig. 1. it may be necessary to state that the height of the eyesight *b* from the ground must be deducted from the point observed. As an example: if the object-pole or staff be marked in feet and inches, and the hair wire in taking a sight strike the same at, say, 8 ft., then, if the eyesight be 4 ft. from the ground, the difference of level between the two stations (instrument and station) will be 4 ft., that is, there will be 4 ft. of a fall from the spirit-level station to that of the station where the staff was placed. On the other hand, should the hair wire strike the object pole at, say, 2 ft. from the ground, these 2 ft. must be deducted from the height of the eyesight, which, as we have said, was 4 ft., then the ground at the station-pole must be 2 ft. higher than that at the spirit-level.

CHAPTER XXX.

DECLINING WOODLAND INDUSTRIES.

Though prices of home-grown timber have rather increased of late years, yet many of our time-honoured woodland operations have now well nigh become things of the past.

A century ago oak bark sold in the London market at about £20 per ton. Now, lucky does the forester consider himself who can secure one-fifth of that amount, or £4 per ton; coupled to which it may be said that the labour now involved is at least one-fourth higher. At no very remote date throughout the length and breadth of our land bark-stripping, or "flawing," was commonly practised, and was justly considered as an industry of purely English origin. Now, however, unless in a few isolated instances, the hut of the bark stripper, the gentle ring of the wooden mallet, and the far reaching trestles of cream-coloured bark, which were the pride of the woodman and beauty of the woodland glades and margins, are almost things of the past, foreign competition and the substitution of chemicals for tanning purposes having dealt a death blow to this industry of our forefathers.

Whether it is likely to be revived again is very doubtful, though the results obtained from chemicals in leather tanning are anything but satisfactory, and cannot compete with the time-honoured preparation obtained from the best class of oak bark.

At one time, and not so long ago, the cultivation of osiers for basket-making held a prominent place in the work

of the woodman and farmer, but now with preferential railway and boat rates, combined with labour expenses over which we have no control, the industry has quite passed out of our hands, and the old, and at one time highly-remunerative osier beds of the Thames Valley and many other places, have almost ceased to exist. French and other continental willows have almost entirely ousted the British-grown wand from the market, and what at one time was a flourishing native industry, and gave employment to a large number of men, women, and boys, has passed from us for ever. It may appear strange, but it is nevertheless a fact, that two brothers engaged in willow culture, one in the Channel Islands and the other only a short distance from the great metropolis, are almost placed on the same footing as regards delivery of their produce to the London market; in fact, the brother from his island home can deposit his osiers in our market at a cheaper rate than those from one of the home counties are delivered. I know of not one but many examples of the once remunerative willow beds of our forefathers being now neglected jungles for the production of poles and firewood.

The hut of the charcoal burner was, not a century ago, a prominent feature of the great forest remains of England, but I believe I am within bounds in saying that there is not one to-day for each of the best wooded counties. Kentish forests at one time teemed with the familiar charcoal burner, and right brawny and thrifty were these natives of the woodland with their rustic wooden huts and piles of rifted firewood. What a change! The ring of the axe and merry laugh have disappeared for ever from our woodland glades and margins. Nowadays charcoal can be delivered cheaper from Continental ports than we are able to manufacture it in England, but about the quality the less said the better.

Fagots too, are being slowly but surely ousted from the markets by the little bundles of cleft wood which are displayed by the door-step of almost every second-class grocer throughout the country. When we think that, in order to compete with late day substitutes, the

“pimp,” or fagot of the present day, has to be delivered in the London market at 2s. 6d. per hundred, the reasons for a dying-out industry will not be hard to seek, and I might add that this was the Government contract price not so long ago. With the decline of the small fagot or “pimp” came the speedy reduction in price of the large or oven fagot, from which the smaller were made. Even in our own day these latter have brought from 18s. to 20s. per hundred, but at present they are in many places a drug on the market. Paupers and casuals to our unions are now compelled to split into firewood a certain quantity of useless batten ends, the refuse of our timber yards, each day, so that the value of our woodland branches as converted into bundles for fire-lighting is being reduced in every way.

These are only a few of the many industries of our woodlands which have become crippled, or quite lost sight of, of late years from one or several causes, the majority of which are quite beyond our control, but it still behoves us to meet, with a bold front, the changes which time have brought about, whether in the way of preferential carriage rates, foreign importations, or cheaper Continental labour.

WOOD LEOPARD MOTH

(*Zeuzera æsculi.*)

(Very destructive to trees, particularly around London).

See Page 209.

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CHAPTER XXXI

INSECTS AND DISEASES INJURIOUS TO FOREST TREES.

THE **Pine Beetle** (*Myelophilus* (*Hylurgus*) *piniperda*) is a dread enemy to not a few species of *Pinus*, but particularly *P. sylvestris*, *P. laricio*, *P. austriaca*, and *P. Strobus*. The injury done by this beetle consists in its destruction of the leading shoots of the tree it attacks. It enters by boring a hole into the side of the shoot until it reaches the pith, after which the course is directed upwards, and an exit made at the terminal bud. This tunnelling of the shoot so weakens it that frequently during stormy weather it is broken across at the point where the beetle entered. Not only are unhealthy trees attacked by the pine beetle, but young and robust-growing specimens frequently fall a prey to its insidious depredations.

June, July, and August are the months when it is most commonly found.

The only remedy is collecting and burning the affected shoots—work that requires to be done with the utmost care to prevent the escape of the wary insect. Burning all brush-wood in plantations is a great preventive.

The **Pine Weevil** (*Curculio* (*Hylobius*) *Abietis*) is another destructive insect, and differs from the former in waging its attacks against the buds of the leaders and branches, as also by eating patches of the bark here and there on the stems and branches. The various species of *Abies* suffer most, but the pines occasionally are attacked as well. It is always most destructive in young plantations growing on the margins of old woods, and equally bad amongst trees that have been planted on the site of a former pine plantation.

The beetle is about half an inch long, and nearly black. One remedy, probably the best, is to place fresh pieces of pine bark on the ground, beneath the infested trees, and, by shaking the trees and examining the traps the following morning, many may be destroyed.

Bostrichus typographus is another pest of our woodlands, and may frequently be seen, like fine white wool, spreading over the stem and branches of the silver and other firs. It spreads with terrible rapidity, first appearing in small patches here and there on the bole, and particularly on the under sides of the branches. The tree infested soon becomes unhealthy, and frequently dies off prematurely. Trees growing in low-lying, heavy ground would seem to fall a first prey to this insect.

Bostrichus laricis is nearly allied to the former, but its devastations, which are, however, not very deadly, are principally confined to the larch. It is usually known as the "larch blight."

The **Elm Tree Destroyer** (*Scolytus destructor*) is about two-tenths of an inch long, stout and cylindrical, and usually confines its depredations to the elm.

In the beginning of June this beetle bores into the inner bark, where it forms galleries, along the margins of which are laid the eggs. Cutting down and burning badly-attacked trees is the best remedy, but promoting exuberant health of the infested specimens by means of liquid manure has been fraught with promising results.

The **Goat Moth** (*Cossus ligniperda*) is most frequently found on the willow, oak, lime, and other trees. Being not only one of our largest native moths, but also one of the most destructive, its ravages are much dreaded, the holes or tunnels made by the moth being of large size—large enough to admit the little finger. Filling up the tunnels with a mixture of soot, lime, and cow manure is an excellent remedy.

The **Pine Shoot Moths**.—(*Retinia buoliana* and *R. turionella*) would seem to be more plentiful in this country than is generally supposed. Quite lately I visited a large plantation of young Scotch fir, the terminal buds of which were greatly injured by the caterpillars of this elaborately-

coloured moth. The moth lays its eggs at the base of the buds, and into these the caterpillars enter by hollowing out the centre, thus destroying the vitality and causing them to take on a withered appearance and to feel soft and empty to the touch. Trees infested by this insect resemble greatly in their stunted shoots and exudation of resin such as have become a prey of the Pine beetle (*Myelophilus piniperda*) only in the latter case it is the fresh young shoot and not the bud that is attacked. The *Retinia* would seem, from all my notes and observations, to be most abundant in what might be termed neglected fir plantations, that is, where the trees have suffered from overcrowding, and if growing under unfavourable conditions as to soil, etc., and particularly when the wood is composed entirely of one species. There is no method of dealing with large infested areas, for the attacked trees have repeatedly been cut over and removed without any seeming diminution in the numbers of the insect. One experiment with a small infested corner has been rewarded with good results, by lighting a fire to windward, and causing the smoke of coal tar to pass over. This might be worth trying in the case of fruit trees infested by particular insects.

The Larch Miner. (*Coleophora laricella*.)—Few, other than those specially interested in tree diseases, have the remotest idea that the yellow, withered appearance of many of our English larch plantations is due to the larvæ of the above tiny moth. It usually attacks young trees, say, from five to twenty years old, and although it may not kill them out, yet the repeated onslaughts year after year tend to keep the trees in an unhealthy condition, and so render them liable to other and more deadly diseases.

Unfortunately the attacks of the larch miner are by no means confined, as is usually supposed, to trees growing under unfavourable conditions, for I have this season noticed in an unusually healthy, fast-growing plantation in Sussex that almost every tree was more or less affected. Certainly in another large extent of larch in Gloucestershire which I examined a few days ago, and where nine-tenths of the trees were being ruined by the *Peziza*, the larch miner was very

abundant; but, I think, that young trees, whatever be the state of health, suffer alike, although where hard-wooded trees form a portion of the crop the larch certainly suffers less than when grown in pure woods. The moth lays its eggs at the end of June on the needles of the larch; the caterpillar mining into and feeding upon the interior of the needle causes it to turn faded and yellow. It lives in the tube thus formed during the winter, changing to a pupa, and ultimately to a moth. It is a most difficult matter with this insect, as, indeed, with all others that are fairly abundant, to suggest a remedy, and I have looked over and examined larch plantations that are differently situated in many respects to find out under what condition the attacks are most persistent, but with little or no success—healthy and unhealthy, native or Tyrolese, sharing alike when grown as a pure crop.

Where the larches are intermixed with hard-wooded trees—sycamore, oak, and beech—the attacks are certainly less frequent, and this I have now noticed in a number of cases. Trees growing at high altitudes do not seem to suffer less than those at only a few feet above sea level, and this point I have paid particular attention to.

Whether the wounds caused by this insect will serve as a nidus for the spores of *Peziza Wilkommii* has yet to be determined, but special importance should be attached to all larch-feeding insects, and their depredations minimised to as great an extent as possible.

The **Lackey Moth** (*Clisiocampa neustria*), so called from the gay colours of the caterpillar, is another destructive woodland pest, eating wholesale the leaves of the oak, elm, beech, poplar, and most fruit trees.

In April and May the caterpillars are hatched, when the leaves are just unfolding. They form a nest or web of silken hairs, generally amongst the smaller branches, in which they live during the day, sallying forth in the evening to feed on the tender foliage. Being very plentiful, they are usually difficult to deal with, but hand-picking and destroying the cocoons are the only practicable methods of meeting the evil.

The **Winter Moth** (*Cheimatobia brumata*), and the **Lime**

Looper Moth (*Hybernia defolaria*).—The caterpillars of both these moths are very destructive to the leaves of elms, limes, and willows, but particularly to the buds of the apple tree.

When full grown they descend to the ground, where they cover themselves and become chrysalides, from which the moths appear from October to December.

Being almost wingless, it is by no means difficult to prevent their ascending the trees by painting a band of any sticky substance around the stems of the trees that it is expected they might attempt to crawl up.

The **Pine Sawfly** (*Lophyrus Pini*).—Fortunately, this insect is not abundant in the British Isles, though on the Continent the damage it does in the pine forests is by no means inconsiderable. The insect may readily be recognised by its wide, flattish body, and usually dark appearance. Having attained to full size in the trees, they form cocoons among the foliage or on the stems, and remain in this condition until the following spring, when, in April or May, the perfect insects make their appearance. The male is considerably smaller than the female, while the full-grown caterpillar, which is of a greenish-yellow colour, with a row of black spots on either side, is about an inch long. The remedial measures are not at all easy, especially when a large number of trees are attacked, but single specimens may be entirely cleared by shaking the caterpillars into a sheet placed beneath the tree.

The **Red Spider** (*Acarus telarius*).—In hot and dry summers trees suffer much from this member of the mite family. Limes and poplars, as also many other trees, are greatly injured, the foliage turning to a russety brown colour, and falling off long before the usual time. There are several remedies, such as fumigating and spraying with a solution of soft soap, but none of these are applicable to a plantation of trees, or even a single specimen of large size.

The **Thorn Fly** (*Aphis Cratægi*) attacks whole hedges or brakes of Quick, especially those in the nursery border; as a rule, the younger and more healthy plants first fall a prey to its depredations.

Sponging with tobacco water, or almost any of the pre-

scribed solutions will rapidly exterminate the fly; but such work is laborious when a large brake or long hedge of the thorn has to be gone over.

The **Larch Aphis** (*Adelgis laricis*) and **Giant Sirex** (*Sirex gigas*) are both, more or less, harmful to the larch. The latter is a formidable and splendid insect, that is, however, not very abundant in this country.

Generally, too, felled trees, or such as are somewhat sickly, are chosen by the female in which to lay her eggs. These are deposited beneath the bark by means of the powerful ovipositor, and in course of time the whitish cylindrical maggots make an appearance, and with their strong jaws form large borings in the affected tree.

Cutting down and burning infested trees is the only practical remedy.

The **Cockchafer** (*Melolontha vulgaris*) is usually pretty abundant, and does most damage by eating the leaves of the sycamore, beech, oak, cherry, and many other trees. It will also eat the roots of most young trees, but those of pines in particular.

The insect is about $1\frac{1}{2}$ in. long, and of a chestnut-brown colour on the upper part of the body, while the head and some other parts of the body are of a bronzy green, and thickly covered with yellowish-white hairs.

In April and May the eggs are laid in a hole in the ground about 5 in. deep, and the grubs are hatched in July. They are of a dirty-white colour, and much wrinkled. In this state they, however, do but little harm; but, after having changed their skins and remained in a torpid state during winter, come to the surface in spring and eat the roots of almost any plant that comes in their way. They again burrow deeper at the approach of winter, coming to the surface again in spring, and, when full grown, are about $1\frac{1}{2}$ in. long, and almost $\frac{1}{2}$ in. in diameter. The perfect insects do not live more than about twelve days, and are easily known by their heavy, awkward flight towards the evening.

The **Spruce Gall Aphis** (*Chermes abietis*).—This is a common insect, and one that renders many fine young spruce trees very unsightly by reason of the cone-like excrescences that are formed at the instigation of the insect on the shoots

of the infested specimen. The formation of this excrescence is brought about by the female aphis piercing with her beak, or sucker, one of the buds, and the drawing off the sap, the consequence being an unusual growth at that part.

When the young larvæ appear they also, by piercing the gall, extract the juices, and the gall enlarging soon causes the larvæ to become embedded at the bases of the leaves, which, by this time, have become curiously malformed. The insects are scarcely $\frac{1}{10}$ in. long.

The only remedy is to collect the cone-like excrescences and have them destroyed, unless in the case of badly-infested trees, which should be cut down and burned.

The **Laburnum Moth** (*Gemiostema laburnella*) is fairly abundant—in England, at least; and, in some instances, every leaf of a tree has been eaten almost wholesale by the caterpillars of this pretty moth. The insect is about $\frac{1}{8}$ in. long, and $\frac{8}{10}$ in. across the fully expanded wing. It is of a silvery-white colour.

The greenish-grey caterpillars are about $\frac{1}{4}$ in. long.

By burning the attacked leaves great numbers of the caterpillars may be destroyed, while, by shaking the trees in May and August, the moths will fly out, and may be caught in a butterfly net.

Wood Leopard Moth (*Zeuzera aesculi*).—(Page 202.)—The caterpillar of this beautiful moth is very destructive to the beech, ash, birch, elm, walnut, privet, &c., and which it bores into, eating and living on the wood. Usually young trees or the branches of old specimens are attacked, and the tunneling is confined in the former, either to the pithy centre or the soft wood near the bark. The moths appear about mid-July, and the female, by piercing the bark with her powerful ovipositors, deposits her eggs, one in each hole. Three years are required for the caterpillar to arrive at maturity when it is nearly 2 in. long. Both in form and colour the leopard moth is particularly elegant, the head and thorax being covered with a thick white pile, the body with a black down, fringed with white at each joint. The wings are white with yellowish-brown veins, a row of rounded bluish spots running between every two.

By stuffing a piece of tow in gas tar, or placing cyanide of potassium in the hole and closing the aperture the caterpillar may be overpowered and destroyed.

A bent wire has oft been successfully used in dislodging the caterpillar.

The Holly Fly (*Phytomyza aquifolia*).—The foliage of the holly is frequently very much disfigured by the grubs of the holly fly, which burrow beneath the upper skin of the leaves, feeding on the internal substance. This imparts a blistered and discoloured appearance, and which, in the case of ornamental varieties, is anything but desirable. Probably no great damage to the infested trees is brought about, but the wholesale destruction of the leaves, as is often the case, cannot but weaken the plant.

In May and June the flies make their appearance, and lay their eggs beneath the upper skin of the leaf, from which the grubs, about $\frac{2}{10}$ in. long, are hatched. These work their way beneath the skin of the leaves, forming small tracks of a more or less circular shape, thus causing the large and unsightly blisters. They quit the leaves about March, by making small holes in the skin of the leaf, and afterwards become chrysalides. The fly is small and inconspicuous.

Picking off and destroying affected leaves, or crushing the grub by pinching the blisters are the only ways of lessening the attacks.

The Oak Leaf Roller Moth (*Tortrix viridana*).—The widespread destruction caused to oak-woods in almost every part of the country by the caterpillars of this little moth would seem to be on the increase from year to year. But it is not the oak alone that suffers, for numbers of the hornbeam and beech are in an equally pitiable condition. Having closely watched this insect for several years, mainly with the view of striving to keep it in check or devise some means of destruction, I have come to the conclusion that a few individual trees may, at considerable expense, be got rid of the pest, but in the case of whole woodlands artificial treatment is quite out of the question. Many observers are under the impression that the caterpillar is most abundant

where the trees grow closest together, and when we consider that both wind and rain destroy numbers of these the fact of isolated trees, and which, consequently, are most exposed to storms, being comparatively free from attack is not to be wondered at. So far as we at present know, the only way to diminish in any appreciable degree the numbers of this insect is by encouraging as much as possible their enemies.

The rook, jackdaw, starling, thrush, and sparrow help immensely in destroying the caterpillars, and the occupants of a rookery will frequently in a few hours clear the pest from the trees over a considerable area of woodland. The same has been noted with regard to the starling, and I have frequently seen the trees over an infested area almost black with this particular bird when in the act of feeding on the caterpillars.

In support of this recommendation it may be stated that insects are far less numerous in the forests of St. Germain, Senart, and Fontainebleau, than in the Bois de Bologne, and where, of course, small birds are scarcer.

Sometimes with the oak leaf roller moth its excessive number proves the means of its extinction, the foliage being devoured before the caterpillars are fully fed; while, as is usual at this season, parasitic flies and ichneumon attack them wholesale, and a box of caterpillars sent to me the other day revealed the fact that each one had succumbed to the attacks of one of these enemies.

The life history of this moth is full of interest, and the curious manner in which it rolls up the leaves is well worthy of study.

Wireworms.—These occasionally do a great deal of damage in beds of seedling trees, particularly Conifers, and in some instances they attack and destroy the seeds before germination. In the case of young Conifers they are gnawed completely through just above or at the ground level, the beds in many instances being strewn with the cut-over plants. *Abies nobilis* and *A. Nordmanniana* suffer to a great extent, and I have frequently been at my wit's end to put a stop to the repeated depredations; but in the case of a newly-formed nursery or freshly made-up seed

beds the attack of the wireworm is always most pronounced. In the case of fresh nursery ground paring off and burning a couple of inches of the top soil in the autumn has been attended with excellent results, as has also dressing the ground with gas lime. When seedlings are attacked hand picking, with the use of sliced carrots, mangold, or potatoes, varied with pieces of oilcake as a bait, are to be recommended. Dressing the seeds with red lead is very advantageous to prevent birds and mice from attacking freshly-sown quantities. Injury from wireworm is not likely to cause any serious consequences after the first year's growth of the plants, especially if the ground has been kept clean and free from weeds during the egg-laying season in June.

The above are only a few of the many insects that injure our forest trees: but those treated of are such as are most familiar to the forester, and whose attacks he has most frequently to wage war against.

Remedial measures are frequently of little avail, more particularly when a whole wood or plantation is attacked; but with single specimens the numbers may readily be lessened by the methods suggested.

Keeping the woodlands free of dead and dying trees and branches is a preventive of insect attacks that should never be neglected.

As showing the injury that can be inflicted on our forest trees by some of these insect pests, the following cases may be mentioned:—

During fifteen years (between 1853-68) the spruce in East Prussia, Poland, and Russia was killed over an area of 7,000 square German miles; while in the Bavarian forests, the loss to the Revenue in one year was £40,000.

In both cases the destructive insect *Liparis monacha* was the cause of injury.

Larch disease.—In all probability the larch disease or larch canker owes its origin to the minute spores formed in the fructification of the now well-known fungus—*Peziza Wilkommii*. It has been pretty conclusively proved that these spores can only find a footing where the rind of the

bark has become in some way injured, such as might be occasioned by the puncture of an insect, by wind, frost, or from many other causes. The spores send down their germ tubes into the cambium, between the bark and the wood, where the moisture and nourishment afforded causes rapid development of the fungus. This soon spreads to the cells of the wood, and the annual layers either entirely cease to grow, or become disorganised and crippled in growth, causing a hollow appearance of the stem at the point of attack. The surrounding bark, by its attempts to heal over the wound, causes a thickened or burly appearance of the trunk, thus imparting to affected trees the cankered, swollen, and distorted look that is so distinguishing a characteristic.

The disease appears in this country on the larch, both common and Tyrolese, at all stages of growth up to 30 years, but rarely after that age.

I have examined a plantation of only four years' growth sadly infested by the *Peziza*, whereas, in other cases, the trees may be fully 20 years old before being attacked.

Cause.—Under what conditions of growth the larch is most susceptible to the *Peziza* is still a matter of vague uncertainty, but there can be little doubt that an enfeebled constitution, as fully explained in the article on the larch (*Trees for Economic Planting*), aided by our peculiarly erratic climate, has much to answer for.

The variableness of our spring weather is, no doubt, one of the predisposing causes of disease, for, although no degree of frost experienced in this country can injure the tree when leafless, yet few are more sensitive when in young foliage.

Bearing on the subject of the larch disease, I have communications from almost every part of the country, and have personally visited and examined many of the worst infested plantations, particularly in England and Wales. Soil, if we exclude peaty, would seem to have little or nothing to do with encouraging the disease, as I have found it equally virulent on dry, sandy, and heavy damp soils, but worse on chalk. Curious enough, the disease is hardly known in the peat bogs of Ireland, and there the rainfall is excessive, while equally strange is it that it

first made its appearance in the eastern and drier parts of England, and has hardly yet proceeded to the more humid west. I have, however, noticed it in certain low-lying still, and damp portions of some woodlands, and where frosts would be most prevalent, but such cases are not general.

Remedy.—Several remedies have been more or less successfully tried with a view to getting rid of the disease on infested trees, such as by cutting and scraping out the injured portions and applying a suitable dressing, but such remedies, although suited for single specimens, cannot be applied to a whole area of infested trees.

Under exceptionally favourable conditions I have known the larch to outgrow the disease, though the cankered, swollen stems are never afterwards of great value for constructive purposes.

Prevention in the present case is undoubtedly the best measure, for when once it has made a headway the larch disease is most difficult to cope with.

By planting only sound, healthy trees with uninjured roots in the most suitable soils and situations, and retaining these in as healthy a condition as possible, can we guard against attacks of the disease.

Much of the spurious offspring of the tree, which now by generous treatment exists for a while, would never, if left free to the action of Nature, come into existence at all; and attention to this will be the first step towards the regeneration of the larch and eradication of the disease. Planting on chalky soils should certainly be avoided.

CHAPTER XXXII.

PRICES OF CONTRACT WORK.

The following list of prices may be taken as approximate to those paid generally throughout the country.

It may be well to remember, however, that in districts where unusually high or low wages are paid, so in proportion will be the contract prices for the various classes of work.

BARKING OAK :						s.	d.	s.	d.
Barking oak	...	...	...	...	...	per ton	21	0	
Loading bark on wagons	...	...	...	...	...	"	3	0	
Barking oak per ton of bark	...	...	...	...	...		30	0	
Chopping bark	...	...	...	...	...	"	8	0 to 10	0

COPPICEWOOD :

Cutting out hurdle rods	...	...	...	...	...	per score	0	1	
" hurdle stakes	...	...	...	...	...	per dozen	0	1	
" rake stems	...	...	...	...	...	"	0	1	
" spade stems	...	...	...	...	...	"	0	1	
" spick gads	...	...	...	...	...	"	0	1	
" dahlia stakes	...	...	...	...	...	"	0	1	
" rose stakes	...	...	...	...	...	per two dozen	0	1	
" besom handles	...	...	...	...	...	"	0	1	
" kidney-bean stakes	...	...	...	...	...	50 in bundle	0	2	
" pea stakes	...	...	...	...	...	per bundle	0	1	
" Birchwood for besoms	...	...	...	...	...	"	0	1	

DRAINING :

Pipe draining, mains. 4ft. 3in. deep, 4in. or 6in. pipes	...	...	...	...	...	per chain	3	0 to 3	6
" " small, 4ft. deep, 1½in. to 3in. pipes	...	...	...	...	...	"	2	0	" 2 9
" " small, 4ft. deep, 1½in. pipes	...	...	...	...	...	"	1	9	" 2 6
Ditches, open, 36in. wide at top, 30in. deep and 9in. wide at bottom	...	...	...	...	...	"	3	0	" 4 0
Scouring out ditto	...	...	...	...	...	"	0	9	" 1 0
Small open ditches, 15in. to 18in. wide at top, 12in. to 15in. deep, and 9in. wide at bottom	...	...	...	...	...	"	1	6	" 2 6
Scouring out ditto	...	...	...	...	...	"	0	6	" 0 9

PRACTICAL FORESTRY.

FAGOT-MAKING:

Making fagots	...	...	...	...	...	per 100	s. d. 4 6
„ oven fagots	...	...	...	...	...	„	3 0
„ fagots for fire-lighting	...	...	...	...	...	„	1 3
Cutting bands for tying fagots	...	...	...	...	...	„	0 4

FELLING AND STUBBING:

Felling oak timber	...	...	...	per ton of 40ft.	s. d. 3 0
„ other hardwoods	...	...	...	„ „	2 6
„ pinewood	...	...	...	„ „	1 6 to 1 9
Stubbing out timber	...	...	...	„ „	3 6 „ 4 0
Cutting underwood from 12 to 15 years' growth	...	...	...	per acre	9 6 „ 12 0

FENCING:

Setting out and mortising four-holed posts,	per score	4 0
„ „ three-holed „	„ „	3 0
„ „ two-holed „	„ „	2 6
„ „ one-holed „	„ „	2 0
„ and cleaving rails	...	0 10
„ „ stakes	...	0 6
„ „ long poles	...	0 6
„ „ short poles	...	0 4
Hanging field-gates	each	4 0 to 5 0
Fixing stile	„	2 0
Preparing posts, rails and pales for tree-guards	per set	0 9
Fixing ditto	„	2 0
Six-wire fence larch posts and creosoted	per chain	35 0 „ 40 0
Fixing same	„ „ „ „ „	4 6 „ 5 0

FIREWOOD:

Splitting firewood	...	...	...	per cord	4 0 to 6 0
„ for charcoal	...	...	...	„	2 6 „ 3 0
Cutting and stacking cordwood	...	...	...	„	2 0 „ 3 0
Burning charcoal	...	...	per bushel of 20 lbs.		0 2
Loading and spreading soil	...	...	per load		0 5 „ 0 6

GATE-MAKING:

Field gate, oak	...	...	...	5-bar	17 0
Posts	...	...	...	per pair	23 0
Iron fastening and ironwork complete	...	...	...		5 9
„ Fixing	...	...	...		4 6
Making 5-bar oak gate	...	...	...		2 6
„ half gate	...	...	...		1 9
„ rough wickets	...	...	...		2 0
„ wrought wickets	...	...	...		3 0
Sawing hardwood	...	...	per 100ft.		3 6 to 4 0
„ softwood	...	...	„ „		2 6 „ 3 0

PRICES OF CONTRACT WORK.

HEDGING :

		s. d.
Trimming hedges, ordinary size	per chain	0 9 to 1
Making bank for quick hedge, digging ditch and planting quick	"	7 6 ,, 10 6
" hedge, without bank or ditch, trench- ing ground, preparing bed, and planting	"	3 0 ,, 4 0
Cleaning young hedges	"	0 8 ,, 0 9
Laying hedge and scouring out ditch	"	2 0 ,, 3 0

HURDLE-MAKING :

Making hurdles	per dozen	3 6 to 4 0
" cattle hurdles (wattle)	"	5 0 ,, 6 0
" Welsh hurdles, for sheep	"	4 0 ,, 5 0

PITTING :

Digging out clay	per yard	0 6
" holes for tree-planting, 15in. diameter and 15in. deep	per 100	1 6 to 2 6
Inserting plants	"	0 6 ,, 1 0
Notch planting	"	2 0 ,, 3 0

PREPARING METALLING :

Quarrying stones	per yard	0 10 ,, 1 3
Breaking stones for roads	"	0 8 ,, 1 0

CHAPTER XXXIII.

PRICES OF FOREST PRODUCE.

The prices of home-grown timber vary greatly in different parts of the country, indeed, in adjoining counties the difference sometimes amounts to several pence per cube foot. Under these circumstances it is difficult to give even an average list of prices that would be applicable, but the following have been carefully compiled from returns received from each county:—

					s	d.	s.	d.
Oak	...	...	...	per cubic foot.	1	6	to	2 6
+ Ash	...	...	...	"	1	3	"	2 0
+ Beech	...	...	...	"	0	10	"	1 4
Elm	...	...	...	"	0	7	"	1 2
+ Sycamore	...	...	...	"	1	0	"	2 6
Alder	...	...	...	"	0	8		—
Birch	...	...	...	"	0	8		—
+ Chestnut (Spanish)...	...	...	...	"	1	4		1 6
" (Horse)	...	...	...	"	0	8		—
Lime	...	...	...	"	1	0		1 3
+ Larch	...	...	...	"	1	1		1 3
Scotch Fir...	...	...	...	"	0	7		0 10
Spruce "	...	...	...	"	0	7		—
Silver "	...	...	...	"	0	6		—
Willow	...	...	...	"	1	6	to	2 6
Poplar	...	...	...	"	0	8	"	1 4

PREPARED PRODUCE.

Firewood ..	...	...	per load, cut	5	0		—
Cordwood ...	...	...	per cord	7	0	to	10 0
Faggots, large	...	...	per 100	15	0	"	21 0
" small	...	...	"	2	6		—
Oak Bark ...	...	...	per ton	70	0		—
Oak Pales, for fencing	4 ft. long,	per score	3	6	"		4 0
Spanish Chestnut	"	"	3	6	"		4 0
Oak Gates, rough	...	...	each	13	0		—
" smooth and painted			"	17	0		—
Hurdles, wattle	...	...	per doz.	9	0	"	12 0
Bean and Pea Stakes	...	...	per bundle	0	3	"	0 5
Crate Wood, 10 to 12 ft. long...	per bundle of 42		1	2			—
Mop Handles	...	...	per 100	3	0	"	3 6
Rake "	...	...	"	6	0	"	7 6
Charcoal ...	...	...	per bushel	1	0	"	1 3

CHAPTER XXXIV.

TOOLS AND APPLIANCES USED IN FORESTRY.

IN order to carry out forest work with dispatch and in the most economical and approved way, it is essential to have tools of the very best description. Unfortunately, even in our enlightened age, many of these are of a primitive make and clumsy to work, the village blacksmith more than the manufacturer of edge tools being called into request to meet the usually limited demand.

Too often, also, tools intended for particular departments are used generally and frequently to great disadvantage.

The tools and appliances made use of in forestry work, many of which are illustrated throughout this work, may for convenience be grouped under the following heads:—

NURSERY AND ROADS.

1. Scotch, or garden, spade.
2. Four-pronged digging fork.
3. Three-pronged potato fork.
4. Dutch hoe.
5. Draw hoe.
6. Reel line.
7. Edging shears.
3. Edging iron.
9. Short-bladed scythe.
10. Dibble made of wood and shod with iron.
11. Hoe for weeding.
12. Rakes, of different patterns.

PRACTICAL FORESTRY.

FENCING.

13. Footpick for making holes for fencing posts.
14. Iron hammer for driving posts.
15. Straining-machine for tightening wire.
16. Straining bracket.
17. Implements used in knotting wire.

DRAINING.

18. Spade, diamond pointed.
19. Graff.
20. Bottoming spade.
21. Scoop.
22. Pick.
23. Shovel.

PLANTING.

24. Planting spade.
25. Planting staff, or iron.
26. Planting hatchet.
27. Planting hoe.
28. Planting pick.
29. Grubbing hack.

PRUNING.

30. Averuncator.
31. Straight-edged pruning knife.
32. Pruning handbill.
33. Pruning chisel.
34. Long-handled pruning saw.
35. Pruning saw.
36. Bowless saw.

FELLING.

37. Felling axe.
38. Snagging axe.
39. Felling saw.
40. Stout Manilla rope

BARK-STRIPPING.

41. Double-faced handbill.
42. Bark scraper.
43. Peeling iron.
44. Mallet.

CHARCOAL-MAKING.

- 45. Heavy axe.
- 46. Firewood saw.
- 47. Drag for withdrawing charcoal
- 48. Turfing iron.

HEDGING.

- 49. Switching knife.
- 50. Cutting-over bill.
- 51. Hedging shears.

APPLIANCES.

- 52. Timber wagon.
- 53 Janker.
- 54. Truck for removing heavy roots.

There are a number of other well-known tools, such as the hammer, nippers, adze, gimlet, etc., that it would be quite unnecessary to mention.

CHAPTER XXXV.

TRANSPLANTING LARGE TREES.

Where immediate effect is required, the transplanting of large trees and shrubs will be an operation of considerable importance, and, though it is fraught with both trouble and expense, the results obtained have led to an increased adoption of the system during recent years.

There is hardly a limit to the size or weight of the tree to be removed when the operator is provided with suitable appliances, and that success has crowned the effort of recent operations in our Royal and other parks is clearly demonstrated. Of late years several appliances for removing large and weighty trees and shrubs have been placed on the market, but amongst these certainly one of the best is that made and patented by Messrs. Faulkner & Sons, and of which an illustration is attached. Its principal recommendations are simplicity of structure, the ease with which it may be worked, and lightness, combined with such strength that even the weightiest tree can be removed. But not only is this tree-lifter valuable where transplanting is being engaged in, for in removing large tree roots, logs of timber, blocks of stone, and heavy materials generally, it has been found most useful.

The apparatus is made somewhat in the form of a four-wheeled lorry, having a steel frame only. The frame at the back is made movable to admit of the apparatus being placed so that the tree to be moved stands in the

TRANSPLANTING LARGE TREES.

centre of the machine. Two stout planks with guide rails are laid across the trench, and the machine is backed on to these. The machine is constructed with four iron rollers, laying along over the side frame and parallel with the frame. Around the rollers a chain is wound, the loose end being fastened to the planking which has been placed under the ball of earth containing the roots of the tree. The rollers are worked with a specially made screw-gear, which is self-sustaining, and can be moved to draw up or lower at will.

The illustration given clearly shows the apparatus with the tree being lifted for transportation.

TRANSPLANTING MACHINE.

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