THE FORESTER

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THE FORESTER

A PRACTICAL TREATISE ON THE PLANTING, REARING, AND GENERAL MANAGEMENT OF FOREST TREES

WITH

AN IMPROVED PROCESS FOR TRANSPLANTATION OF TREES OF LARGE SIZE

BY

JAMES BROWN

FORESTER, ARNISTON

SECOND EDITION—ENLARGED

WILLIAM BLACKWOOD AND SONS
EDINBURGH AND LONDON
MDCCCLI

TO

ROBERT DUNDAS, ESQ.

OF ARNISTON

SIR,

THE OBJECT OF THE FOLLOWING BOOK IS THAT OF DIFFUSING, AS FAR AS IN MY POWER LIES, A SOUND AND EXTENDED KNOWLEDGE OF ARBORICULTURAL OPERATIONS; AND AS I AM NOT AWARE OF ANY LANDED PROPRIETOR WHO HAS THIS OBJECT MORE AT HEART THAN YOURSELF, I BEG TO DEDICATE MY WORK TO YOU, AS AN HUMBLE EVIDENCE OF MY RESPECT AND ESTEEM.

I HAVE THE HONOUR TO BE,

SIR,

YOUR MOST OBEDIENT SERVANT,

JAMES BROWN.

PREFACE

THE Author desires to express to the public his gratification at the rapid sale of the First Edition of "THE FORESTER," as it indicates that the spirit of improvement is rapidly progressing among all interested in Arboriculture. In order to render the book worthy of continuance in public favour, it has been entirely re-written, a number of new sections upon important subjects added to it, and the whole brought out more in detail, for the purpose of making it better adapted as a complete guide in all forest operations: in short, it has been so much enlarged and improved, that it may be considered altogether a new book.

Since the appearance of the First Edition in 1847, the Author has been extensively employed by landed proprietors, in various parts of England and Scotland, in surveying and reporting on the present state and future management of plantations, and of grounds adapted for planting. His observations and experience have thereby been much extended, inasmuch as each district usually presents some distinctive features, depending on the nature of the soil, aspect, and elevation above the sea. The ordinary conditions of such lands, their capability of improvement, and the views of proprietors as to the extent and position of woodlands on their estate, are matters rather of private business than of public interest, and hence the instruction to be gained by such surveys, and from the details of any practical report thereon, is interwoven with, and forms a part of, the general contents of the book. But, as regards districts which are of great extent, and which correspond in the great features of geological structure, and elevation from the sea, it has been suggested that, as a considerable portion of the high-lying parts of the kingdom is unplanted, and in a great measure unproductive, some specific information might be useful as regards the fitness of such lands for the profitable growing of timber. The Author having, in his recent surveys, examined several mountainous districts, where planting has not hitherto been adopted on a large scale, has been led to consider this subject as one of peculiar interest and importance. It embraces several considerations which admit of wide application—such as the employment of the industrious inhabitants of the respective districts—the improvement of adjacent lands by the draining which is often indispensable for new plantations—the shelter afforded to the land generally, and the consequent amelioration of climate, to say nothing of so ornamental an addition to the landscape beauty of a mountainous district. In many parts of both England and Scotland, the value of timber for mining purposes is a further and great inducement for planting; and one reason why so obvious an improvement has not been carried out, seems to be a distrust whether trees can be profitably grown in moorlands of great elevation. Another and still greater discouragement arises from the want of that plain and practical information which it is the object of this book to supply; and here it is that detailed examples are of use in showing the several points to be observed, and the right course to be pursued, in adapting the various kinds of trees to the proper soil and situation. In an Appendix, therefore, the Author has now added some extracts from his Notes on Lands so situated, (omitting merely local descriptions and names,) and trusts they may be found useful as examples for surveying and reporting on other districts corresponding in their general features to those which are described in the several Notes.

In the present Edition of "THE FORESTER," as also in the former one, the Author has confined himself entirely to a detail of the results of his own experience in forest operations; and, in doing so, his whole aim has been that of making his work plainly useful as a forester's guide. He is of opinion that every book pretending to be practical should be written in the plainest and most simple language, so that the most common workman may understand.

It may by many be considered that a practical work, such as the present, is incomplete without a chapter being devoted to the most successful method of growing the different kinds of Coniferæ recently introduced into Britain. Relative to this point the Author begs to remark, that he has, during the last six years, been planting out the most approved kinds on a variety of soils and situations between five hundred and a thousand feet elevation; but as he has not as yet had his views fully brought out with regard to these, and as he does not wish to lay before the public any part of tree culture which he cannot treat of with confirmed experience, he has deferred such a chapter till another opportunity, which he hopes yet to have in due time.

January 1851.

CONTENTS

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

CHAPTER VI.

CHAPTER VII.

APPENDIX

REPORT ON THE STATE OF EXISTING PLANTATIONS, AND GENERAL EXPEDIENCY OF PLANTING ON AN EXTENSIVE SCALE.

DIRECTION TO BINDER.

The Diagram to be inserted at page 328.

THE FORESTER

CHAPTER I.

Importance of Woodlands in Great Britain—Present prospects of Forestry in Britain—Value of Wood as a Crop upon Land—Laying out of Land for new Plantations—Utility of Fencing and Enclosing of Ground for young Trees—Management of Hedge Fences—Whin Hedges—Making of Walled sunk Fences—Building Dry-stone Dikes—Building of Turf Dikes—Wooden Palings—Wire Fences—Gates and Wickets.

SECTION I.—IMPORTANCE OF WOODLANDS IN GREAT BRITAIN.

The cultivation of woodlands, as a source of profit to the proprietor, is not of equal importance to the welfare of every country. In any country thinly inhabited by man, or in a country but newly taken possession of by civilised man, such as America, New Zealand, or Australia, natural forests prevail in great abundance; indeed, often to such an extent that the new settlers find forests of timber trees to be a mere nuisance, and are very frequently obliged to destroy them, in order to have the land put under a crop more profitable for their purpose for the time being. We are aware that this is frequently the state of things relative to forestry in many newly settled districts of a newly discovered country, but it is ultimately a very unprofitable way of going to work, even in a country where natural forests prevail; for, were forestry maintained as an art among new settlers in such countries, much profitable and useful timber might be retained upon the newly improven lands, which might prove of great advantage to generations coming after, as well as to the settlers themselves; and, as an example of this, witness the scarcity of useful wood in some parts of the United States of America at the present day. And from this I mean to infer, that the raising of artificial forests in any newly inhabited country is not of primary importance to the settlers; but the retaining a part of the natural forests is of great ultimate importance to them, and provision should be made by the laws of such a country for preserving a proper quantity of the natural forests for ultimate good. But the case is altogether different in an old-established country like Britain, where the natural forests have for centuries disappeared, and where the inhabitants must either buy timber from other countries, or raise it upon the land in the form of a crop.

There is no country upon the face of the earth which would be more benefited by an extended system of forestry than Britain. The navy demands skilful forestry and extending of woodlands in order to support it; the present advanced state of agriculture demands the same thing; and the general welfare of the whole country has a right to it. Relative to each of these heads it will be necessary to make a few observations. First, The navy of Great Britain demands skilful forestry and extending of woodlands in order to support it. Many have argued that "there is no need of being apprehensive of wood becoming scarce for the supply of the navy, so long as we can procure plenty of the best of wood for shipbuilding from foreign countries, in addition to the large supply growing in the Government forests in the different parts of England." I cannot agree with those who reason in such a superficial manner. When we reflect upon the enormous quantity of oak wood consumed in the building of one man-of-war ship, the conclusion is forced upon us, that, as a nation, we would soon be wrong in the extreme, were we to neglect the rearing of a supply of timber for the purpose, and to depend upon foreign supplies, which at best must always be precarious. It takes fully one hundred and fifty thousand cubic feet of timber to build a seventy-four gun-ship; and allowing, upon an average, that the trees in an oak forest, when arrived at maturity and ready for shipbuilding, stood at the distance of about thirty feet from each other, we could only have about fifty trees from an acre; and supposing that the same trees were from one hundred to one hundred and twenty years old, there would probably be about seventy feet of timber in each at an average; consequently, we see from this calculation, which is pretty near the truth, that no less than the matured crop of forty-four acres of woodland, or two thousand two hundred full-grown trees, are required for one such ship.

It is stated upon good authority, that there is very little more than one-sixteenth part of the timber used at the royal dockyards supplied by the Government forests, extensive as they are considered to be; consequently the remaining quantity, excepting what may be purchased from private landholders in the country, must be furnished from abroad; and from this it is evident to every man who has the welfare of his country at heart, that the produce of the Government forests, in order to answer the end in view, ought to be increased tenfold.

The policy of depending upon foreign countries for the supply of timber for such a great work as our navy is therefore ridiculous in the extreme, and more particularly when we have so much waste land in the country, of excellent capabilities for the growing of timber, the greater part of which is inaccessible to the plough of the farmer, and therefore would by no means diminish the available quantity of land which might be improved for the increase of food for our population.

Another important question naturally arises here—namely, Are the natural forests abroad in a state likely to supply the great and increasing demands for the British navy? We must answer in the negative. Every country upon the face of the globe, with which England has ready communication, is rapidly progressing in the march of improvement; and it is well known that, as civilisation makes progress, and agricultural pursuits extend, natural forests diminish and eventually become extinct, —as is the case with ourselves at the present day; and at the same time, as civilisation increases, the demand for timber increases also. Now we must infer from this, that each country, as it becomes more refined in the arts and comforts of life, will have at least enough to do with its own home timber, and will require to encourage forestry in order to keep good its own supply. Let us consider the state of America relative to timber, as an example of what I have above asserted, and I am of opinion that in a very short time many other countries will be in like condition. A. H. Hillhouse, in his translation of Michaux's *North American Sylva*, says—"Though three-fourths of our soil (North America) are still veiled from the eye of day by primeval forests, the best materials for building are nearly exhausted. With all the projected improvements in our internal navigation, whence shall we procure supplies of timber fifty years hence for the continuance of our marine? The most urgent motives call imperiously upon Government to provide a seasonable remedy for the evil."

I may farther add, under the present head, that, at the present day, the United States are depending upon the wooded regions in Canada for the supply of their useful timber; and in that country, where so much wood is necessarily consumed for fuel, the supply cannot meet the demand for a great many years; and it is now the opinion of many practical men, that in a few years wood will not only be very scarce, but at the same time very dear—much beyond any price we can form any adequate idea of at the present day. But it is to be hoped that these matters will undergo serious consideration, in order that such a state of things may be in a great measure avoided; and the remedy is, an improved and extended system of forestry throughout the whole of our island.

Second, The present advanced state of agriculture in Great Britain demands a skilful and extended system of forestry.

It is allowed by all who have laid their attention to the improvement of waste lands in our country, that the rearing up of healthy plantations improves the general climate of the neighbourhood; and not only is the climate improved to a great degree, but the very soil upon which forest trees grow is much improved by the gradual accumulation of vegetable matter from them.

I would ask this plain question, What is the natural cause of so much waste land being found in the north of Scotland, and in many parts of England? Can it be denied that it is the want of trees to give shelter? Why is it that proprietors of land complain so much of great tracts of it being worthless, growing nothing but the inferior grasses, mosses, rushes, and heaths, upon which even one sheep cannot find food upon two acres? Is it not for the want of plantations to give shelter? It is. And now that Government is very wisely granting loans of money for the improvement of such lands, we may naturally expect to see great things done in this department in the course of a very few years. Now that the agriculture of our country is improving rapidly, forests ought to go on in the same degree—not keeping behind, but rather in advance; for what profit will be derived from a superior system of cultivation in the land, if the fields we cultivate be not sheltered from the evil effects of our uncongenial climate by healthy and judiciously laid out plantations? In the improvement of all waste lands there ought to be at least one-tenth part of the same planted, in order to give shelter; and wherever this is not attended to, disappointment is the natural result: for if this be not done as the improvement of waste lands advance, such will, without doubt, be unproductive; and very likely, from the holder of such land finding that it will not pay him, he will allow the same to fall back into its original state of nature.

Third, The general welfare of the country demands an extended and improved system of forestry.

If the population of Britain is doubling itself every fifty years, where is our supply of food to come from, in one hundred years hence, if the waste land be not improved by forestry? This is a question which demands serious consideration, and must, upon reflection, point out the influence of planting upon the general welfare of the country. If any piece of waste land, after being drained and ploughed, will yield six bolls per acre, in a state unsheltered by forest trees, the same land will yield at least ten bolls per acre if judiciously sheltered by them; and from this we are bound to conclude, that the inhabitants of the country have a right that such a state of things should exist, seeing that in so many cases they are compelled to leave their native country from the want of such a state of things, and expend their money upon works of the very same nature in a foreign country. Were proprietors of waste land to lay off the same in a judicious manner with plantations, the money which is now carried away by industrious men to America, &c. would be spent at home upon their estates. And not only is the community at large benefited by an extended system of improvement, but every proprietor who will plant forest trees, not only gives shelter to his fields, but, at the same time, greatly enhances the value of his estate, as shall be treated upon in the proper place.

SECTION II.—PRESENT PROSPECTS OF FORESTRY IN BRITAIN.

Considering the present rapid advances which agriculture is making towards perfection, it appears very evident that forestry will, and indeed must, follow at the same rate.

It is very observable that the principal improvements which have, for the last twenty years, taken place in the science of farming, have, for the greater part, been confined to the draining and manuring of the best lands upon proprietors' estates, where, indeed, plantations for the greater part do exist, or are not, in consequence of superior locality, much needed in order to produce shelter. But, now that the improvements in farming are becoming of a more extended nature, even to the cultivation of the *bare moor* and *barren moss*—which cannot, properly speaking, be made fruitful without the influence of shelter—we must, and indeed will, ere long see plantations spreading wide in all such districts. We now observe that landed proprietors are becoming aware of this fact, and are wisely acting upon it. They see that the bringing in of moorland will not pay them, until shelter be produced by plantations. Several extensive proprietors of land of the description above alluded to have, within the last ten years, gone on extensively in making plantations in such districts; and this at once points out that a grand era in the history of arboriculture is about to take place throughout the whole island of Great Britain. Moreover, I am convinced that, ere another period of fifty years shall have elapsed, there will be as much attention paid to the rearing of timber trees as there is now bestowed upon the rearing of farm-cropping; for, in all high-lying districts of a country, the rearing of plantations will become, not a secondary object, as at present, but a primary one, seeing that the land will not produce abundance by any other means.

I am aware that there are not a few who entertain the unnatural opinion, that, by and bye, the art of arboriculture will be so well understood that timber trees will be made to grow much more rapidly than at present; and, as this appears to me to be a false notion, I shall here speak my mind upon the subject, because I am anxious that no false estimates should be made by people who may indeed be enthusiasts in the matter of tree-growing, but who want the practical knowledge to enable them to speak soundly, and with experienced judgment, upon the matter.

Relative to the above opinion, I lately read the following paragraph in a public print: "In an age when everything useful and ornamental becomes the subject of scientific investigation and general study, it seems singular that arboriculture should be at once so universally practised, and in its principles so utterly neglected. We may reasonably expect that the time is not far distant when arboriculture, being of the same family as agriculture and horticulture, will at length share the same distinction—that it will be taken out of ignorant hands, and engage the attention of the ingenious and scientific. Nothing seems wanting to this charming art but some successful method of giving a speedy effect to wood, and of bringing the enjoyment of it, in some sort, within the lifetime of the planter—that is, giving it at once a magnitude sufficient for picturesque purposes."

With regard to the above quotation, I have to remark, that I perfectly agree with the author in his opinions relative to forestry, as contained in the two first sentences; but his enthusiasm for forest improvement, as expressed in the last sentence, betrays the want of sound practical knowledge upon the subject in question; and, as I have already said that I am aware of several men of influence and character who hold the same opinion, I hereby beg to give my advice, as a practical man, *not to hold by the same*, as it is not founded upon sound scientific principles; and my reasons for differing from such men are as follows:

Every individual species of tree has, by the laws of nature, a tendency to grow at a rate peculiar to itself; and if any tree should be urged to grow at a rate beyond what nature has allowed it to do in general circumstances, the same tree will be unhealthy and soft in the quality of its wood; and although it may appear healthy and large in bulk of timber, it must be, and always is, worthless for any permanent purpose. For let it be here particularly understood, that, in the cultivation of every vegetable substance whatever, the cultivator, in adding unnatural bulk to it, as in the case of the turnip, does not add woody matter or carbon to it in the natural proportion which exists in the plant as found in a state of nature; but, upon the contrary, he adds merely a watery half-prepared matter, which is liable to perish quickly after the life of the plant has become extinct. And this is exactly the case in the growing of trees, as in the growing of turnips or potatoes. Let us take another example in illustration of the point. The *poplar* is the fastest growing of all our forest trees; and I may say that the oak is the slowest in coming to useful bulk. The poplar, at forty years of age, agreeably to its common nature, will often contain sixty cubic feet of timber; while the oak, at the same age, will not, agreeably to the same law, contain more than the third part of that quantity. Now, if it were even possible to urge the oak to grow at the same rate as the poplar, what would be the natural consequence? Would it not be that of deteriorating the quality of the wood, and consequently lessening its value as useful timber? And yet this is the state of things, relative to forestry, which the author, in the above sentence, wishes to see speedily brought about, where he says, "giving it (wood) *at once* a magnitude sufficient for picturesque scenery." I have always observed, in the case of making fences, gates, &c., both with oak and larch wood, that the trees which had been grown rapidly, of either sort, when converted into those purposes, never last more than half the time that the wood of the same age does, but of a slower growth. Moreover, I have also had occasion to observe, that of two trees of equal age, and of the same sort of timber—if grown, the one exposed freely to the air, and upon a moderate soil, and the other confined and drawn up weakly in the heart of a plantation, in a rich soil—the wood of the tree which was exposed to the free air, and grown upon a moderate soil, will last a great deal longer, for any purpose, than the wood of the one which was confined, and grown upon a rich soil. And this at once points out to us, that, if we wish to have valuable timber trees, we must not urge them to grow at a rate much beyond what nature has allowed them; neither must we confine them too much, but give them a free circulation of air in the plantation. In conclusion upon this head, I beg to say, that the prospects of forestry are at the present day very encouraging in Britain; but too sanguine expectations must not be entertained relative to the future, in so far as relates to the quickening of the growth of trees; for if we wish to have healthy plantations, and if we wish the same to produce sound and healthy timber, we must study nature, and do our work along with her, and not try to outdo her, as many would wish to do.

SECTION III.—THE VALUE OF WOOD AS A CROP UPON LAND.

The value of wood, as a crop upon any given piece of ground, depends much upon the treatment it may have received in its cultivation. Trees, like every other useful product of the soil, may be considerably deteriorated in value by unskilful and careless management; and they may also be greatly enhanced in value by skilful and careful management. Besides, the value of wood varies according to the nature of the land planted, and also according as the locality may, or may not be, conveniently situated as regards a ready market for the sale of timber.

A plantation of trees, of whatever species it may be composed, is always of more value to the grower when in the neighbourhood of a thriving seaport, than the same plantation would be in a far inland district. The reason of this is obvious; for in the neighbourhood of a ready market for timber, the distance for cartage is not necessarily much calculated upon by the purchaser, consequently, he is enabled to give a fair price to the seller. For example, were I to purchase good ash timber from a proprietor whose plantations were within two miles of a shipping port, I would be enabled, upon consideration of the short distance, to give him 2s. per cubic foot: in this case, I would calculate upon selling the same wood at 2s. 6d. per foot, allowing the 6d. which I would receive extra for the covering of all necessary expenses and my own profit. Again, were I to buy the same quality of ash timber from a proprietor whose plantations were thirty miles from a shipping port, I could not give in this instance more than 1s. 3d. per cubic foot, because I would have to calculate that, although I got 2s. 6d. for this wood, it would take 1s. 3d. per foot to cover my expense of conveying the timber to the market, and at the same time to have a little profit for my own labour. And thus it is in all cases, that, for every mile of distance from the market, the purchaser of wood is obliged to give less to the seller; and this because he has to meet the extra expenses incurred in each mile of cartage, previous to getting it brought to market.

However, I may here state as a general rule, which I have verified from my own experience, both in the Lowlands and Highlands of Scotland, that land under wood will, at the end of sixty years, under good management, pay the proprietor nearly three times the sum of money that he would have received from any other crop upon the same piece of ground.

This assertion, I am aware, will be considered extravagant by many proprietors; but to those who may consider what I have here said as beyond the truth, I beg to say, that although it may be in reality beyond what they have themselves experienced as to profits arising from their plantations, yet I must say, that in all cases where good management has been introduced, what I have said will be found a practical truth; and in order to illustrate the point, I shall here give two examples, exactly in detail as I have them in my note-book, of the different transactions as they took place under my own experience in the felling of wood upon gentlemen's estates, both in the Lowlands and Highlands of Scotland.

Upon the estate of Craigston, in Aberdeenshire, where the plantations are for the most part of larch, Scots and spruce fir, I have thinned them at all stages, from that of sixteen years old up to that of sixty, when they were cut down as ripe. And having taken a valuation of the trees, as taken from an imperial acre of plantation ground, at the different stages when thinning was required among the different plantations between sixteen and sixty years, I make the average value of wood as a crop, upon an imperial acre of land in the district of country mentioned, as undernoted:—

		£ s. d.	£ s. d.
At first thinning, which was at 14 years old, I took from one acre of mixed firs 600 trees at ½d. each,		1 5 0	
Deduct expenses of cutting the same,		0 5 0	
			1 0 0
At second stage, which was at twenty years old, I took from an acre of mixed firs 800 trees at 2d. each,		6 13 4	
Deduct expenses of cutting the same, and also that of keeping good the plantation, &c.,		2 0 0	
			4 13 4
At third stage, which was at 28 years old, I took from an acre of mixed firs 500 trees at 8d. each,		16 13 4	
Deduct expenses, as above,		4 10 0	
			12 3 4
At fourth stage, which was at 35 years old, I took from an acre of mixed firs 300 trees at 1s. 6d.,		22 10 0	
Deduct expenses, as above,		6 0 0	
			16 10 0
At fifth stage, which was at 45 years old, I took from an acre of mixed firs 200 at 3s.,		30 0 0	
Deduct expenses, as above, and of sales, &c.,		8 10 0	
			21 10 0
At final cutting, when about 60 years old, I have taken from an acre of Scots firs and Spruce 180 trees, at 12s. 6d. each,		112 10 0	
Deduct from this, expenses of sales,	L.12 10 0		
Do. original expenses of planting,	3 0 0		
Do. expenses of trenching an acre of ground, and making the land good as at first,	8 0 0		
		23 10 0	
			89 0 0
Net produce of an acre of woodland in 61 years,			144 16 8

In making the above statement of the value of fir plantations, as I had experience of them in Aberdeenshire, it is but fair to say, that the woodlands upon the estate mentioned had been very badly managed—consequently, their value was under many others in the same county. They had not been attended to in the way of properly thinning them in due time, which neglect had very much lessened the value of the whole per acre. I may remark that, upon the Earl of Fife's estate at Duffhouse, I have frequently observed, that many of the fir-woods, of like standing with those on the estate of Craigston in so far as soil and situation could affect them, were much better, and far more valuable, and that occasioned by superior management; and I could point out many other estates in the same district, the wood of which, from better management, was worth one half more per acre at the different stages, as stated above. But as I had these from observation only, and not from actual experience, I merely wish to observe, as to this matter, that instead of exaggerating the value of woodlands in the north, I have given a low statement, and one the truth of which I can vouch for.

Upon the estate of Craigston, there were generally planted upon the acre four thousand trees. Now, from looking over the above statement as to the number of trees thinned from the acre at all the different periods mentioned, from first to last, it will be seen that many of them had never come forward to any value—these, no doubt, having died from the want of attention. Thus we see that, instead of the number of trees which were planted, we can only account for two thousand five hundred and eighty; the remainder, about one thousand four hundred, having failed in some way or other; and that, no doubt, resulted from the previous bad management, which prevailed upon the place in the growing of woods.

The annual rent of the land, at an average, upon which those plantations grew, was reckoned at about 10s. per acre; and had it been occupied by a tenant for the purpose of grazing, the proprietor would have received only £30 for an acre during the period of sixty years; but being occupied by trees, we see that he received by the end of the period of sixty years, when the crop was cleared off, no less than 48s. for each year of the period—and this, too, after deducting every necessary expense which the proprietor was put to. And even after deducting compound interest upon the original outlay and rent, progressively, during the periods when no return was received, it will be found, as I have formerly stated, that such land, when planted with trees, will pay fully three times the amount of money that it could do under the hands of a farmer; and this points out that wood, as a crop, even when very indifferently managed, is exceedingly profitable to the proprietor, and adds greatly to the value of his estate.

Again, in the county of Mid-Lothian generally, I have cut down and thinned woods to a great extent, upon a number of landed properties: these consisted of mixed hard-wood plantations, oak plantations, larch plantations, as also Scots and spruce fir plantations. Upon these estates, I have thinned the various kinds of plantations, at all stages, from eight years up to seventy, eighty, and even one hundred years. And in order to point out clearly and intelligently the value which I have found derived from the different sorts of timber, at a given age, I shall give a statement of the thinnings which I have taken from an acre of wood, of each of the kinds above mentioned; and in doing this, I beg here to be understood, that, in the greater number of the plantations of each of the kinds I have taken my data from, they were not in good state, having been much neglected before I had occasion to visit them: consequently, I must say, that their value, in most cases, might have been about one-third more had they been well attended to; but my object, in the mean time, is to give their value as I found them.

The following statement shows the medium value of a mixed hard-wood plantation, with firs to act as nurses, and is taken from the thinnings of plantations which I have made upon eleven different estates in Mid-Lothian.

	£	s.	d.	£	s.	d.
At the first thinning, which was at an average 10 years from the time of planting, I have taken generally 700 larches at 1½d., ...	4	7	6			
Deduct from this expenses of cutting, &c., . .	0	10	0			
				3	17	6
At second thinning, being on an average when the trees were 16 years old, I have taken 600 larch and Scots firs at 3d. each, ...	7	10	0			
Deduct expenses as above, ...	1	8	0			
				6	2	0
At third thinning, when the trees were 20 years old, I have taken 700 larch and Scots firs, averaging 6d. each, ...	17	10	0			
Carry forward, ...	17	10	0	9	19	6

	£ s. d.	£ s. d.
Brought forward,	17 10 0	9 19 6
Deduct expenses,	2 15 0	
		14 15 0
At fourth thinning, when 25 years old, I have on an average taken 600 firs at 1s. each,	30 0 0	
Deduct expenses, for keeping up the fences, cutting, &c.	3 10 0	
		26 10 0
At fifth thinning, when 30 years old, I have taken 80 firs at 2s. 6d.,	10 0 0	
Deduct expenses for pruning, &c.,	3 0 0	
		7 0 0
At sixth thinning, when 35 years old, I have taken 110 hard-wood trees of various sorts, averaging 8s. each,	44 0 0	
Deduct expenses,	6 18 0	
		37 2 0
At seventh thinning, when 40 years old, I have taken 100 hard-wood trees at 15s.,	75 0 0	
Deduct expenses,	9 5 0	
		65 15 0
At eighth thinning, when 50 years old, I have taken 100 trees at 30s. each,	150 0 0	
Deduct expenses,	10 6 0	
		139 14 0
At ninth thinning, when the trees were about 60 years old, I have taken 30 hard-wood trees at 40s.,	60 0 0	
Deduct expenses of sale, &c.	6 0 0	
		54 0 0
At final cutting, when the trees were about 70 years old, I have cut from an acre of land 50 hard-wood trees, at 60s. each,	150 0 0	
Deduct from this expenses of sale, &c., £15 0 0		
Original expenses of planting and enclosing, 5 0 0		
Expenses necessary for trenching an acre of woodland for agriculture, 15 0 0		
	35 0 0	
		115 0 0
Net produce of an acre of mixed hard wood, in 70 years,		469 15 6

The average rent of the land from which I have taken the trees, as above mentioned, may be about 30s. per acre; and if we divide £469, the value of wood, as taken from an acre in 70 years, by seventy, the number of years, we have £6, 14s. as the yearly rent for that time, instead of £1, 10s.; and this, too, after deducting every necessary expense which could be incurred by the proprietor. And even if we deduct compound interest progressively, it will be found that the proprietor has fully three times the income from a crop of wood that he could have received, had the land on which it grew been in the hands of a farmer.

The following statement shows the medium value of an acre of oak plantation, at the end of one hundred years, as I have found them in Mid-Lothian, with firs to act as nurses:—

	£	s.	d.	£	s.	d.
At 8 years, being first thinning, 800 larches at $1\frac{1}{2}$d.,	5	0	0			
Deduct expenses of cutting, pruning, &c.,	1	5	0			
				3	15	0
At 12 years, being second thinning, 500 larch and Scots firs, at $2\frac{1}{2}$d.,	5	4	2			
Deduct expenses of cutting, pruning, &c.,	1	15	0			
				3	9	2
At 18 years, being third thinning, 900 mixed firs, at 4d.,	15	0	0			
Deduct expenses of cutting and pruning, and of keeping good the fences, &c.,	3	5	0			
				11	15	0
At 23 years, being fourth thinning, 200 firs, at 1s.,	10	0	0			
Deduct expenses, as above,	2	0	0			
				8	0	0
At 27 years, being fifth thinning, 100 firs, at 2s.	10	0	0			
Deduct expenses, as above,	1	10	0			
				8	10	0
At 31 years, being sixth thinning, 100 firs, at 3s.,	15	0	0			
Deduct expenses, as above,	2	5	0			
				12	15	0
At 32 years, being seventh thinning, 150 oaks, at 5s.,	37	10	0			
Deduct expenses of peeling, cutting, &c.,	6	5	0			
				31	5	0
At 36 years, being eighth thinning, 40 oaks, at 10s.,	20	0	0			
Deduct expenses, as above,	2	10	0			
				17	10	0
At 40 years, being ninth thinning, 50 oaks, at 15s.,	37	10	0			
Deduct expenses, as above,	4	0	0			
				33	10	0
At 45 years, being tenth thinning, 30 oaks, at 25s.,	37	10	0			
Deduct expenses, as above,	3	10	0			
				34	0	0
Carry forward,				£164	9	2

				£	s.	d.	£	s.	d.
Brought forward,							164	9	2
At 50 years, being eleventh thinning, 25 oaks, at 35s.,				43	15	0			
Deduct expenses of sale, &c.,				5	15	0			
							38	0	0
At 60 years, being twelfth thinning, 20 oaks, at 50s.,				50	0	0			
Deduct expenses, as above,				4	10	0			
							45	10	0
At 70 years, being thirteenth thinning, 15 oaks, at 80s.,				60	0	0			
Deduct expenses of sale, &c.,				6	10	0			
							53	10	0
At 100 years, being final cutting, 35 oaks, at 140s.,				245	0	0			
Deduct expenses of sale,	£24	0	0						
Original outlay in planting per acre,	5	10	0						
Expenses of trenching the land and the crops,	15	0	0						
				44	10	0			
							201	10	0
Net produce of an acre of land in 100 years, as found under oak wood,							£502	19	2

From this last statement it will be seen that the oak plantation, at the end of one hundred years, pays the proprietor £5 an acre per annum; whereas the mixed hard-wood plantation pays nearly £7 an acre at the end of seventy years; and this is actually the case, as I have the result from my own experience. I have, indeed, in several instances, found the oak much higher, per acre, than here stated; and I have also found it much lower: my object here has been to give the medium in both cases; and, generally speaking, a mixed hard-wood plantation will be found more profitable than oak alone; and the reason I have found to be this—plantations are generally badly managed, and oak trees suffer from bad management more than most other trees. Oaks, when much confined in their young state, soon become tall and slender, and will not readily recover themselves again—at least as compared with ash, elm, or sycamore, &c.; consequently, it is generally from bad management that the oak is found under the value of mixed hard-wood per acre. But in most cases, where the soil is well adapted for the growth of the oak, and where attention has been properly bestowed upon it, it will be of considerably more value from eighty to one hundred years than any other tree—all depending upon the nature of the soil and the management.

The following is a statement of the value of an acre of larch plantation, upon favourable soil, at the end of sixty years, when it may be considered at its highest value :—

	£	s.	d.	£	s.	d.
At 10 years, thin out 500 trees, at 1d. each, . .	2	1	8			
Deduct expenses, ...	1	0	0			
				1	1	8
At 15 years, thin out 500 trees, at 2½d., . .	5	4	2			
Deduct expenses, ...	1	8	6			
				3	15	8
At 20 years, thin out 600 trees, at 8d., . .	20	0	0			
Deduct expenses, ...	2	10	0			
				17	10	0
At 25 years, thin out 300 trees, at 1s., . .	15	0	0			
Deduct expenses, ...	3	0	0			
				12	0	0
At 30 years thin, out 200 trees, at 3s., . .	30	0	0			
Deduct expenses, ...	3	15	0			
				26	5	0
At 35 years, thin out 150 trees, at 5s., . .	37	10	0			
Deduct expenses, ...	4	5	0			
				33	5	0
At 40 years thin, out 100 trees, at 10s., . .	50	0	0			
Deduct expenses, ...	5	10	0			
				44	10	0
At 45 years, thin out 100 trees, at 20s., . .	100	0	0			
Deduct expenses, ...	10	0	0			
				90	0	0
At 50 years, thin out 50 trees, at 30s., . .	75	0	0			
Deduct expenses, ...	7	10	0			
				67	10	0
At 60 years, or final cutting, 100 trees, at 50s., .	250	0	0			
Deduct expenses of sales, &c., . £25 0 0						
— original expense of planting, 3 0 0						
— expense of trenching the land, 8 0 0						
	36	0	0			
				214	0	0
Net value yielded by an acre of larch in 60 years, .				£509	17	4

From this statement of the value of an acre of larch plantation, it will be seen that at the end of sixty years, under favourable circumstances, the proprietor will receive £8, 10s. as the rent of his land per acre ; and so it is. Larch, when it thrives well, pays better than any other crop of wood in a given time. Nearly two crops of larch could be had off land by the time that the oak had arrived at its maturity; and the larch will generally be found at its full value at or about sixty years.

The Scots pine and spruce fir take much longer in coming to maturity than the larch does; the Scots pine in particular cannot be said to have arrived at maturity under eighty years; and upon the same principle of calculation as already shown in the three statements given, the average value of an acre of Scots pine, at the end of eighty years, may be taken at about £300; and spruce fir at about £260. The reason of the inferiority of the value of these is, that the Scots pine is not so much sought after in its young state as the larch is; neither is the spruce fir; both being much inferior in the value of their wood till of full age, and even then the larch sells at one fourth more than either of them.

What I have said above refers to the value of a crop of wood when trained up as timber trees. There are, however, many proprietors, both in England and the west of Scotland, who cultivate their wood lands upon the principle of coppice-woods, without allowing almost any of the plants to become timber of useful size. This system of rearing what may be termed general coppice-woods, is indeed very profitable near large manufacturing towns, such as Liverpool and Manchester; for near such markets young growths of almost all sorts of hardwood meet a ready sale, and at high rates; and as this method of cultivating woodlands is attended with very little trouble, and requires very little practical knowledge in the grower, it is much resorted to in many parts of England, even where the cultivation of large timber would ultimately pay the proprietor three or four times the amount he receives for his crops of coppice-wood. Now this is certainly an error much to be regretted, and which ought to be exposed; and in order to this, I beg to make a few remarks, that proprietors possessing such coppice-woods may be able to judge for themselves whether their woodlands, so managed, pay them or not.

This year (1848) the Earl of B——— requested me to visit his woodlands upon his estate at H——, in Lancashire, which I did; and upon looking over his lordship's woodlands there, I found them to consist mostly of oak, ash, hazel, and mountain-ash coppice, with only a very few young timber plantations, which had by no means been well managed, having been much neglected both as regards thinning and pruning, His lordship being a most active-minded and improving nobleman upon his estates, saw that the system of management which had hitherto been pursued among his woodlands was not as it ought to be; many of his coppice-woods had been cut, from time immemorial, at periods of about fifteen years, and were now becoming worthless from age; and he wished to introduce a new system of management in this department, which he would have done at an earlier period, but was disadvised from doing so by many who maintained that his estate of H—— was not adapted for the growth of heavy timber. Upon examining the nature of the soil and situation upon the estate, I was thoroughly convinced that few estates in the north of England were better adapted for the growth of heavy oak timber, and I advised his lordship accordingly. Now, here is an estate, the woodlands of which, as now found under mixed coppice, and cut down at periods of fifteen years, have paid the proprietor no more than twenty shillings per annum of rent. These woodlands have indeed served to supply the market with cheap hoops and bobbin-wood, but it is a profitless speculation to the proprietor; for had the same land been planted with oaks and a mixture of larch and Scots firs, the proprietor would, instead of twenty shillings per annum per acre, have received at least £5 per annum; and if his lordship proceed as I have advised him in this matter—that is, to do away with the coppice-wood gradually, and replant with oaks for a permanent crop, and make up with larch and Scots firs for nurses—he will ere long not only receive five times the present amount of rent for his woodlands, but he will also beautify his estate in a tenfold degree. And besides this, his lordship will at the same time be setting an example of improvement to his neighbour proprietors, who appear to be against the doing away with the old system, however profitless it may be. It is my opinion that there are very many landed proprietors in England situated in the same manner. They have a great extent of woodlands, growing coppice of the description I have described—for the produce of which they receive a ready market, but at a very low price: therefore it is that they are not inclined to enter deeply into the improvement of their woodland, thinking that it is not a profitable business to grow wood, not having experienced a better system of management, and seeing they can seldom realise more than thirty shillings per acre for its produce; whereas, were such proprietors to replant, as I have said above, they would eventually derive about five times the income from their woodland that they now do by their present system of management under coppice.

As I have already said, if the proprietor can sell his coppice at a fair price—which can generally be done in the neighbourhood of a market for such wood—it is proper and right that he should do so, in order to supply his neighbourhood with the sort of wood most in use; but where a proprietor cannot get for his wood crop at least three times as much money as he could from the same land were it under agricultural crops, he has a right to say that there is something wrong in his district as regards the value of his woods. No proprietor of woods is called to grow any sort of wood-produce for his neighbours, and sell it to them at a cheap rate, while he can, by altering his system of wood management, sell his produce to a greater advantage at some other place, and in another form.

From what has been stated above, it will be seen that, in order to make wood come out as a valuable crop upon any piece of land, much depends upon the management of the parties who have the superintendence of the same; and this not only as regards the training up of the crop, but also in the choice of the kinds of wood planted, whether these are adapted to the wants of the wood-market in the neighbourhood. For example, in the county of Aberdeen, where all sorts of hard-wood are scarce, I have sold ash for 4s. a foot; while in the Lothians, where ash-wood is plenty, I could not get more than 2s. a foot for the same quality of wood; therefore, in the northern counties of Scotland, the proprietors who pay attention to the growing of ash-wood will find a high price for it; while, upon the other hand, fir, which is very plenty in the same parts, sells at a very low rate.

Again, in Mid-Lothian, where hard-wood is plenty, it is bought at a moderate rate; while good fir, which is comparatively scarce as compared with the north, is generally sold at a good price in the Lothians.

These examples I consider quite sufficient for the present purpose. And further, upon the same point I beg to say, that it is not alone the simple value of the timber that makes plantations of so important a nature upon a gentleman's property—there is the shelter that they afford to all agricultural purposes; for where no plantations are, there is invariably an inferior crop of grain upon the fields, as well as an ill-fed live stock, which should all be taken into account; and in doing so, I am of opinion that, upon any landed property, well-managed plantations are incalculably of more value than land three times their extent in the hands of a farmer, but without trees to give shelter; and it is well known by every proprietor of land, that he receives by far the highest rent for those parts of his lands which are most sheltered by his best plantations. And further, of whatever value land may be in the hands of a farmer without plantations to give shelter to the same, it is of very much greater value when properly sheltered by them.

SECTION IV.—LAYING OUT OF GROUND FOR NEW PLANTATIONS.

It is admitted by every person of a refined taste, that no object is so ornamental upon a gentleman's estate as an extensive healthy plantation, situated upon a well-chosen spot, and having a well-defined tastefully bending outline; and this being a point of the first importance in arboriculture, it ought to be well considered by all who would wish to excel in the profession. I am aware that many think, and indeed say, that forest-trees will grow as well in an untastefully-defined plantation as they will do in one laid out upon the first principles of refined taste, provided that the soil be good enough,—which is a false estimate of what good taste is capable of doing. And in order to contradict this erroneous opinion, I do assert, that a young plantation laid out according to scientific principles, combined with good taste, will succeed much better than one laid out in a careless manner, as will be shown by-and-by, under the present head.

As the future welfare of a plantation is considerably affected by the manner in which it is laid out, no man ought to attempt the laying out of ground for one, who is not naturally possessed of good taste for that sort of landscape-scenery which is based upon the laws of nature, which will enable him to lay out the proposed plantation in such a manner as to give the greatest possible effect in ornamenting the neighbouring country. It is also necessary that the person who would lay out ground for a new plantation should be possessed of a knowledge of the nature of the growth of each sort of tree when planted upon any given soil or situation; which knowledge will enable him to judge rightly as to the effects that certain trees will have when planted in any given spot; and he will also be enabled from such knowledge to say truly, whether or not trees will grow well in the situation chosen for a new plantation. And it is further necessary that the party, in the laying out of a new plantation, should be acquainted with, or at least have in view, any local peculiarities of the district, relative to cold and destructive winds from certain points. From such knowledge he will be able to lay out the proposed plantation in such a manner, that it shall have the greatest possible effect in giving shelter to the surrounding fields, which is the principal end a proprietor aims at in having woods upon his estate.

The larger that any piece of plantation is, the sooner will the trees therein come to useful size, and answer the desired end; and the smaller it is, the more likely are the hopes of the planter to be disappointed. And the reason of this is obvious:—for the young trees growing in an extensive plantation, as soon as they rise a little above the surface of the grass or heath, begin to shelter one another; whereas, if the plantation be narrow, the young trees can hardly be said ever to come the length of sheltering one another—for every breeze of wind blowing through the whole breadth, acts upon every single tree almost as powerfully as if each tree stood singly and alone. Therefore, it is most profitable for proprietors always to plant in large masses.

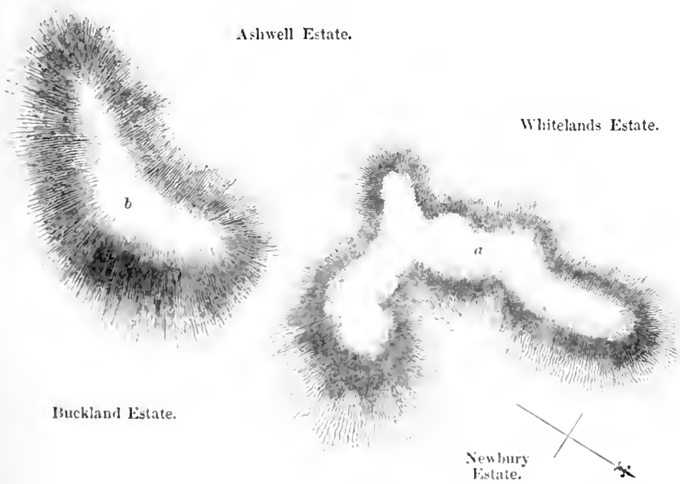
Trees planted in a mass of one hundred acres extent, will be more healthy, and come sooner to profitable size, both as affording timber and shelter, than they would if planted in a mass of ten acres. From this it follows, that if a proprietor wishes to plant one hundred acres upon his estate, he will raise more healthy timber by planting in one mass, than he would do by planting the same extent in four masses of twenty-five acres each.

No young plantation, upon an exposed situation, should be less than one hundred yards broad at any given point; and, where the soil is of a light, thin, mossy nature, and not apt to raise trees to good size, one hundred yards may even be too little for breadth. If there be much mossy ground upon the site intended for a new plantation, or if there be much of it consisting of poor, thin, gravelly heights, as is often the case in unimproved districts, a narrow or small plantation will not succeed profitably. A small plantation may succeed upon a good loamy soil in a sheltered situation; but upon a bad soil, and an exposed situation, I would advise not to plant at all, unless it be done in large masses.

Almost every gentleman's estate lies in a manner peculiar to itself; the wind that might prove hurtful to one estate, might not do so to another marching with it: therefore it is, that the particular winds which prove most hurtful to an estate, should always be taken into consideration in the laying out of a plantation upon it.

By referring to Fig. 1, this peculiarity in the difference of situation affecting landed property will be at once evident.

Fig. 1.



The estate of Whitelands being situated upon the west side of the hill *a*, which runs nearly south and north, would be greatly sheltered from all storms of wind from the east and south-east; consequently, in laying down plantations upon the estate of Whitelands, the greater length of the same, in order to protect the land from the north and south winds, would require to be made from east to west; and if the situation were exposed to destructive west winds, plantations meant to protect the lands from it would require to be made from north to south. Again, Newbury estate, being situated upon the east side of the hill *a*, the lands upon it would be sheltered from the west and south-west winds, but would be much exposed to the north and east winds; consequently, the same estate would require to be sheltered by plantations, extending their greater length from east to west, which would protect the lands from the north winds; or from north to south, in order to protect from the east winds.

There being a considerable opening between the south end of the hill *a* and the north end of the hill *b*, as indicated in the figure, the north part of the lands of Ashwell occupying the west side of this opening, and those of Bucklands occupying the east, great care is necessary in laying down plantations under such circumstances; for either the east or west wind passing through such an opening, gathers force from being confined in its passage between the two hills; therefore, in order to protect each estate from the effects of winds passing through unchecked to either side, a mass of plantation would require to be situated right in the opening, having a convex side turned to the east, and another to the west, which would naturally turn the wind to either side, and cause it to spread along the hills.

Again, in order to protect the lands upon the west of Ashwell from the north, plantations would require to be laid off from east to west; and in order to protect them from the west, they should be laid off from north to south.

Upon the estate of Bucklands, again, the land requires to be sheltered more particularly from the north and east winds; therefore, plantations laid out upon it with the view of protecting from these winds, would require to be made from east to west in the one case, and from north to south in the other.

From what has been said, it will appear plain why one estate may be injured by the wind from a certain point, while another marching with it may not be injured by the same at all; thus the estate of Whitelands, from being situated upon the west side of the hill *a*, is completely sheltered from the east wind; while, upon the contrary, the lands of Newbury are naturally exposed to the east. The northern parts of both the estates of Ashwell and Buckland are, from their natural situation upon the opening between the two hills, nearly alike exposed to the east and west winds; while the southern parts of these estates are sheltered by the hill *b* differently: therefore it is that, in the laying out of plantations upon any landed property, those matters, which I have here endeavoured to explain by reference to Fig. 1, must in all cases be kept in view by the intelligent forester.

I have already said above, that the welfare of a young plantation depends in a great measure upon the manner in which it is laid out. I also said that a plantation laid out according to scientific rules, combined with good taste, will succeed much better than one laid out in a careless, unscientific manner. The following are the rules by which I generally guide myself in the laying out of a new plantation:—

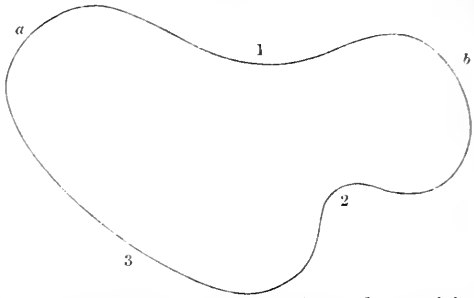
First,—In laying out its boundary line, avoid all straight lines upon the exposed sides; and, if possible, make no straight lines upon any side: they are disagreeable to the eye of taste, and are without meaning when applied to natural objects: in nature there are no straight lines, and that for a wise end, for they are without strength to resist outward pressure.

Second,—The greatest extent of a new plantation should be laid off against the prevailing wind of the district; and, at the same time, the greatest extent should be kept along the highest part of the ground to be planted.

Third,—The best possible form of boundary line which can be thrown out against the wind, upon the most exposed side of a plantation, is the convex. Such a form of boundary line weakens the strength of the wind when it hits upon it: the strength of the storm is, as it were, divided when it hits upon the projecting bend of a well-defined convex.

Fig. 2 is a sketch of the outline of a plantation with its exposed sides *a* to the north, and *b* east, representing two convex bends thrown out against the storm from those points.

Fig. 2.



Now, from considering this attentively, it will at once appear evident, that trees growing behind a bend of this description, and the outer trees forming themselves the bend, are, from the position in which they are arranged, proof against the effects of storm, as compared with others forming a straight line, or a concave bend. Upon the convex bends, as at *a* and *b*, Fig. 2, when the wind hits, its force is weakened, because the line of fence recedes from the wind, as it were, at any given point; and in proof of this, I may refer to the action of the sea upon the different-shaped bodies which may be made to pass through the water. For example, the forepart of a ship is nearly of the convex form, and when the water hits upon it, it spends itself along each side of the vessel. Again, were a ship to have its forepart made flat, it could not be urged through the water at all; and again, were the forepart of a ship to be made concave, instead of the vessel being made to go forward, it would be driven back, and this is exactly the principle of the action of the wind upon the different forms of fence-lines; and from this we see that the concave bend is the worst for the purpose of protecting from the storm anything behind it: consequently, in making such a bend in the line of a plantation fence, great discrimination is requisite to know when it should be made.

Fourth,—Upon the most sheltered sides of a plantation, the boundary line may be made to bend one way or another, as good taste may direct; but in all cases making a concave bend only where there is a good breadth of planting immediately behind it.

By glancing at the concave bend 2 in Fig. 2, it will be observed that it is backed by a great breadth of planting from the north *a*, and is also well protected by the convex bend *b* upon the east; besides, its situation is upon the most sheltered side of the plantation — namely, the south; and such concavities may be made upon the same principle, few or more, according to the extent of the ground planted, and also as the private taste of the proprietor may suggest; but in general cases, the fewer of them the better, for the welfare of the plantation; but where stock are to be sheltered, it is often necessary to make them. For example, if in Fig. 2 there was no concavity at 2, the storm blowing from the east, cattle could have no real shelter along the edge of the wood at that point; but in such a bend in the outline of a wood as shown at 2, stock could not receive any injury excepting from the south, which is, generally speaking, not subject to stormy weather in this country.

Fifth,—The highest parts in a neighbourhood ought to be chosen for the site of a plantation. By choosing such a situation, the greatest possible shelter is likely to be attained for the neighbouring fields; and, at the same time, a plantation situated upon a height always forms a prominent and a pleasing object to the proprietor. A bare height always carries along with it the idea of barrenness; but when planted with trees, it forms one of the most pleasing objects in the landscape of a gentleman's estate.

Sixth,—In the laying out of a new plantation in a high exposed country, intended principally for the protection of live stock, there ought to be several rather deep sinuosities upon the most sheltered sides. These sinuosities ought to be upon a bold wide scale, so as not to cause any weak point to project from the body of the plantation; for if this be the case, such weak points would not thrive, and consequently always have a mean appearance.

Seventh,—If in the general arrangement of the boundary line it should be found necessary to make a bend, having its concavity to the storm side, care should be taken to construct such a bend in a hollow part of the ground, or at least as low as possible; and it should be backed by a good breadth of planting behind. See Fig. 2 at 1.

In the laying out of a new plantation, there is much room for the display of good taste. Every person is pleased with the effect of well-arranged figures upon grass in a flower-garden; and the several plantations upon a gentleman's estate ought, in like manner, to be well-laid out figures, upon a large scale. Many have told me, when speaking upon this point, that it is superfluous to lay out a piece of plantation with as much view to taste as is necessary in garden and pleasure-ground scenery; but I have always maintained that taste is as necessary in the one case as in the other, and that any proprietor has a right to tasteful arrangements, and is pleased therewith when surveying his farms, as much as with the other when surveying his pleasure-grounds. If in the general arrangement of a young plantation, a display of taste were to be injurious to the welfare of the same, then I would say, let taste have nothing to do in the matter; but the truth is quite the reverse of this. All true taste is based upon the works of nature; therefore, when we make the bendings and turnings of the boundary line of a plantation in conformity with the securing natural strength to resist the storm, we at the same time give the most pleasing effect to the mind of the person who looks upon it.

The bendings in the outline of a plantation should always be made to follow the natural rising and falling of the ground; that is, where any lateral heights may project from the main body of the ground laid out for a plantation, make the fence-line take a bold convex turn in the same direction, and that just so far as may be considered necessary for the extent in view; and where a hollow of the ground occurs, make a fence-line take a bold concave turn there, coming up again in the form of the convex where the ground begins to rise.

This will be more fully understood by referring to Figs. 3 and 4.

Fig. 4 represents the side of a hill as laid off by me for a plantation, and the dotted line represents the fence. The concave bend *a* is made in a hollow, sheltered part; and the convex bend *b* rises over the high ground adjoining, but is not extended to the extreme tail or bottom of the hill ground; because it may,

Fig. 3.

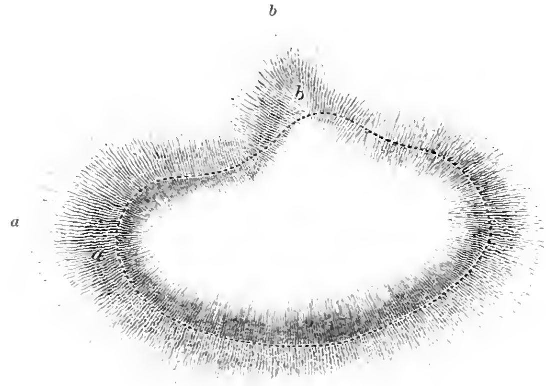
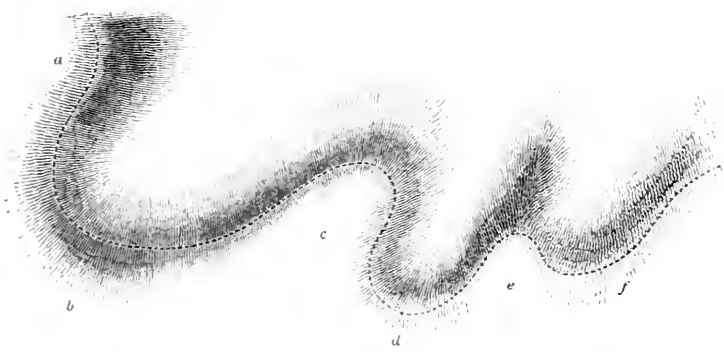


Fig. 4.



and often is, found extremely advantageous to retain a part of such high ground in the field, in order that sheep and other stock may have the benefit of the same for lying upon at certain seasons of the year when the lower grounds may be in a damp state; and besides, I have already said that the bends need only be extended so far as may be considered practicable for extent and general purposes, but in all cases the retaining of the form of the natural ground should be kept in view. The concave bend *c*, it will be observed, is made to extend far back into the hollow ground; for such a hollow part, when sheltered by plantations nearly all round, is one of the greatest benefits possible for stock at all seasons, both as regards storm in winter and shade in summer, and more particularly if the bottom there be dry.

The convex bend *d* is again extended beyond the tail or bottom of the hill ground, and that in order the more effectually to add shelter to the adjoining hollow part *c;* and the same remarks apply to the concavity *e*, which is also much sheltered by the bends *d* and *f*. Now, these points are most necessary to be attended to in the laying out of woodlands upon hill countries, where, indeed, the welfare of stock is often more to be taken into consideration than the giving of mere shelter to field-cropping.

Fig. 3 is the representation of a high knoll of ground which it is wished to form into a plantation in an exposed district. At *a* the hill-ground runs out to something like a mere point, and in this case the line of fence is kept a little higher, in order to give the convex bend a bolder and wider turn; for I have already said that all weak projecting points ought to be avoided in the proper laying out of a plantation boundary; and had the fence line at *a* been brought out in the exact natural form of the tail of the hill, a mere point would have been made, which should, in all cases of this nature, be avoided. And the very same remarks apply to the projecting point of the hill at *b*, where the fence is also kept back in order to strengthen the interior; and by the same being thus kept a little back, the appearance is improved, and yet in all these cases the natural form of the hill is retained.

In the laying out of a new plantation, if it is at all to be seen from the windows of the proprietor's mansion, or from any part of his pleasure-grounds, great care should be taken to make it have the most pleasing effect when viewed from such points; for if it should be badly laid off it will prove a continual eye-sore, and if well laid off it will prove a constant source of pleasure.

Besides the converting of hill-ground into plantations, there is also to be considered the planting of glens and other local hollows, which would be otherwise of very little value to the proprietor for any agricultural purpose, but which, if at all adapted to the growth of trees, under skilful forestry may be made the most profitable of all situations for the growing of timber. And, relative to this, I must say, that even upon a very inferior soil, trees will succeed far better upon slopes and in hollow parts than they will do upon a rich piece of land situated upon a level country. This appears to be most natural to the welfare of trees in general, which is a wise provision of nature, seeing we cannot cultivate such land profitably in the rearing of any other crop.

In the laying out of such hollows or glens for the rearing of plantations, I may remark here that the fence or boundary line ought to be made for the greater part to follow the undulations of the brow of the glen; that is, the boundary line of the ground to be planted in the hollow should be made to correspond, as far as other local circumstances will allow, with the natural line of the tail of the background above and the head of the slope; for this is the system which gives the most pleasing effect. But in saying this, I by no means wish to be understood as advocating that nothing ought to be done in order to improve upon the natural appearance of such irregularities as we often find existing along the edges of hollows or glens; on the contrary, there is no part of forest architecture in which there can be more taste displayed, not only with the view of giving effect, but with the more important view of giving the benefit of increased shelter from storm to the cultivated grounds along the sides of such parts.

It is well known to all country people, that in glens or hollows of any extent there is generally a draught of cold wind rushing along when the same is not sensibly felt upon the higher grounds above—at least at any considerable distance back from the brow of the hollow; and such cold winds are often very hurtful to crops in the adjoining fields, particularly in the case of frost and cold damp in the spring months. Now, in order to prevent the evil effects of such draughts of damp and frost winds in the spring, it is very proper to have convex bends rising out of the glen or hollow, at well-chosen points, and extending a considerable way upon the level ground above, and always endeavouring to bring up such a bend at a part most likely to intercept the rush of wind from the glen to the higher grounds; and such bends should not be made upon a small contracted scale, but to a considerable extent, by which means the ground above is greatly protected from the effects of sudden gusts of wind, which are very apt to arise from such parts, and which are almost always hurtful.

Many maintain that the planting of hollows with trees adds very little to the shelter of the neighbouring country; but in this I am decidedly of a different opinion; for the very existence of trees in a hollow sifts the wind passing through it, and very much impedes its passage and softens its temperature; and more particularly, when projecting parts are made to jut out at proper and judiciously chosen parts upon the level country, much good is done. And not only do such juttings prove beneficial as regards shelter, but they, in my opinion, add greatly to the general effect of the whole, as appearing most natural, and agreeing with a refined taste.

The method of laying out plantations in the form of strips, so often to be met with in Scotland, gives a poor and mean appearance to a gentleman's estate, particularly when found about the home grounds. The form in which they have generally been made is in straight lines, from twenty to thirty yards broad. In such narrow belts of wood the trees are very seldom found in good health; and, upon a little consideration of the matter, this is not to be wondered at—because, from the narrowness of such strips, the proprietors were always afiaid to thin them, wishing to keep them in a thick state, in order to give as much shelter as possible; and the natural consequence is, from being left too thick, the one tree soon kills the other. And even where such strips have been well managed, it cannot be expected that they could produce either good healthy timber or make a good shelter; for, being so narrow, the trees never come to shelter one another. But it is a happy circumstance in the history of arboriculture, that few such strips are now planted. Gentlemen are now beginning to see the impropriety of such a method of raising plantations; and now, almost in all cases of good management, we see the old-fashioned narrow strip giving place to the well-defined extensive plantation, which is, indeed, the only profitable way of rearing trees for any useful purpose.

The above assertion, I am aware, will be considered by many too sweeping a condemnation, and as having reference to all plantations in the form of strips; but in what I have said above upon this point, I have simply stated the objections which I have as a practical forester to the system of planting trees in too narrow strips, with the idea of growing useful timber in them; and I do further assert, that narrow strips are, above all other forms of plantations, the least likely for the rearing of timber to a profitable and useful size. However, there are many proprietors who, from circumstances of a local nature, are inclined—and I may say are often obliged—from the want of space, to plant in the form of strips; and, for the guidance of such proprietors, I beg to submit the following observations upon this point, which may, in many cases, be found useful:—

In all cases of planting strips in a moderately exposed country, if they are made nothing less than forty yards in breadth, they may, if well managed in the after-rearing, be made to produce good and useful timber; but much under forty yards, I think, it is not advisable to plant strips, at least with the view of ever producing either valuable timber or permanent shelter.

It often happens that upon small landed properties it is deemed of the first importance to have the greatest possible extent under farm-cropping; and, at the same time, it is also a matter of great importance to have the land subdivided by narrow strips of wood, in order to produce shelter. In cases of this nature there is, indeed, necessity for taking up little room or space in the form of plantations; and in such cases I would recommend the following profitable method of rearing hedgerow timber upon small properties:—

Wherever it is found of importance to have a strip of plantation much under forty yards to shelter a part of an estate, and where the land is considered too valuable to have much of it converted into plantation ground, let the strip of land intended for the same be laid out and fenced in the usual manner. In planting this strip, let it be considered what sort of hard-wood trees will thrive best as a permanent crop upon the land; and if the soil be of a moderate quality, we will say a mixture of oak, ash, and plane. Let a row or line of these be planted immediately behind the fence, upon the most sheltered side of the strip, mixing them regularly, and at distances—say fifteen feet apart; or plant one sort continuously for a certain distance, if that should be considered necessary, upon consideration of a variety of soil occurring in the line, and, having done this, make up the body of the strip with such trees as may be considered proper upon account of soil and situation, and of kinds that will be most likely to produce shelter quickly, and be profitable in the cutting down entirely as thinnings. Let such a strip of plantation be carefully managed, and as directed for other plantations in another part of this book, paying particular attention to the proper pruning of the line of hard-wood trees behind the fence, keeping the others well off them as they advance; and, in due time, if they be attended to, they will make rapid progress, being situated upon the sheltered side. I may say that, by the time they may attain thirty years old, they will be strong, spreading, vigorous, and hardy trees; and at this stage, if the body of the strip have been kept rather thin of trees, in order to make the row of hard-wood upon the sheltered side hardy by degrees, the whole of the trees in the strip, excepting themselves, may be cut down, and the hard-wood alone left as a line of hedgerow timber.

Now, relative to this, it may be asked, why plant a strip at all, when only a row of hedge timber is intended to remain ultimately? In answer to this, I have to say that, had the hard-wood trees been planted alone, without other trees in the form of a strip to shelter them for a time, they would have made but slow progress, and possibly might have been as long again in attaining a size fit for shelter; besides, the proprietor has, in this case, the benefit of early shelter by planting in the form of a strip in order to nurse his permanent trees, which shelter is continued, by the advanced state of the hard-wood trees, after all those in the strip have been removed; and he also has the value of the nurses to pay him at an early stage. Now, the advantages of this system over the common way of rearing up strips are these: Where narrow strips are planted with the intention of remaining as such for an indefinite period, we in most cases find the trees in them weakly and worthless, from being too much drawn up, and this state of the trees is occasioned by the want of space in the breadth of the ground allowed; and, generally speaking, by the time that the trees in such narrow strips have attained forty years, they begin to decline, and the strip becomes a mere waste. Whereas, when there is one line of hard-wood trees planted upon the sheltered side of such a strip of plantation, it is at once understood that they are to be the object of the cultivator's attention for permanent shelter; and, seeing this, he is not afraid to cut and thin other trees near them, which is the very state of things wished for; and if the row of hard-wood trees be allowed ample space, and paid attention to, they will, by the time that the trees in the other part of the strip are failing, be in a healthy and most useful state for remaining as valuable hedgerow timber, and will prove a beneficial shelter to the fields for generations after their nurses have been taken away. Another advantage of this system is, that the proprietor reaps a good rent for his land from the sale of the trees cut down, independent of leaving a row of permanent timber trees, which will act better as a shelter to his fields than his strip ever could have done as treated in the usual manner; and he has also the double advantage of again bringing his land under the plough, after the crop of wood has been removed, which he could not have done had he allowed his strip of plantation to remain in the usual manner. And in conclusion upon this head, I beg to say, that I have, in all cases of good management, found hedgerow timber infinitely superior, in every respect, to narrow strips of plantation, even where such were under what might be considered fair management. Trees in narrow strips seldom live to great age, from the want of space, even when tolerably managed; whereas hedgerow trees, when reared in the manner I have stated—which is applicable to high parts—attain, from having ample space, their full natural vigour and dimensions, and live to double the age of trees found in a strip; and when allowed to grow rather closely together, they make a much better shelter than an unhealthy strip. Therefore it is, that in all cases where land is considered of great value for farm-cropping, and where strips cannot be made of sufficient breadth, I would recommend the planting of hedgerow trees in preference to the usual method of planting narrow strips, and that either in the way I have recommended, or in a fence-row at once, if the climate and soil be good.

SECTION V.—UTILITY OF FENCING AND INCLOSING OF GROUND FOR YOUNG TREES.

It is absolutely necessary that every piece of ground laid out for a plantation should be fenced in some way or other previous to its being planted. A fence not only prevents the inroads of sheep and cattle, but it, at the same time, tends very much to shelter the young trees, and to bring them on rapidly. It is, indeed, surprising to observe the difference that a very low fence makes upon the growth of young trees, as compared with those which are not protected by one. Any proprietor or forester, upon looking through his several plantations, will observe that, in all young plantations, the most rapid growing, and, at the same time, the most healthy trees in it, are to be found immediately behind the outer fence; and, on the other hand, in all older plantations, the best grown, and, at the same time, the most healthy trees, are to be found in the centre of the same, or, at least, a considerable distance back from the fence. Now, it may be asked, what is the reason that the best wood is found in the inner parts of old plantations, while the most rapid growing trees are to be found, when young, behind the boundary fence? The reason, as proved from experience, is this:—

During the first eight or ten years of the age of any young plantation, the boundary fence is the only shelter that the young trees have; and it is evident that those trees which grow immediately behind the fence will receive most of the benefit of its shelter; consequently, from the circumstance of their receiving more shelter than their neighbours further off, they must grow more rapidly, until such time as their tops begin to rise above the level of the fence, when they are considerably checked by the cold winds. At this stage they begin to grow thick and bushy, rather than advance in height; and immediately upon their becoming so, they begin to shelter all their neighbours inside, which again begin to have double the advantage of their neighbours outside; for the trees upon the outside had shelter only so long as they were below the level of the top of the fence; whereas those inside have now a shelter, which every year increases upon them for their advantage, in height as well as in thickness. All this comes in to prove that a fence is a great mean of furthering the healthy development of a young plantation, independent of its protecting from the inroads of cattle at the same time. I always calculate that a plantation with a good fence is ten years in advance of one without such protection.

It may not be out of place here to state the great necessity there is for keeping good all fences which surround plantations, to a period beyond which it is likely that the trees will not be injured by the access of sheep and other cattle; and more especially, as I have often had occasion to remark the evil effects of sheep in particular being allowed to have access to plantations at an early period, I find it the more incumbent upon me to point out the evils arising from such a habit being allowed upon many estates.

Upon many gentlemen's estates I have observed sheep and other cattle grazing in hard-wood plantations not above twenty-five years old, and this was allowed under the impression that the rent which was received for the grazing did more than any additional benefit which could be derived from an opposite system of preserving the trees by fences. This, however, I beg to say, is a practice very much injurious to the welfare of any young plantation; for sheep, in particular, when allowed to have free access into any plantation composed of trees in a growing state, and having their bark smooth, are certain to injure the same, from the greasiness of their wool coming in contact with the bark and impeding the action of light and air; and, under such circumstances, I have frequently had occasion to see many fine and apparently healthy trees die suddenly. Upon the other hand, heavy cattle, when allowed to graze in a wood of small extent, among growing trees, are always inclined to hang about under their shade in the warmer part of the day, at which periods they invariably commence gnawing the bark, which is smooth upon such young trees, as well as the shoots of the tender branches where they can reach to them. Therefore I would advise all proprietors, as they value the welfare of their woods, never to allow cattle of any description to have access into a wood, unless the trees in it are considerably advanced towards maturity, when the bark of the most of forest-trees becomes hard and covered with rough scaly protuberances, which resist the action of either the greasiness of the sheep, or the teeth of large cattle. It may be asked, at what stage would it be safe to allow the grazing of cattle to take place where trees are? In answer to this, I give it as my opinion, that after trees have attained the age of forty years, and have received their final thinning, they may, in the generality of cases, be considered safe from the inroads of cattle.

Many different methods of fencing have been adopted for the inclosing of young plantations, &c., upon landed property; and, no doubt, different methods will still continue to be adopted, according to the different sorts of materials to be had in abundance in the neighbourhood of the plantation or other inclosure which may require to be protected; and as fencing is very often a very important part of a forester's duty, I shall, in the following sections upon fencing, enter rather minutely into detail upon the method of erecting the different sorts of fences, and shall show the advantages of one sort of fence over another, in so far as they are suited for different purposes, and for different situations, with any other particular relative to them that may be useful to the practical forester. And before leaving this section, which is merely meant to point out the advantages of fencing, I may be allowed to say, that every practical forester ought to make himself, as nearly as possible, master of the art of fencing in all its most useful parts; and having myself, in the act of visiting gentlemen's estates, seen much of the great advantages derived from men, acting as overseers upon estates, being well up to this sort of work, as well as the disadvantages to proprietors of having men as overseers who were not well acquainted with it, I am now the more anxious that the art of fencing should be properly understood both by foresters and land-stewards; because, from possessing such knowledge, they are the better able to be intrusted with the improvements which may be carried on by the proprietor in whose service they may be employed. I shall not confine myself strictly to the description of fences which may be considered adapted to the inclosing of woodlands: I shall also point out the method of erecting fences adapted for parks and pleasure-grounds, the knowledge of erecting which is often as essential to the forester and land-steward as that of cultivating the soil for their respective crops.

There are *seven* sorts of fences in general use in this country,—namely, 1st, The thorn and beech hedge; 2d, The whin hedge; 3d, The stone and lime wall, as applied to sunk fences; 4th, The dry stone dyke; 5th, Turf dykes; 6th, Wooden palings; and 7th, Wire-fences upon wood and iron posts.

Each of these fences is more particularly adapted for some particular purpose or situation more than for another; therefore, after devoting a separate section to the method of erecting each of the above sort of fences, I shall devote a separate section in order to point out the advantage of using one fence rather than another in any given situation.

SECTION VI.—MANAGEMENT OF HEDGE FENCES.

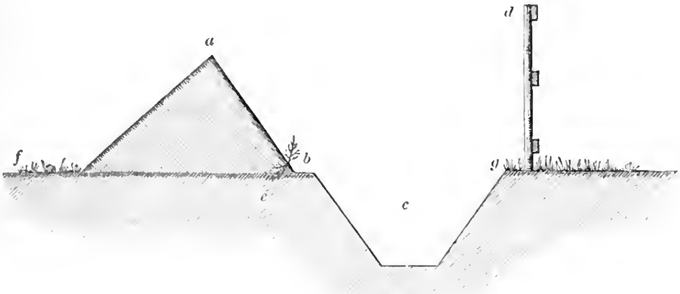
There is no fence more generally in use in the cultivated districts of Britain than the thorn hedge; and considering its permanent nature as a fence upon good land, it is certainly the best adapted for all purposes where a neat and clothed appearance is the object. The hedge is very much improved by having one-third of beech plants mixed among the thorns in planting, and this, more particularly upon high situations with a light soil. There the thorns are very apt to die early; but when mixed with a proportion of beech plants, which thrive well in a light soil, the fence is much improved both in health and appearance. The soil upon which I have found the thorn thrive best as a hedge fence, and in which it is likely to live to a great age, is a heavy loam upon a dry bottom. In all light soils, such as moss, sand, or gravel, thorns are very apt to die suddenly if not attended to very carefully in the way of regularly cutting and cleaning once a year at least; and it is in order to prevent this tendency of the thorn to die prematurely in such situations that I recommend a mixture of beech to be planted among thorns in a hedge. I have frequently had occasion to observe, that even where a thorn hedge had failed to succeed in a high situation upon a light soil, (being a mixture of gravel and moss,) when I had it repaired by a mixture of beech plants, the thorns recovered, and made an excellent fence along with the beech; and this I believe to be principally owing to the effects of shelter produced by the beech retaining its leaves during winter and sheltering the thorns; besides, the beech being fond of a light, dry soil, throve well, and supported the thorns.

Many recommend the practice of manuring poor light soils, for the reception of thorn plants, in the forming of a hedge fence; but this I can by no means approve of; and I mention this circumstance in order to put the inexperienced upon their guard. I have often had occasion to observe, that those hedges which were planted with manure in a light poor soil, and upon a high situation, did indeed grow freely for the first two or three years after planting; but as soon as the manure had lost its effects upon the plants, they fell into a state of bad health; and in the course of five years from the time of planting, such a hedge was much inferior to others which had received no manure upon the same soil and situation. The best manure for thorns in a light soil is a good dressing of clay or heavy loam, if it can possibly be had; and if that cannot be got, plant them in the natural soil, and pay strict attention to keeping clean in summer, and cutting in autumn or spring.

In the planting of mixed thorn and beech hedges, two methods are practised, according as the soil may be damp or dry. The one method is, that of planting the hedge on the brow of an open ditch, made at the same time, for the purpose of keeping the roots of the hedge dry, and for collecting and carrying off water from the field or plantation which it surrounds. The other method is that of planting the hedge upon the surface of the soil, without any ditch whatever; and either of these methods may be adopted according to circumstances; although, for my own part, I am decidedly in favour of the latter method, as being the most neat and least expensive in erecting, as well as taking up much less room in the field; and where the soil is dry, it thrives equally well.

Fig. 5 is a section of a hedge planted upon the brow of a ditch; and by referring to it, the method of planting the same will be easily understood.

Fig. 5.



In executing the work of planting a hedge of the description shown in the above figure, the operator first stretches his line along the run of the ground where the hedge is to be planted, and which it is understood has been previously set off by pins driven into the ground; but instead of placing the line in the exact run of where the hedge is to be planted, the operator pins it down about five inches to that side of the run upon which the open ditch is to be made. He next proceeds to level, and clean from all weeds, &c., with the common spade which is used in doing this work, the surface of the ground, all along upon the run or hedge line, as far as his line has been stretched, to the breadth of about twenty-four inches back from his line; and having done this, in a manner to correspond with the rising or falling of the ground in the run of the hedge, observing to level up or reduce any sudden inequality, he next proceeds to *natch* off carefully the edge of the ditch upon which his line was first stretched; and in doing this, the operator turns his face to the side where the ditch is to be, and with his foot he forces the spade pretty deeply into the ground, cutting the surface exactly all along by the line; but he must observe not to cut perpendicularly with the spade, but to cut with a considerable slope to the ditch, in order to form part of its side, as may be seen by glancing at Fig. 5, where *b* represents the point upon which the line rests, with the slope of the ditch under; and when he has finished the cutting of the one side as directed, he will lift his line four feet to the opposite side, in order to form the other side of the ditch, as at *g;* observing to make the second cut exactly parallel with the first. And in the act of cutting, he must turn his face again to the ditch, in order to form the opposite slope. Both sides of the ditch being marked off, the operator with his spade next raises the turf, or whatever the surface may be, but which should be always cleaned from weeds, the outer edge of which he first marked off at *b;* and lifting it up, he turns it upside down upon the part which he formerly levelled for the planting of the hedge, which part is now termed the *bed*, as at *e*, upon which the roots of the young plants are to be laid; and in doing this part of the work, five inches of the level part must be left between the side of the bed and the edge of the ditch, which is termed the *scarcement*, and is meant to support the bed firmly, as well as to prevent the rolling down of loose earth from the bank *a* into the ditch *c;* therefore the operator, in lifting the soil from the edge of the ditch in order to make up the plant bed, must keep it regularly five inches back from the edge; and in preparing the bed for the reception of the roots of the young plants, it must be made three inches above the level part, or scarcement, upon the outside, and this in a compact level manner, and must slope backwards from the outer edge at an angle of about forty-five degrees. (See Fig. at *e*.) And this in order that the roots of the plants may not be flat, but dip into the earth, and that their tops may incline a little upwards.

The bed and scarcement being finished, as has been directed above, and made perfectly clean from weeds, the next part of the work is to have the plants prepared for putting in; and as it is presumed that the plants—say thorns and beeches—have been brought forward in due time and put into the earth by the roots in a dry part near the work, the operator will bring them forward, and before putting them into their bed, he will, with a pruning-knife, and not with an axe, as many carelessly do, cut every thorn plant down to within about four inches of the top of the root—or in other words, leaving only four inches of the stem of each plant. But with regard to the beech plants, if any are to be planted among the thorns, they must not be cut at all, not even the tops; for they do not succeed well if cut at this stage; and beech plants for this purpose may be from eight to twelve inches high. Having the plants thus prepared, the principal operator will take a few plants, both of thorn and beech, in his left hand, and with his right he will lay the plants upon the slope or bed prepared for them, putting in successively two thorns and one beech, at the distance of about seven inches, plant from plant. In laying the plants upon the bed, the top or cut part of the thorn may be made to project over the outer edge of the bed about two inches, which part will set away young shoots to form the hedge; but the beeches must be allowed to have all their top part lying out, with their roots upon the same level with those of the thorns.

As the principal operator or workman proceeds in thus laying out the plants upon their bed, another careful person follows him, and, collecting the finest of the soil from the part of the ditch opened in making the bed, he puts it upon the roots of the plants, covering them very carefully, and using caution in order not to displace any of the plants while lying in their uncovered state; a third man follows, who puts on another spadeful of earth from the surface of the ditch all along upon that put on by the second man, which second spadeful will be enough to cover the roots securely; and when this is finished, the whole of the soil thus put upon the roots of the plants should get a firm tramping with the feet, in order to make the plants firm in their place, and exclude the drought from the roots. This being done the whole length of the line, the whole of the earth contained in the ditch *c* is then thrown out and made to form the bank above the roots of the plants, in the shape as seen in the figure at *a*. The size of the ditch is generally made four feet wide at top, and fifteen inches at bottom, and two feet deep; and the size of the newly formed bank which is made from the earth taken out of the ditch, will be nearly two and a half feet deep at the point above the plants at *a*, and from four to four and a half feet wide at the base. After the earth has been all thrown out of the ditch, and it is properly formed, smooth upon each side, and level in the bottom, the bank should next be formed to nearly the same slope as the edge of the ditch under it; but as it is formed of loose earth, it is better to keep the slope of the bank a little flatter than that of the ditch under; and in order to prevent any of the loose earth tumbling into the ditch from the bank, it should be tramped and made firm as the work proceeds. And when the whole is finished, it should receive a firm clapping by means of the back of the spades, which keeps it all firm and smooth above.

In the finishing, the level scarcement ought to be left in a clean and neat manner, without any roughness lying upon it; and the tops of the thorns should all project regularly, and the soil be made firm about their necks. In this manner the whole line of hedge is to be done, one line-length after another; and when the whole is finished, a three-barred paling ought to be put up upon the outside of the ditch, in order to protect the young hedge from the inroads of cattle. The paling when put up will require to be kept good until such time as the hedge becomes a proper fence of itself, which upon an average may not be till it has grown nine or ten years.

The method of growing hedges, as has been directed above, is excellently adapted for land of a wet character, or rather where the draining of the land has not been attended to; for no thorn hedge will succeed unless the ground upon which it is planted be rendered dry; therefore, if the ground where a hedge fence is to be planted is not either naturally dry, or made so by artificial drainage, the plan as above detailed must be resorted to. Besides, it often happens that, in the laying out of ground for a new plantation, the drains in it require to be run into some large ditch, in order to act as an outlet for the water; and in this case the system of fencing with a ditch answers well—that is to say, all other circumstances corresponding;—and in such a case, the ditch requires to be placed next the wood, with the hedge and bank outside, with the paling upon the outer tail of the bank, as at *f* in Fig. 5.

In Mid-Lothian I get hedges of the description above specified planted, and every part of the work done in a complete manner, for 10d. per rood of six yards; and the plants for the same length will cost about 6d., reckoning thirty-two plants to the rood.

I shall now refer shortly to the other method of planting hedges, namely, that of planting in the surface soil without any ditch whatever. In all cases where the soil is either naturally dry, or has been rendered so by artificial drainage, and where there is at the same time no necessity for any ditch as an outlet for water from drains, &c., made in the neighbourhood, whether that may be in the case of an adjoining field or plantation, I would advise not to plant hedges in the form of ridge and ditch, but simply in the common soil of the line of fence required. In planting a hedge in this manner, I have the ground dug, in the line of the hedge to be planted, three feet wide by fifteen inches deep; and in the act of digging, I have all root-weeds carefully picked out, which ought to be particularly attended to in the planting of all hedges, seeing that the eradicating of such afterwards has a tendency to disturb the root of the plants too much, and check their growth by admitting too much drought. When the whole length of the ground for the intended hedge has been thus prepared by deep digging and cleaning, I have it very nicely levelled by the eye, in the first place; and when I consider the ground to be nearly as level as I wish it, I next stretch the line along the middle of the ground, stretching it pretty tightly, in order that it may tell the level by its tightness; for where the ground is hollow, the line will be above it; and where the ground is high, the line will be lying too close upon that part. And having the line thus tightly set, I go upon it with my feet, keeping it right under the middle of the soles of my shoes; and in this position I tread the earth firmly, walking sideways all along the length of the line; and by doing this, I have the soil firm about five inches upon each side of the line. Coming off at the end of the line, which I allow to remain, I make up with fresh soil, from one side of the line, any inequalities caused by my feet in walking along; and in doing this, I beat the new surface with the back of the spade as I proceed, keeping about seven or eight inches in breadth level on the one side of the line, and only about two or three upon the other. This being done, I next take out an opening with the spade upon that side of the line which has the least level ground upon it, and this opening I make about nine or ten inches deep, according as the roots of the plants may require, and taking care to have the opening neatly cut by the run of the line. I next have the plants prepared as formerly stated, and put them in along the side of the firm level edge, observing to keep the stalks of the thorns about two inches above the surface, and the beeches all the height, as formerly stated; then fill in the earth, and make the whole firm and level, which concludes the work of planting the hedge.

I may further add, relative to the two methods of planting hedges just detailed, that by the last-mentioned system I have found the plants so dealt with come much sooner to full size than those planted upon the edge of a ditch; therefore I am much in favour of the same; and there is another advantage attending this system of hedge-planting without a ditch, which gives it great preference as compared with the other, namely, the taking up of very little room in the subdividing of any inclosure; for it must be observed, that where there is a hedge and ditch, much useful land is occupied; but where there is no ditch, the least possible quantity of land is occupied by the fence. But in choosing or refusing the one or the other, much depends upon the circumstances to be overcome, which must all be taken into consideration. Upon the estate of Arniston, where most of the hedge-fences have been reared upon the ditch system, we are now putting a drain-tile into the ditches and filling them up; and in doing this, many of the hedges which formerly were stunted in appearance are, from the receiving of an additional supply of soil about their roots, improving much in appearance; and this work promises altogether to be a great improvement.

The cost of digging the ground and putting in the plants for the last-mentioned kind of hedge, will be about 4d. per rood; and if we include the price of the plants also, the whole may cost about 10d. per rood.

We now come to speak of the after-management of the hedge-fence, which is a matter of the very greatest importance to the welfare of such fences, seeing that many of them die from the want of due care being bestowed upon them; and, as I have already said, the great points in their management are regular cutting and cleaning. Supposing that a young hedge of beech and thorns has been planted any time between the first of February and the end of March, it will during the following summer make considerable shoots. The thorns will at least have made shoots of nine inches at an average, but the beech plants will have made comparatively little progress, because they naturally require a longer period to establish themselves in the soil; but if they have appeared fresh in the leaf, and only made from two to three inches of young wood upon the top shoots, it is quite satisfactory; and indeed, had the thorn plant not been cut down, they very possibly would not have made a greater growth than the beeches; and had the beeches been cut down in the same manner as the thorns, it is very possible that the one half of them would have died. This explains the reason for cutting the one and not the other; that is, the growth of the thorn plant is encouraged by severe cutting, while that of the beech in its young state is the reverse, particularly as regards the old wood.

I am aware that many foresters are in the habit of cutting over in autumn the shoots of the first year in young thorn-hedges; but to this practice I beg to object; because I have found, from observation and experience, that it is an error. I, in all cases of hedge-culture, allow the plants to remain uncut until they have two years' wood upon them; and when they have arrived at this stage, I cut them over to about nine inches high, and dress in the sides also pretty closely, say in the month of November; therefore, during the first two summers after the hedge has been first planted, all the attention necessary to be bestowed upon it, is that of keeping it clear of weeds, which is simply done with a small spade, termed the hedge-cleaner, (Fig. 6,) which is about four feet in length, including the handle, and the spade itself is three and a half inches broad by about seven inches long, excluding the hose, which is about the same length as the spade. This spade is kept pretty sharp upon the edge, and is wrought much in the same manner as a gardener does a Dutch hoe. The hedges should be cleaned twice in the season—namely, in the months of June and August.

Fig. 6.

Before entering further into the management of hedges as a fence, it may be necessary for me here to explain the nature of my objection for not cutting over thorn-hedges of one year's growth as many do. It is this: Having from experience found that a young hedge not cut the first season after planting, is much superior two years afterwards to one that is cut in the usual way, I two years ago set myself to prove the matter upon practical principles. I therefore planted two pieces of hedge, and left the one cut, and the other uncut, during the following winter; and during the second summer I watched the progress of each minutely: the hedge that was left uncut, came away much earlier in the season than the one that was cut over; and during the summer I found the leaves and shoots of the uncut hedge much stronger and healthier in appearance than those of the cut one; and in the month of October, when the wood of both was fully ripened, upon comparing them together, I found the older shoots of the uncut plants decidedly superior to those that had been cut. From this I concluded that, when the shoots of the first year's growth are left upon the plants during the second year, they, from having a great surface of leaves and prepared young wood upon them, are enabled to carry on the vital functions more early and readily; consequently, much nourishment is drawn up from the soil, and a regular proportion of woody matter made in the plant; whereas, in the case of the cut plants, I considered that, in the early part of the second summer, when the uncut plants were expanding their leaves and drawing nourishment both from the soil and air, the cut ones, from the want of young wood, had to make new leaves, and young wood also, before they could grow as rapidly as the others. But after the plants are two years old, and properly established in the soil, I have always found that they grow more vigorously from being well cut; therefore it is that I object to the cutting of thorns until they have their roots properly established; and that is, after they have been two years in the soil.

In the training up of a hedge, where the object is that of having a firm and compact fence, capable of resisting the ordinary efforts of cattle of any description, the best mode is that of keeping the ground, immediately under the hedge plants, clean from all weeds, as this secures the health of the hedge in the under part, and allows it to spread down to the very ground; whereas, when weeds are allowed to grow under the hedge, it soon becomes bare and naked of branches, and proves open and weak there.

In the cleaning of hedge fences, it is also an object of great importance to dig the ground and keep the same clear of weeds at least one foot beyond the *drip* on each side; for this secures a free current of air passing through, without which a hedge fence is sure to become bare under. This cleaning, once the ground has been a few years regularly kept, may be done for one halfpenny a rood per year throughout the whole period; but if the hedges have been allowed to become dirty from the want of attention, and if they have not been cleaned for several years, as is too often the case, they may cost four or five pence a rood to put them in order, even for one cleaning, besides the injury done to the fence. These observations I make here in order to point out the great necessity and propriety of keeping all hedge fences clean; for although it may indeed cost a proprietor a few pounds each year to do so, still, if the work be neglected only for three or four years, a much larger sum is eventually required to put them right, independent of in a great measure ruining his property.

Having said this much as to keeping clean all hedge fences, I in the next place have to say, that in the training up of a hedge, where the object is that of having a firm and compact fence capable of resisting cattle, the great point is, after that of keeping clean, to cut the fence yearly according to a given form; and this form must in all cases be regulated by the situation in which the fence grows, by the object in view, and in a great measure by the taste of the proprietor. In order to illustrate my meaning more fully, I shall make a few remarks upon each of these points. I said that it is necessary to cut hedge fences yearly; and I believe that there are very few practical foresters who will not agree with me upon this point; for every one who has had his attention directed to the rearing of such fences, at once sees the difference between a hedge not cut yearly and one that is cut yearly. In the first case, the hedge soon begins to get bare at bottom and over-bushy at top; besides, it very soon becomes loose and open, and without firmness or compactness to resist as a fence ought to do. In the latter case, the hedge, from being regularly cut, is kept close in texture from bottom to top, and is healthy and long-lived as compared with one not regularly cut.

In cutting young hedges and training them up to maturity, I in all cases allow the plants to remain uncut till the end of the second year, when, for the first time, I cut them over about nine inches from the surface, and at the same time I cut in the sides pretty closely also, using for the purpose what is termed the hedger's switching-bill, (see Fig. 7,) and never the shears, as some do in cutting young hedges. The shears, in all cases where they are used for cutting a hedge, make a rough wound, which is generally attended with the loss of a bud or two under the wound; but the switching-bill, upon the contrary, makes a clean cut, and no bad consequences follow. Besides, a hedge that is cut by using the bill is in all cases trained up more closely and firm than one cut with the shears. In cutting a hedge for the second time, which will be when it is three years old, I cut it down to about twelve inches in height, making it regular on the top level; and in the side cutting I leave only about one inch of a spur of the last year's growth. This I continue to do each year successively until I have the fence of full size: that is, in each successive cutting that I give a young thorn-hedge annually, I leave it four inches higher, and one broader on each side, than it was the previous year, until I have it four feet high, after which period I keep it down each following year as nearly to the old height as possible. For every forester must be aware that, in cutting hedges, they will increase in height and breadth of their own accord under the best system of cutting; seeing that, in the act of cutting off the annual shoots, there is always a short piece left, called a spur, at the base of every young shoot cut. So much, indeed, does this increase the bulk of the best-kept hedges, that in course of time it is found necessary to reduce them in bulk, and to allow them to come away anew again, which yet remains to be explained. A hedge, in course of a number of years, however well kept, generally outgrows itself, from the cause above stated; and this state of a hedge is easily known by its becoming loose in habit, and of an open, overgrown appearance. Now, there is no way of renewing a hedge in this state but that of cutting it in, or what is termed *ribbing;* and this ribbing con-

FIG. 7.

sists in stripping the hedge of its side branches, and allowing it to make new wood all over. But in doing this, caution must be used; for I have more than once seen, where hedges had been ribbed without due caution, that they died down to the surface, and consequently had to be cut over at that part, and allowed to grow up anew from the old roots. Therefore, in the ribbing of a hedge, the following points must be kept in view:—When it is found necessary to *ribb* in a hedge, let it be considered whether or not the situation be an exposed one; and if the situation be not an exposed one, nor in a part of the country exposed to the sea, nor more than six hundred feet above the level of the sea, the ribbing may be done from November to the first of April, as may best suit. In doing the work, the operator will use what is termed the *ribbing-bill*, which is much stronger and heavier than the switching-bill, and has less hook upon the point. In ribbing the hedge, the operator cuts off all the lateral branches *upwards*, to within about four inches of the main stems upon each side; and the hedge over all should also be reduced in height to about three feet. It should also be kept in view, in the case of ribbing in a hedge, that if sheep or cattle are in the habit of grazing in the field adjoining, the ribbing should be done at a period when the field is under farm-crop, and when there is to be no stock grazing for a year or two after; for if it should be done at a period when sheep or other animals are in the field where the hedge is, they are sure to injure it by eating the young shoots as they grow; besides, their hair and grease are injurious to the welfare of a hedge so closely cut in. Again, where the situation of a hedge to be ribbed is much exposed, do not ribb it before the month of March or April, when any severe check from the effects of exposure is likely to be over for the season. From this rule not being observed, I have frequently seen hedges die down to the ground when they were ribbed in the winter season upon a high and exposed part.

Switching hedges is generally done for a halfpenny per rood, and ribbing for twopence; that is to say, when such work is contracted for by hedgers.

There is also the renewing of old and neglected hedge fences to be taken into consideration; and as work of this kind often comes under the management of the land-steward and forester, I shall make a few remarks upon the same. It very often happens that where hedge fences have been badly managed for a few years successively, they begin to die out by degrees: this is evidenced by many of the plants becoming stunted in appearance, and by gaps occurring here and there from deaths among the plants, and the more healthy of them becoming tall and spreading. A hedge in a state of this kind would not be sufficiently renewed by ribbing in. In order to renew such a hedge, the plants require to be all cut down to within about six inches of the ground, observing to make the cuts upwards. When this is done, and the rubbish removed, the ground should be well cleaned, and dug to the extent of about eighteen inches upon each side of the hedge line, and all gaps among the old stumps made up with new or young plants. In making up with young plants, I have to observe, that thorns should never be used in such cases, as they never succeed well where old thorns have been growing; but in all cases of this nature, use beech plants, for they thrive well among old thorns. Work of this kind may be done during fresh weather any time during winter; and in order to have the hedge continue sound and prove a good fence afterwards, it must be kept clean, protected, and regularly cut, as has been already stated.

We now come to consider the form in which hedge fences should be trained up; and, as I have already said, this form must be regulated by the situation in which the fence grows, by the object in view, and in a great measure by the taste of the proprietor.

There are four forms of hedge fences as generally adopted in different districts of Scotland; namely, the wedge-shaped, the full-sided, the square-shaped, and the upright. The form of each of these will be better understood by referring to Figs. 8, 9, 10, and 11, which represent an end section of each of the four different forms mentioned.

A few remarks upon each of these forms of hedges will be enough under the present head.

The wedge-shaped hedge, an end section of which is represented by Fig. 8, is of all others the best form for a high-lying district where snow is apt to prevail; and it is, moreover, the form which

FIG. 8.

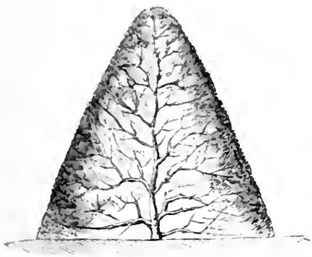


FIG. 9.

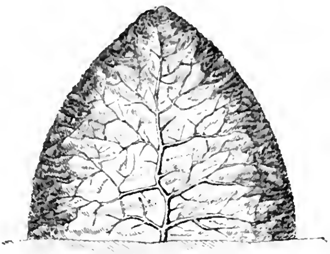


FIG. 10.

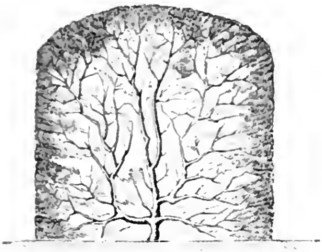
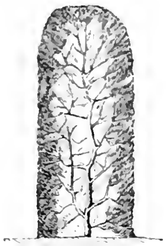


FIG. 11.



is by far the simplest to keep in order in the way of cutting. In high-lying parts of the country, hedges are often much injured by heavy falls of snow resting upon them; and in a case of this nature the wedge form is the best for a hedge that can be adopted, seeing that much perpendicular pressure cannot lie upon any part of it. It is this shape of a hedge that we have upon all the high-lying farms upon the estate of Arniston; and although snow often lies there pretty heavy, none of our hedges are ever hurt by it.

The full-sided hedge, an end section of which is represented by Fig. 9, is the most common form to be found in all agricultural districts, for which it is very well adapted; for, by its bulging sides, it is not easily approached too close or injured by stock of any kind; but it is very apt to go out of order, and to overgrow itself, if not under skilful and good management. Excellent specimens of this form of hedge are to be seen in the Lothians of

Scotland, where the soil is well adapted for its healthy development. It is not, however, adapted for a high-lying county where snow is apt to prevail, for its bulging sides are very apt to be crushed and broken by the weight of snow lying upon it; and this I have had frequent proof of, in Aberdeenshire particularly.

The square-shaped hedge, an end section of which is represented by Fig. 10, is solely adapted for gentlemen's home or policy grounds, and ought never to be introduced either as a wood or a field fence; and I merely advert to it in order to point out its impropriety for general use. It is all very well to have a fence of this kind round a garden, where it may be well kept; but as a general county fence, it is the most liable of all to become overgrown and useless.

The upright hedge is an admirable fence, and is well adapted for pleasure-ground scenery, or about home parks, but not at all for a farm or field fence. Now I think it is plain, from what I have said, that, in choosing the form of a hedge, it is always of the first importance to consult what is most useful rather than that which is most ornamental. It would be foolish to rear up a hedge in the square form upon a high-lying district, merely for the sake of gratifying the taste, when it is well known that such a form would not answer. In short, such a state of things would be bad taste; yet it is very often to be observed. For my own part, I consider the wedge-shaped and the full-sided forms the best that can be adopted for usefulness; and the other two I consider merely as ornamental forms, but well adapted for the producing of extra shelter upon home grounds.

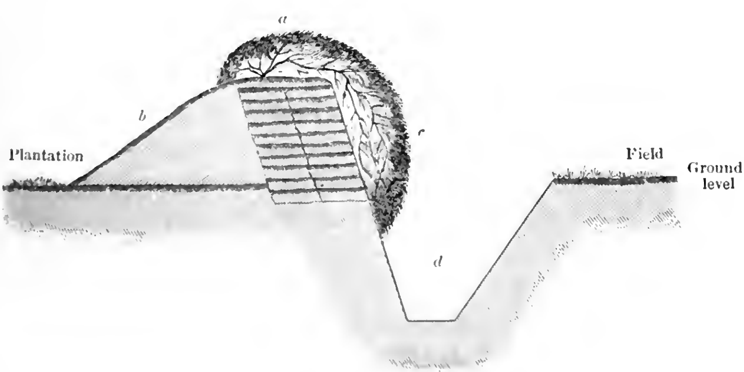
SECTION VII.—THE MANAGEMENT OF WHIN OR FURZE HEDGES.

The whin or furze hedge is one which prevails much in many parts of the north of Scotland as a plantation fence; but it does not, in my opinion, make a fence worthy of being recommended, seeing that the whin is extremely apt to be injured by a winter of severe frost; and, in their best condition, the whin hedges form such harbours for rabbits, that they are extremely objectionable as a fence for young plantations. I do not know of any case in which whin hedges have been planted where a properly-managed hedge of thorn or beech would not do much better in every sense of the word, it being longer lived and more ornamental.

I am aware that in many parts of the north of Scotland where whin hedges are, it is considered that any other sort of hedge would not thrive nor make a useful fence nearly so well. But as to this I am decidedly of an opposite opinion; for in many parts of the north of Scotland, not more than four hundred feet above the level of the sea, whin hedges may be found in abundance, forming miserable, half-dead looking fences, where, if thorn and beech had been planted instead, a permanent, good-looking fence would no doubt have been reared. Again, and in opposition to this, upon the estate of Arniston we have excellent thorn and beech fences fully eight hundred feet above the level of the sea, which at once shows that even in a high district a thorn and beech hedge is much to be preferred to any other. Notwithstanding this, many are much in favour of whin hedges as a plantation fence; and upon this account I shall give a few directions as to the method of rearing them.

By referring to Fig. 12, the method of rearing whin hedges,

Fig. 12.



as generally practised in the north of Scotland, will be easily understood. *d* is an open ditch, broken about four feet wide at top, and sloped in to about one foot wide at bottom. It will also be observed, that the slope of the ditch upon the field side is more flat than that of the plantation side, and this is in order to make the plantation side of the ditch act better as a fence. The ditch is made about three feet deep from the ground level, and the turf, as taken from the surface of the ground in making the ditch, is built upon the plantation side to about the height of other two feet above the surface, making the fence altogether, from the bottom of the ditch, five feet high. In order to make the turf-built part of the fence secure, it is made about two feet thick, with the same slope backwards as the side of the ditch under, and founded firmly upon the surface. The earth, as taken from the ditch, is banked firmly behind and a little over the top of the turf, in order to form a bed for the sowing of the whins, as at *b*. The whole being finished, the seed of the whins is sown in a line along the top of the bank, as at *a*, about eighteen inches back from the upper edge of the fence.

When the young plants appear above ground, the seed being sown in April, they are kept clean during the first and second years, and thinned when too thick; and the third summer, when they have become pretty strong, they receive a dressing with the switching-bill. In doing this, they are cut in the direction of the field—that is to say, the bill is entered at the back or plantation side of the whins, and brought forward, cutting towards the ditch, or downwards; and by this means the young shoots are made to grow out in that direction, presenting all their points to the field, and consequently forming the best position for a fence. Whin hedges ought never to be cut at any time of the year but when they have newly shed their flowers, which is about the middle of June; for it is then that they form their young wood, and are consequently most improved by cutting. I have seen many whin hedges die from being cut in spring or autumn; consequently they ought never to be cut but in the beginning of their growing season. In the training of a whin hedge, they are made to lie over the slope, as at *c*, and not allowed to spread much back into the wood. The best fences of this description that I have seen are upon the Earl of Fife's estates in Aberdeenshire.

SECTION VIII.—STONE AND LIME WALLS AS APPLIED TO MAKING SUNK FENCES.

The building of stone and lime walls is, properly speaking, more a part of masonry than of forestry; but it must be admitted that foresters and land-stewards, who have to superintend country business generally, are often called upon by their employers to give an estimate of the expenses of buildings of this nature. And more especially as I have frequently to produce estimates of masonry in so far as it is applied to fencing, it is more than likely that other foresters may have to do the same; and it is for this reason that I advert to it.

Stone and lime walls are most frequently built for the purpose of policy-fences, or for sunk fences. As to the erecting of walls for the protecting of home or policy grounds, the dimensions of such must in all cases be regulated by the view of the proprietor: that is, if the proprietor merely wish to have a wall erected in order to protect his home grounds from the inroads of cattle, the same may be built sixteen inches thick at bottom, twelve inches at top immediately under the cope; the cope may be ten inches high, pick dressed, and project two inches over the building on each side; and the whole height of the wall may be made, including the cope, five and a half feet. A stone and lime wall of these dimensions may in general be got done for 2s. 9d. per lineal yard, calculating that the stones have to be quarried and carted a distance of about a mile.

If the proprietor wish to have a stone and lime wall erected, sufficient to protect from the inroads of people who may be apt to transgress in the neighbourhood, as well as to retain deer that may be kept in the home parks, he would require to build it at least about seven feet high; and a wall of this height would require to be eighteen inches thick at bottom, and fifteen inches at top of building immediately under the cope, which would require to be at least twelve inches high. A wall of such dimensions may in general cases be got done for about 4s. 9d. per lineal yard, including carting of stones as above. A great point to attend to in the building of stone walls for fences is, to see that no soft or bad stones be used, particularly in the outer part of the building; for if such be used, the wall is sure not to last long, nor give anything like permanent satisfaction; therefore, the forester or land-steward who may be intrusted with the inspection of such work, should be most careful to see that this point be enforced upon the contractor. There is another point to be observed in the erecting of all stone walls, whether these may be built with lime or not; and that is, to see that all the stones used in the building be laid upon what is generally termed their natural bed; that is, the natural seams in the stones should lie horizontally in the building, and not vertically.

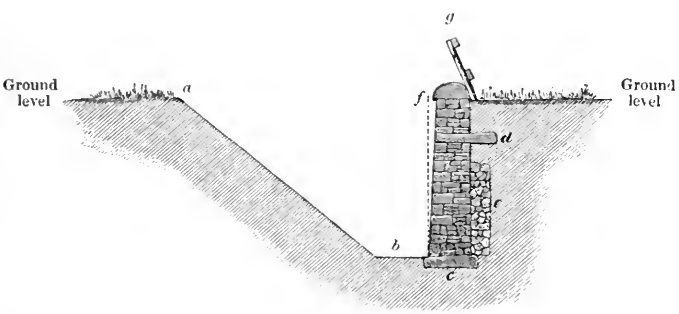
Having said this much as to the building of stone and lime walls as they are generally applied to the fencing of policy grounds, I now come to treat of them as they are generally applied in the making of *sunk fences*. But previous to giving directions as to the manner of doing this sort of work, I will say a little as to the propriety or impropriety of making sunk fences.

The sunk fence is one which, from its very name, is meant to be hidden. It is a fence often to be met with upon noblemen's and gentlemen's estates of old standing, and was a hundred years ago very much introduced in the laying out of grounds and home parks; but now since wire fences have come to be so much used, the erecting of sunk fences is fast giving way, and they are very seldom introduced; excepting, indeed, where they may answer some particular purpose, as on the slope of a hill or brae, for which situation the sunk fence is admirably adapted, and is of all others the most fit and suitable. No doubt, "taste is everything;" but, in my opinion, in the matter of fencing, that taste is always the most pleasing to all parties which can produce something light and airy, and of the most natural appearance, and at the same time at the least amount of expense. Now, in applying this to the erecting of sunk fences near or about home parks—where, indeed, taste should always be taken into consideration—we at once see that a sunk fence is, in regard to lightness, airy and natural appearance, much inferior to the wire fence, and is, at the same time, much more expensive in the first erection; therefore, in my opinion, sunk fences ought never to be made upon any level piece of ground, but instead, the wire-fence should be erected. But upon any steep, sloping bank, where it is desirable to have a fence, I would recommend the sunk fence, with a low wire fence on the top, as a complete and answerable thing. As I am aware that many proprietors are much in favour of sunk fences as generally made, I shall here, in order to assist superintendents of such work, give a detail of the manner of erecting them.

There are two sorts of sunk fences—namely, the angular and the trapezoid. The angular is made with a wall upon one side, and a paling fence upon the top; and the trapezoid is made without any wall, but having a paling fence in the centre. The construction of these will be better understood by referring to the following Figures.

Fig. 13 is an end section of an angular sunk fence, as often met with in the home grounds of old seats. The dis-

FIG. 13.



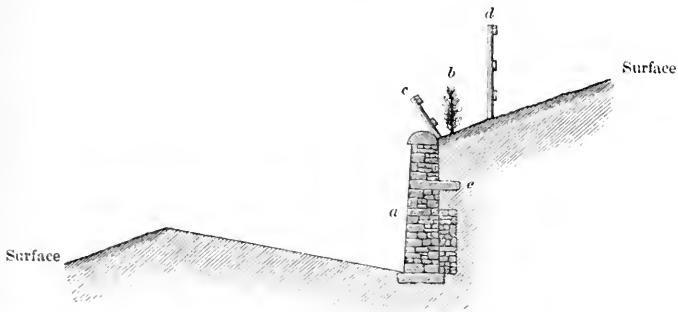
tance from a to f is generally eight feet, being the surface of the opening or ditch; the height of the wall, including the cope from f to b, is generally about five feet six inches; and the breadth of the ditch at b, being the bottom, is generally from eighteen to twenty-four inches. But in the act of excavating a sunk fence of this description, it is always necessary to calculate upon the thickness of the wall; that is to say, if it be required to make the sunk fence eighteen inches wide at bottom and eight feet wide at top when finished, and if the wall is to be eighteen inches thick, it will be necessary to make the opening at least three feet wide at bottom in the first place, and nine and a half feet wide at top. In building the wall upon a sunk fence, it ought to be founded upon large flat stones, laid upon their natural bed, as at *c*; and these ought to extend at least three inches wider than the bottom of the wall. The wall ought to be at least sixteen inches broad at bottom, and thirteen at top immediately under the cope; the cope-stones ought to project two inches over the wall upon the ditch side; and the wall should be built of the best stones in the neighbourhood, and well-prepared lime. The cope-stone should always be above the surface of the ground, as shown at *f* in the Figure. I have frequently observed sunk fences of this description tumbling down at a very early period after being built: this was occasioned by the damp ground behind the wall not allowing the lime to adhere to the stones—the wall, as it were, being always kept in a moist state. In order to prevent this effectually, a space of about eight inches wide should be filled up with dry stones immediately upon the back of the wall, about three feet high from the bottom, as represented at *e* in the Figure. This acts as a drain for the conducting away of the water; and, consequently, the building is kept dry and good. In order to carry off the water from behind the wall into the ditch *b*, holes about three inches wide by six inches deep may be left at convenient distances all along the bottom of the wall; and these holes should go right through the thickness of the wall at bottom, and should communicate with the drain behind.

In order to make the fence more effectual for the field upon the side of which the wall is built, a low paling ought to be erected immediately behind the cope, and made to project over the top of the wall, as seen at *g* in the Figure; which paling may not be more than two feet high, and it may be either made of wood or iron, as may be found most expedient. Many have a hedge planted upon the top where the paling is shown in the Figure, which is, indeed, a great improvement where shelter is wanted upon a high part; but this is not generally necessary with sunk fences upon level ground—where, indeed, they are not meant to be seen—but only upon slopes where the situation is an exposed one.

Fig. 14 will explain the nature of the sunk fence with a hedge, as it is adapted for a high unlevel part, where immediate shelter is found of the greatest importance.

I consider the sunk fence, as represented in Fig. 14, to be one excellently adapted for a high-lying county, upon the slopes of

FIG. 14.



rising and unequal ground. The wall *a*, which is four feet high with cope, may be very properly built of stones, without the addition of any lime if thought necessary, excepting the cope, which should in all cases be put on with lime; and in such a case the wall need not be more than fourteen inches through at bottom, and ten inches at top; and if the wall be built without lime, it will not be necessary to make a drain behind, as formerly advised, seeing that the water can perfectly well escape without it. The hedge *b* should be planted about sixteen inches back from the top of the wall. In order to protect the hedge, while in its young state, from cattle upon either side, it is necessary to have a two-barred paling, *c*, upon the ditch side of the hedge, and a three-barred one, *d*, upon the upper side. We have some of these sunk fences upon the high farms upon the estate of Arniston, which answer the purpose excellently, few fences being better adapted for a hilly country—that is to say, where the line of fence runs at right angles with the slope of the ground. In the first instance, there is shelter produced for stock by the wall itself, which is yearly increased as the hedge grows; and ultimately, when the hedge has arrived at perfection, a clothed appearance is produced, which gives a very pleasing effect.

I may further state, relative to the building of sunk-fence walls, that it adds much to their strength to have them secured by what is termed through-band stones, as shown in Fig. 13 at *d*, and in Fig. 14 at *e*. These through-band stones should be put on about two-thirds of the height of the wall, with at least one to every six feet in length, and should consist of large' flat stones about three inches thick, and of a length sufficient to reach from the front of the wall to at least one foot into the solid earth behind, into which they should be firmly bedded, in order to prevent the weight of the bank, if it should give way above, from pressing forward the building. Another point to attend to in the building of sunk fences, and which adds much to the strength of the whole, is, instead of building the front of the wall perpendicularly, to make it lie back about three inches at the top; or, as masons term it, "the top should be three inches backwards off the plumb:" this is indicated by the dotted line in Fig. 13, which shows the true perpendicularity—the wall standing three inches back from it at top.

We now come to speak of the cost of erecting sunk fences with walls; and the undernoted calculation will show this, as it is taken from my own note-book, containing an account of work of the same nature per lineal yard:—

Cost of erecting a Sunk Fence as shown in Fig. 13.

To excavating and removing earth 100 yards distant—say 3 cubic yards, at 6d. per yard, . . .	£0	1	6
... quarrying 2 carts stones, at 3d. per cart, . .	0	0	6
... cartage of do. one mile, at 1s. per cart, . .	0	2	0
... building 1 yard in length, including lime, . .	0	1	4
... laying turf on the slope, ...	0	0	3
... wood-paling on top, ...	0	0	3
	£0	5	10

Cost of erecting a Sunk Fence as shown in Fig. 14.

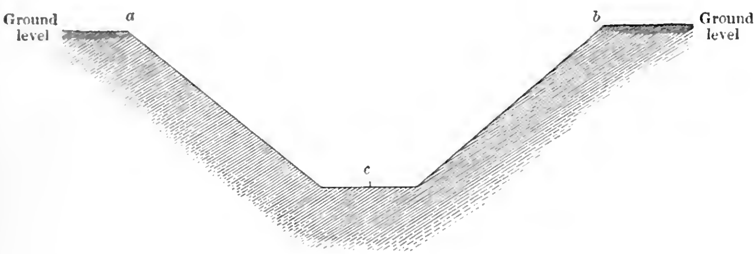
To excavating and removing earth 100 yards distant—say 2 cubic yards, at 4d. per yard, . . .	£0	0	8
... quarrying and carting stones one mile, . .	0	1	3
... building 1 yard in length, including lime for cope only,	0	0	5
... laying turf on the slope, ...	0	0	1
... putting up double paling, ...	0	0	7
... digging ground and planting hedge, including plants for same, ...	0	0	3
	£0	3	3

In giving the above estimates, I beg to be understood that, in many cases where materials are easily attainable, the work may be got done for much less money.

The *trapezoid* sunk fence, as I formerly mentioned, is made without any wall, having a paling in the centre. It is not so generally in use as the angular sorts which I have already described, being only introduced into low marshy parts of the country, where walls cannot well be had on account of the want of stones; and in such districts it answers a double purpose—namely, that of an outlet for the carrying away of water from the adjoining fields, as well as forming a fence.

The construction of the trapezoid sunk fence will be understood from the undernoted Figure, which is an end section of the same.

FIG. 15.



These fences are generally made fifteen feet wide at top, as from *a* to *b*; five feet deep, and three feet wide at bottom; and are in most cases excavated at the rate of 8d. per cubic yard—removing the earth to the distance of one hundred yards. A paling is generally erected along the bottom of the sunk fence, as at *c*, in order to keep back cattle from either side; and when the slopes are finished and properly levelled, the turf from the top should be laid down upon the sides again. When this is insufficient, both sides should be turfed from bottom to top, by carting it from a distance; because, if not turfed, the slopes are very apt to crumble down into the water-course, and set the water to work in undermining the sides. Besides, where cattle are to be pastured upon either side, it is absolutely necessary to have it laid with turf. Work of this description ought to be done in the spring, or at least in the early part of summer, so as to have the turf growing and bound to the soil before the floods of autumn set in.

Fences of this description are not now much in use, it being old-fashioned, and, in my opinion, unsightly. However, as there are many of them both in England and Scotland, particularly in the flat-lying mossy districts, I have considered it but right to advert to the making of them. I have even assisted in the making of such a fence myself in the Lowlands of Scotland, particularly in Fifeshire, in wet undrained districts, where it answers well both as a fence and an outlet for superfluous water; but in high-lying, drained, or well-improved districts, it is a fence of no importance.

SECTION IX.—THE BUILDING OF DRY STONE DYKES.

The most extensively used fence in the high inland districts of Scotland and the north of England, is the dry stone dyke. From the nature of the country in those high districts, stones are plentiful, and of course easily attainable; from which circumstance it is a fence much in use for all purposes. Stone dykes have the effect of affording considerable shelter both to young plantations and agricultural cropping as soon as they are erected for that purpose; and are also of great importance in high countries, as giving immediate shelter to cattle in the adjoining fields, which is a great point in favour of their extensive use. This, of course, is not the case with a young hedge fence, which requires from nine to twelve years to produce shelter of great importance.

The dry stone dyke used to be built entirely without the addition of any lime or mortar to bind it, and consequently it was always apt to be broken down by cattle or any other strong pressure coming in contact with it; but, within twelve years past, a great improvement has been effected in the building of them, by having the top, or cope stones, all put on and bedded in lime, which keeps the dyke altogether in a more firm and compact state than that built upon the old principle of having no lime upon any part of the dyke.

Dry stone dykes are built of various heights, from four to six feet; but the most approved height for general purposes may be said to be five feet over all. In giving directions as to the proper manner of executing the work of building dry stone dykes, I shall here give what are termed *Specifications* for building dykes of the description mentioned; and as they are of the most approved sort for work of this kind, such a copy of specifications may no doubt prove useful to foresters and land-stewards in general who may have occasion to superintend such work. The following is a copy of the specifications which I use in erecting our dykes upon the estate of Arniston:—

MINUTE of AGREEMENT between ROBERT DUNDAS, Esq. of Arniston, on the one part, and THOMAS PRINGLE, residing at Stow, on the other part—for erecting a March Fence between the farm of Yorston and the farm of Outerston, upon the estate of Arniston.

First,—The stone dyke to be erected under the present agreement is on that part of the line of march beginning at the present shepherd's house, and from said shepherd's house to the extreme summit of the hill.

Second,—The said dyke shall be built according to the following specifications:—

The dyke is to be five feet high. The foundation must be laid with large flat stones, which foundation must not be less than thirty-four inches over. The setting-off of building upon the said foundation must be twenty-eight inches, leaving a scarcement of three inches upon each side. At twenty-seven inches in height, the dyke to have a row of through-band stones, six at least to the rood of eighteen feet. The dyke to be built forty-five inches of double, and the cope and coble to stand fifteen inches. The coble stones to project at least two inches over the doubles. The cope and coble to be properly bedded, built and pointed with lime, which must be mixed with the regular and proper quantity of sand. The whole to be finished in a sufficient and workman-like manner, to the satisfaction of A. B., who is appointed inspector of the work.

Third,—The said Thomas Pringle binds and obliges himself to execute the whole of the work, in terms of the above specifications, at the price of *twelve shillings* per rood of eighteen feet, lineal measure; and to complete the same before the first day of next, but with power to the inspector above named to extend the time for building as he may see proper and right.

Fourth,—The said Thomas Pringle further binds himself to uphold the said dyke for five years from the time that the work is finished, and at the expiry of that period to deliver it over to the proprietor in a proper state, and to the satisfaction of the said inspector, or any qualified person who may be appointed by the proprietor.

Fifth,—The whole of the stones used in building the dyke must be of good quality, and approved of by the inspector above named. And no crop of rock or wasting stones shall be used; and the contractor shall pay the tenants of Yorston or Outerston for any damage they may sustain from quarrying or driving the stones through their fields or over their grass lands.

Sixth,—The contractor, on receiving full payment of the price, shall either find good security for implement of the contract, or leave in the hands of the proprietor the sum of sixpence per rood for the said period of five years. In witness thereof, these presents, written by A. B., are subscribed by the said Robert Dundas, Esq., at Arniston, the twenty-third day of May, in the year eighteen hundred and forty-eight, before these witnesses, P. S., W. M., and R. S.; and by the said Thomas Pringle, at Stow, upon the day last mentioned, before these witnesses, J. P. and A. H.

P. S *Witness.* R. DUNDAS.
W. M. „
R. S. „

J. P. *Witness.* THOMAS PRINGLE.
A. H. „

Having given the above form of specification for the erecting of stone dykes, I consider it superfluous to add more upon that point, as any intelligent man may, from consulting the same, be perfectly qualified to take charge of such work. A dyker is, properly speaking, a business separate from that of a forester. No forester or land-steward can be expected to be an adept in building stone dykes himself: all that is required on their part is to know how the work ought to be conducted upon right principles, and to be so far a practical judge of the matter as to detect what is wrong from what is right as the work proceeds. There are dykers enough in most districts where such fences are in general use who can be got to do the work at a fair rate; and all that is required of the inspector is to see and to be able to know how the work should be done. I may, however, here state, that in building stone dykes the inspector should examine minutely, as the work goes on, if the same be well built together; that is, he must see that no open spaces be left in the body of the dyke, which should in all cases be firmly packed with the smaller stones; and the method which I take, when suspicious in this matter, is to give the dyke a stroke with my foot about half height on the one side, and if opposite to this part where I strike the dyke it come out a little, just in proportion to the stroke given, as may be observed by another person on the opposite side, the dyke may be considered *well packed*; but if the stroke of the foot does not tell upon the opposite side, and cannot be observed by the eye, it is certain that the dyke is hollow within, there being no due solidity throughout so as to cause one stone to press upon another from side to side when the stroke is given. The inspector ought also to see that all the stones used be put or laid on their natural bed, and that every individual stone rest upon two lying under it, and never upon one.

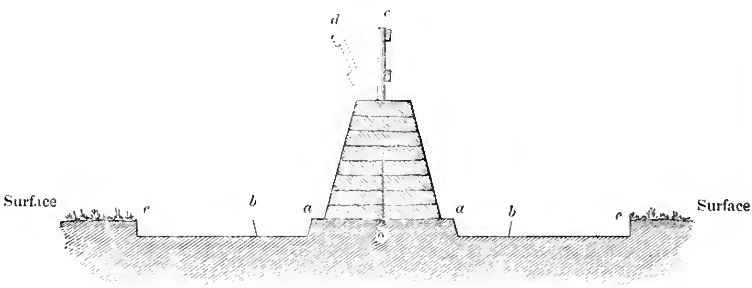
The cost of erecting stone dykes is various in different parts of the country, that depending entirely on the price of labour in the neighbourhood where the dyke is to be erected, as well as upon the conveniency of getting stones for the purpose. If stones are to be carted far for the line of fence, the expense becomes considerable; but the stones being laid down, it is generally got done for two shillings and ninepence per rood of six yards, including the cope and coble well put on with lime. In Mid-Lothian I have seen dykes put up for five shillings per rood, including every item of expense; and in this case the stones were plenty in the adjoining fields, consequently the cartage was easily executed. In other instances, where the stones were difficult to quarry, and where the stance of the dyke was about a mile from the quarry, I have seen fourteen shillings per rood paid; therefore, in calculating the expenses of erecting dry stone dykes, the distance of cartage for the stones is the most material point of consideration. A dyke five feet high, as I have specified above, requires about ten cart-loads of stones to the rood; and when the quarry is opened, and the nature of the stones observed, it will not be a difficult matter to calculate the quarrying, cartage, and building, in any particular district.

SECTION X.—THE BUILDING OF TURF DYKES.

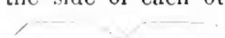
In many high-lying parts of Scotland, where stones are not easily got at, and where, upon account of the nature of the soil, it would not be advisable to plant hedges, a very neat and answerable fence is often put up for the purpose of enclosing both young plantations and agricultural fields, termed the *turf dyke.*

The nature and dimensions of turf dykes, as I generally build them, will be at once understood by referring to Fig. 16, which

FIG. 16.

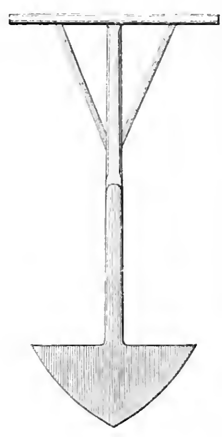


is an end section of a turf dyke; and as they are not, like stone dykes, built by a class of men making such work their business, but must be built entirely under the eye of the forester or land-steward, I shall enter rather minutely into detail of the method of erecting them, so that any intelligent man, from consulting the Figure and directions herein given, may be enabled to erect turf dykes in any part.

The line for the erecting of a turf dyke being laid off by a set of pins running along the tract of the ground upon which the fence is to be, the operator, in beginning the work of building, first measures eighteen inches from the centre of the line of fence as at *o*, to one side as at *a*, where he fixes the end of his line into the ground, and, stretching it along the run of fence as far as his line will reach, he fixes the other end of it eighteen inches from the centre, in the same manner as at the end where he first started, and of course upon the same side of the fence; and having his line tightly stretched and *pinned* exactly eighteen inches from the centre at any given point, he next proceeds to edge off with a spade the whole length of the line, in order to form one side of the foundation-stance of the dyke. In edging off the side of the stance along the line as has been stated, the operator must cut the surface or turf, standing with his face to the field and his feet upon the foundation part of the intended dyke, and this in order that the edge of the stance, as at *a*, may be cut with a considerable slope outwards, as shown in the Figure at *a*, upon each side. This sloping of the edge of the stance or foundation is meant to answer a two-fold purpose, namely—the turf when cut from the ground with a slope, when laid on in the building of the dyke, corresponds with its sloping upwards; and the edge of the stance, when finished in a sloping manner, lasts much longer than it could do if it were cut perpendicularly. In the same manner the other side of the stance should be cut or edged, as has been directed for the first; measuring also the other side eighteen inches from the centre to the opposite side, making the foundation three feet wide over all, as seen from *a* to *a*. The foundation having been marked off as has been directed, the operator next proceeds to measure outwards from the edge of it, as from *a* to *b*, upon each side, a turf fifteen inches broad at top; and placing his line to the same measurements, he edges off with his spade—which should be an old half-worn one, kept pretty sharp—a line of turf fifteen inches broad, the whole length of his first line on each side of the stance; and it must be observed here that, in edging off these turfs upon each side, the operator must cut them with his face to the stance of the dyke, in order to make the outer edges of the turf slope contrary to the inner edges, as shown in the Figure at *b b*; consequently the two turfs, when cut and turned upside down and laid along the side of each other upon the foundation, will appear thus  . This answers a two-fold purpose as the work proceeds—namely, the turfs are at once prepared to answer the sloping of the dyke as it progresses upwards; and as the turfs, in the case of joining them in the centre of the building, are much improved by having a portion of earth put between the seams, this can at once be done by filling up the opening caused by the contrary slopes meeting in the centre, which opening is at once readily filled from paring the bottoms of the turfs when lying as turned up out of the earth, and levelling them for another layer of turf coming above progressively.

The two lines of turf being formed by edging them off with an old sharp spade, as directed above, a second man follows with what is termed the *flaughter-spade*, (see Fig. 17,) with which spade he cuts the turf line, now formed by the man before him, right across into convenient lengths—say eighteen inches; and as he cuts the turf into those lengths, *proceeding backwards*, he by a jerk of the implement turns each turf as it is formed with its grass side uppermost. Each turf, as it thus turned up, is laid hold of by a third man, who lays it upon its bed in the forming of the dyke, &c., always taking care to lay the first course of turf three inches within the outer edge *a*, on each side, which is meant to form the margin, in order to support the dyke the more firmly. When the three workmen have got the first course of turfs laid on the stance, they all proceed to have them properly placed, joined in the seams, levelled, and made properly firm; and in the same manner they proceed throughout, one edging off the turfs with a line to an exact measurement corresponding to the width of the dyke as it advances; consequently each succeeding layer of turf, as it is laid on above another, will be proportionally narrower than the one under: a second cuts the turf across into convenient lengths, and heaves them up for his neighbour in order to lay hold of them the more readily and put them upon their place in the building. From the Figure representing the turf dyke, it will be observed

Fig. 17.



that the same is built from materials taken equally from each side; and this is necessary in order to the more speedy building of the whole, as well as taking an equal proportion of the surface from each side, which will not cause the making of the one field poorer than the other, as would be the case were the turf taken all from one side.

The thickness of the turfs must in all cases be determined by the nature of the soil. If the soil which forms the turf be light and sandy, the less of such material that is taken up the better, as it is extremely apt to moulder down quickly; therefore, in a light sandy soil, do not pare the turfs thicker than three inches; and if the soil be heavy, four or five inches may answer; but as a general rule in this matter, do not take the turf thicker than you have plenty of the fibrous roots of the grass in it.

It will be observed from the Figure that the first four layers of the turf are double—that is to say, two in breadth; and this is necessary, for the great breadth of those under-turfs would render the work necessarily difficult were they put on whole. My rule in this case is to make the under half double turf, and the upper half single; and in all cases I put on the upper turf with the grass up.

These dykes are generally made about thirty inches broad at the bottom, and tapering regularly upon each side to twelve or fourteen inches at top.

In the erecting of all turf dykes, it is of the greatest importance to the future welfare of the same as a fence, to build them at the offset a few inches higher than it is ultimately intended they shall be; because they in almost all cases subside a few inches shortly after being put up. This is the more necessary to be kept in view where the soil or turf of which the fence is built is of a mossy or soft nature; and of this I have, indeed, had ample experience, which makes me desirous of guarding others against mistakes of the same kind. And in order to make provision against too much subsiding, I here recommend the following hints:—Where the natural surface is very rank of grass or weeds of any sort, cut the same as bare as possible with a scythe previous to cutting the turf; and in the building of the same, if they are damp and spongy, make the dyke at least nine inches higher than you wish it to be; that is to say, if you wish your turf fence to be thirty inches ultimately, make it thirty-nine or forty; but if the turf used be off a moderately firm, loamy soil, three inches may be quite enough to allow for subsiding. Where it is intended to have a paling fence upon the top, as is always necessary unless the dyke be made very high, such a paling should not be put up until the fence has well subsided, else it would fall considerably under the paling afterwards.

In all cases of erecting turf dykes, I recommend putting a paling on the top, (see Fig. 16 at *c*,) in order to prevent sheep or cattle of any description from getting over into a plantation or adjoining field. If the fence is placed upon the edge of a wood, and meant to protect it only, the paling may be put up as represented in Fig. 16 at *d*; but if it is put up for the purpose of dividing two fields, then the paling must be put up as represented in the same Figure at *c*.

These palings should be of larch-wood, two bars deep, well nailed to larch stobs driven into the dyke so deep as to go through it into the solid ground. These turf dykes can be got done for one penny per yard; and if we include a two-barred paling, with five stobs to the rood of eighteen feet, and include also men's time in putting it up, with nails, the whole may be got done for 5d. per yard.

There is another form of turf dyke often to be met with in high parts of the country, made after the same manner as the *whin-hedge fence*, (Fig. 12,) which is an exact representation of the same thing; therefore I need not say more upon it here, only that in general, instead of whins being sown upon the top, one or two bars of paling are put on the top according to the height.

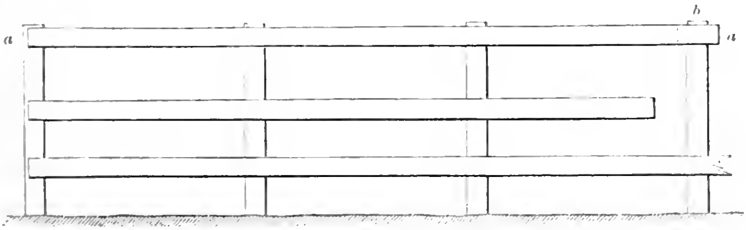
Where much water prevails upon the ground, and where it is likely by any sudden run to injure a turf fence of the description mentioned, an open drain twenty-four inches by fourteen may be made along the outer edge of the pared ground, as at *e*; and the earth taken out of it may be thrown in towards the bottom of the dyke in order to keep that part high and set the water the more decidedly into the drain. The building of turf dykes should always be done in the spring or the early part of summer, in order that the turfs may be well grown together before winter sets in. Upon the estate of Arniston we have several miles of turf fences such as I have described above, and they answer the purpose excellently. Sheep are, indeed, apt to rub them much away at the bottom; but in order to prevent this, a few stobs should be driven into the ground upon the sheep walk, to act as rubbing posts, which will in all cases entice the sheep from the fence.

SECTION XI.—THE METHOD OF ERECTING VARIOUS SORTS OF WOODEN PALINGS.

The variety of designs for wooden palings is endless; and for me to give, in a work of the present nature, anything like a description of those termed ornamental palings, would be superfluous; therefore in the mean time I shall confine myself to the description of a few only, and those such as are considered the most useful for general purposes.

The most generally useful of all wooden palings as a structure for a fence, is the horizontal, (see Fig. 18;) and this is, when well

Fig. 18.



put up, a fence by no means void of ornament. The wooden paling, as shown in the above Figure, consists of strong posts or stobs, generally about three inches diameter, driven into the ground at intervals of three and a half feet in the line of fence, upon which stobs the bars are nailed horizontally at regular distances from, and parallel to, each other. As there is no fence more commonly in use than the above, it will be of importance to make a few practical observations as to the manner of putting it up.

Having fixed upon the exact line upon which a wooden paling is to be erected, ascertain the height that will be necessary for the purpose in view; and having decided upon this—say a three-barred paling—then in this case the fence will require to be about three feet high above ground when finished. Next ascertain if the ground be of a hard or soft nature in the line of fence to be erected. If soft, the stobs for the paling will require to be put at least two feet into the ground, in order to make them properly firm in their place, and to resist the presure of cattle; if hard, then eighteen inches in the ground will be sufficient for the depth of the stobs in the ground. And, for one example, in the present instance we shall say the ground upon which the paling is to be erected is hard; consequently, if the height of the paling, three feet, be added to the necessary depth of the stob into the ground—namely, eighteen inches—we have four and a half feet as the length of the stobs required for the fence; therefore let stobs of that length be brought forward and laid all along the line of fence, laying down one stob for every three and a half feet in length of the fence, which is quite sufficient; and upon having the stobs laid down as directed, have the horizontal rails laid down also, beginning at the one end of the fence line, and laying down three bars together continuously to the other end, observing at the same time, in laying out the stobs and rails, to keep them a little to one side of the exact line of fence, in order that the men in working may not be continually interrupted by them lying in their way; also observing not to lay the rails down carelessly upon the top of the stobs, but to have both so distinct that the workmen can have it in their power to lay hold of either stobs or rails without them coming in contact with each other. I may here state, that the general size of stobs used for this purpose is about three inches diameter, and they may be either round wood, halved, or quartered as the size of the wood may answer in making them. The best sort of wood for stobs, which have to be driven into the ground, and which are continually exposed to the extremes of both wetness and dryness in the soil, is the larch. As far as my experience goes in this matter—and I have had much of it—I find that even oak itself, when driven into the ground as a common stob, will not last nearly so long as larch of the same age; and I may further state here, that of all the sorts of wood which I have used as stobs to a fence, Scotch fir and alder are of the shortest duration; and next to these, beech. The horizontal rails for paling are generally made eighteen feet or a rood in length. These are sometimes made of larch, and sometimes of spruce or Scotch fir. Larch is out of all question the best for this purpose, and is generally sawn to the size of three and a half inches by seven-eighths of an inch. Spruce fir is, in my opinion, the next in quality for paling rails, Scotch fir being inferior to it for lasting. Both these are generally cut four inches by one inch.

The stobs and rails being all laid out as directed, the operator will next provide himself with a garden-line for stretching along the run of the fence; also a common nail-hammer, or what is termed No. 3 paling-hammer, with claws for pulling out nails, (see Fig. 19.) He will also require a bag for holding the nails, and not have them lying and scattered about, as many carelessly do; and this bag may be of leather or of coarse sail-cloth, as may be most conveniently had; and as there are two sizes of nails used in the putting up of paling, this bag ought to be divided into two apartments, by being simply sewed up the middle. Another important tool in the operation of fencing is what is commonly termed the *stob mell*. Many use merely a block of ash-wood about ten inches long and six inches in diameter for this purpose, having of course a handle to it; but a mell of this description never answers well, nor can a workman do much execution with it: they ought all to be made of iron, and may be about 12 lb. weight. Fig. 20 represents the iron stob-mell which we use at Arniston, which in the hands of an expert workman is a powerful implement.

Fig. 19.

If the ground be very hard, and it be considered difficult to get the stobs driven into the ground, not only upon the consideration of the loss of time that would be occasioned by having the men toiling and beating upon a stob for some minutes before they could get it the desired depth into the ground—but upon the consideration also of the waste of the stobs that would be occasioned, it will be proper and necessary to be provided with what is termed a *borer*, (see Fig. 21.) This implement consists of a heavy piece of iron, *a*, which is pointed, round, and hollow in the centre, in order to receive the handle *b*. This pointed piece of iron—or *shod*, as it is termed by the workmen—may be made about twelve inches long, and about three inches diameter at the top where the handle is inserted. The handle should be about four feet long, in order that the operator may have the more lever power upon it; and in making a hole for a stob with it, it is forced into the ground by repeated strokes downwards from the workman, who holds it by the top, *c*, in his hands, and is found very powerful in making holes in hard ground.

Fig. 20.

Fig. 21.

These implements, as described, together with the nails, are all that are necessary for the putting up of a paling fence; and having described them, we shall now proceed to show how they are used in the work.

In commencing to put up the paling, all the materials being laid down, first stretch the line along the run of the intended fence, and pin it down about two inches to the one side, in order that the stobs may be put in the exact run intended for them; and having done this, cut a piece of wood the exact length that you wish the height of your stobs to be above ground when driven in; then, if the ground be hard, take the borer and make a hole with it for the first stob; which being done, send the stob down by the mell to the desired depth, measuring the proper height of it above with the stick; or, which may be more handy, the height may be marked upon the handle of your mell and applied at once to the stob. If your rails are of unequal lengths, next proceed to lay a single bar along upon the ground by the side of your line, allowing an overlap of about five inches at each joining; and having this done, proceed first to put in a stob at the joinings of the rails, without regard to exact distances in this case. Upon having a stob driven into the ground at each joining of the rails, next proceed to put in the stobs between these, to as nearly three and a half feet as the spaces will permit; and after you have the stobs driven in regularly as far as your line is stretched, look over them and see that they are regular both on the top level and in a line upon the side view; and this can be readily done by beating down one where too high, or beating with the mell to a side any that may be a little out of the line. And having the stobs all properly in, and in proper state, let two men take hold of a rail and place it along the top, forming the upper bar, (see Fig. 18, *a a*) and observe to have the end of the rail commencing upon the first stob nearly flush with the perpendicular of the same; that is to say, merely covering the breadth of the stob, as seen at *a* upon the left hand side of the Figure; and the man upon the other end of the rail will observe to have it about two inches over the breadth of the stob upon which he nails it, as shown at *a* upon the right-hand side of the Figure; and this in order to form a *splice* or joining to secure strength in the part; and in this state let the first bar at top be nailed on, observing to keep it rather under the top of the stobs, as shown in the Figure. Upon lifting the second bar, which should be a continuation of the upper one, let the man who is hindmost keep his end of the bar about two inches behind the stob upon which his neighbour nailed his last joint, as represented at *b* in the Figure; and in this manner the two men will go on with the putting on of the top bar the whole length of the line of stobs put in, and in the same manner return with the second bar, which should be about nine or ten inches under the upper or first one. In putting on the second and third bars, it is not so necessary to have the joints of these made upon the stobs as directed for the upper bar: they may be joined in the middle, or where it may chance to happen, according to different lengths of the rails; because the two under bars are not likely to require to have so much strength as the upper one, which is always pressed upon by cattle, &c. The second bar being nailed on, the third or under one should be put on about seven inches under it; and the reason of thus making the bars closer as they come down upon the stobs, is the more readily to keep back sheep or lambs, those spaces being most on a level with their bodies.

In the same manner the whole of the length of the fence is put up, one line-length after another; and in this manner two active expert men will put up twenty-five or thirty roods in one day, where the soil is moderately easy.

The cost of erecting a three-barred paling may be calculated thus:—

	s.	*d.*
To 3 roods of rails, at 7d. per rood, ...	1	9
To 5 stobs, $4\frac{1}{2}$ feet, at 2d. each, . . .	0	10
To 20 nails, at $7\frac{1}{2}$d. per 100, ...	0	$1\frac{1}{2}$
To men's time putting up one rood, ...	0	$3\frac{1}{2}$
	3	0

In erecting wooden palings, it will not be always found that three bars will answer every purpose; for where cattle, sheep, and lambs are grazing, four bars will often be found necessary to keep them in; as also it may often happen, that where there is a height upon the line of the ground upon which the fence is to be run, two bars may in such a situation prove as effectual a fence as three or four in other situations. And as I have frequently been asked by proprietors as to the expenses of erecting palings according to the number of bars in them, I shall here give a statement of the different prices of each, which I consider enough upon this head, seeing that whether two, three, or four bars are to be erected, the description given as to the manner of erecting the three-barred is equally applicable to the whole.

In the following valuation, I calculate upon larch-wood being used:—

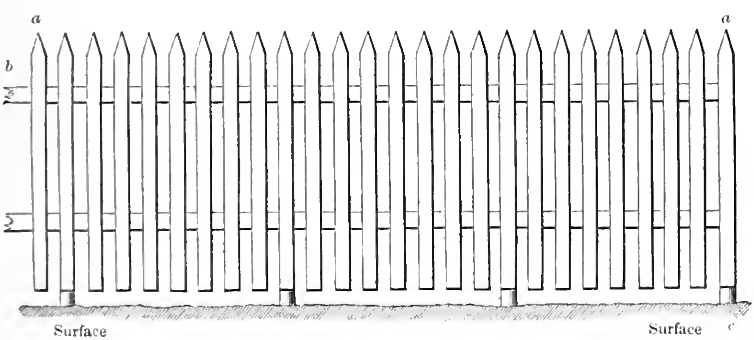
					s.	d.
Cost of a	1-bar paling	with 3 feet stobs,	per rood of 18 feet,		1	3
Do.	2	do.	4 feet do.	per do.	2	1
Do.	3	do.	4 feet 6 inches do.	per do.	3	0
Do.	4	do.	5 feet 6 inches do.	per do.	4	2
Do.	5	do.	7 feet do.	per do.	6	0
Do.	6	do.	8 feet do.	per do.	7	6

In erecting a paling above four feet high, if the ground be of a soft nature and not likely to hold the stobs firm, three rances may be required extra for the rood, with a foot-pin each. The value of each, with pins, may be stated at 4d., or 1s. extra per rood.

Next to the horizontal paling which has been described above, the most important and generally useful is the *upright*, which is made of various heights in order to suit different purposes. It will be enough for me to give an example of the manner of putting up one of these; and by referring to Fig. 22, this will be readily understood.

Fig. 22 is a sketch of an upright fence made of larch-wood. The upright spars, as shown from *a* to *a*, may be either sawn wood,

Fig. 22.



three inches by three-quarters of an inch, or small larch trees, three inches diameter, cut up the centre by a saw-mill according to taste. I shall here suppose that we have to erect a fence of the description above stated, and that the same is required to be five feet high.

In the first place, have all materials brought forward, and the line stretched along the run of the intended fence, in the same manner as directed for the putting up of the horizontal fence; and put the stobs into the ground in the same manner as there advised, observing to keep them about four feet distant from each other, and allow the tops of them to be twelve inches under the extreme height of the uprights; consequently the stobs for a five-feet spar fence will require to be four feet high above ground when driven in. The stobs being put in along the whole length of the first line, and carefully levelled along the tops, at least in such a manner as to correspond with the nature of the ground, the next part of the work is to have the upper rail nailed on to the exact height of the tops of the stobs, observing to join the rails upon the stobs in the same manner as formerly advised; and the upper rail being nailed on, the second (there being only two horizontal bars in the fence at present under notice) must be nailed on and joined upon the stobs in the same manner, keeping about sixteen inches from the surface of the ground, or two feet under the upper one. In putting on the upright spars upon the frame-work now formed by the stobs and two horizontal rails, have one of them nailed on at the extreme end where you intend commencing, observing to keep the top of this upright twelve inches above the upper rail *b*, and place it at the same time so as to cover the stob forming the extreme end, as at *c*—the stob appearing at bottom only; and in the same way go on putting on an upright upon the face of every third stob the whole length of your line of stobs, being very exact in measuring the top of each to twelve inches above the upper bar; and when these are done, put a nail into the top of each of these uprights, but only so far into the wood as not to be taken out easily without the aid of the hammer. On having put a nail into the top of each, have your line tied to the one upon the extreme end, and go along with it in your hand, making one turn of it round each nail as you pass along, keeping the line tight as you proceed; and having stretched it along the tops of the spars tightly by the use of the nails, the line will now act as a top guide for putting on all the rest of the spars between to their proper height, which could not have been done easily otherwise. The fence being five feet high, the uprights will require to be only four feet nine inches in length, they being kept three inches up off the ground or surface, as seen in the Figure. In putting on the spars, pay no attention particularly to their regularity at bottom, but be very particular as to how they range and take the eye at the top. In nailing on these spars, be careful to have them put on as near the perpendicular as possible, keeping from two to three inches of open space between each two; and always endeavour to have an upright put on so as to cover each stob from the view, which can be easily done by a little attention in regulating them. A fence of this description should always have the spars nailed upon that side which is to be most seen; consequently, this point should always be taken into consideration before commencing the work.

The cost of erecting, per rood of six yards, an upright larch fence five feet high, such as I have just described, may be calculated as under:—

	s.	d.
To $4\frac{1}{2}$ stobs, 6 feet long, at 4d. each, . . .	1	6
... 2 roods rails, at 7d. per rood, . . .	1	2
... 48 upright spars, (*small larches halved,*) at $1\frac{1}{2}$d., .	6	0
... 100 nails, at $7\frac{1}{2}$d., ...	0	$7\frac{1}{2}$
... men's time putting up 1 rood, . . .	1	0
	10	$3\frac{1}{2}$

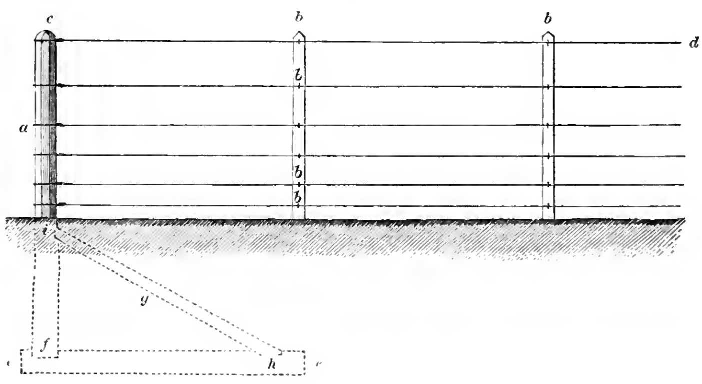
There is another description of paling fence, which until lately was much used throughout Britain — namely, the *stob dyke*, as it is termed in Scotland. This fence is still often to be met with in many parts of the country, and consists of a continuous row of wooden stobs driven into the ground as nearly as close as they can be got to one another, and bound together at the top by one bar or rail, with a nail through it into the head of each stob. This sort of paling, from the great quantity of wood used in it, is expensive at the outset, and is now, in all cultivated districts, superseded by the horizontal paling, which is superior in every respect, being more durable, and cheaper in the first instance also. It is not, in my opinion, worthy of being continued as a fence; for even where it is thought much of on account of its closeness in producing shelter, a much better fence is produced by the upright spar, which will last double the time of the stob dyke, and is infinitely more elegant. From the stobs which form the stob-dyke fence being all inserted into the ground, they soon waste, and, in fact, all waste at once, and must be entirely renewed; but the upright spar, or the horizontal paling, having only a few stobs in the ground, these can be renewed, and the rails answer a second set of stobs; as I have often experienced.

SECTION XII.—THE ERECTING OF WIRE-FENCES UPON WOODEN AND IRON POSTS.

The wire-fence, from the nature of the materials of which it is made, is decidedly the most ornamental of all; but although it must be admitted to be the most ornamental of all other fences, and although, from the nature of the material, it will last much longer than a mere wooden fence, great caution is necessary in adopting it in many situations. As I intend to give a few remarks, when done with this section, as to the propriety of using a particular fence in a particular situation, and for a particular purpose, I shall not, in the mean time, enlarge upon the utility or non-utility of the wire-fence, but proceed directly to the practical part of erecting them. In this I hope to be able to give such directions as may enable any intelligent man to erect them in a perfect manner upon any gentleman's property.

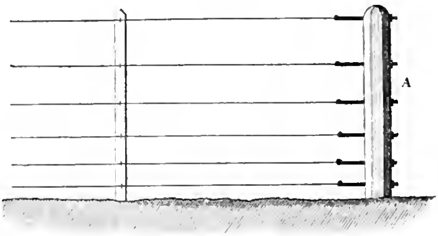
Figs. 23 and 24 represent the extreme ends of a wire-fence

Fig. 23.



upon wooden posts, nearly four feet high, and adapted for sheep and cattle.

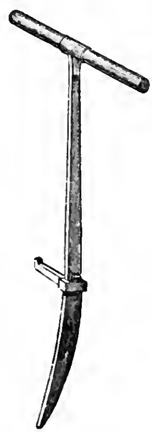
Fig. 24.



The exact line for a wire-fence being fixed upon, have the first *post* or *straining-pillar*, *a*, Fig. 23, made as there represented. Have it made of the best larchwood, taken from a full-grown tree, the wood of which may be considered ripe and full of resinous sap; and not of the wood of a young tree, as is too often done, the quality of which, although apparently as good, will not endure nearly so long as that of a full-grown tree. The wire-fence for sheep and cattle, as here represented, is in general made three feet nine inches high from the surface of the ground to the top wire *d;* consequently the post *a*, which is sunk three feet into the ground, will require to be made seven feet long, allowing four inches for the round upon the top above the level of the upper wire, as at *c;* and if it is to be made octagonal in shape, as is generally the case, it will require to be at least seven inches diameter, measuring from any two opposite sides. In preparing the straining-post, it is advantageous to the strength as well as the duration of it, not to take any of the outer wood off the part which is to be sunk in the ground; for the more bulky that part is, so much the greater, in every respect, will be the stability of the work. Therefore, in dressing the straining-post, only do so to the part which is to be above ground, and, if possible, put the lower part in with the bark upon the wood, as in the natural state, which will preserve it from rot better than either charring or tar could do. Having the post made with half-inch holes bored through it at proper distances for the reception of the wires, as shown in the Figure, have another piece of larch prepared, six feet long, eight inches by six inches, to act as a sole for the post to rest upon in the ground, as indicated in Fig. 23 by the dotted lines at *e e*. In this sole cut out a part, upon the broadest side, about two and a half inches deep, the whole breadth of the wood, large enough as to hold the bottom of the post in it, as at *f*,—observing to leave about four inches upon the end for a heel; into this groove fix the bottom of the post, as shown in the Figure, and secure its firmness by two garron nails driven through the post into the sole. This being done, have another piece of larch-wood, *g*, so long as to have the one end fixed in another groove to be made near the point of the sole, as at *h*, and the other end in another groove, to be made only one inch deep, upon the post a little under the surface of the ground, as at *i*. This piece of wood, which should be about six by three inches, is called the underground stay, and is meant to act as a support against the strain of the wire; while, at the same time, it is not seen above ground, and consequently gives the fence a light and neat appearance when finished.

The first straining-post having been completed in the manner stated, the next step in the work is to have a pit dug in the ground for its reception, observing to make the one end of it exactly where the fence is meant to begin, extending it in the direction of the line of fence very exactly, so far as to hold the sole when put in, and about three feet deep. In making these pits for the reception of the posts, the ground is in almost all cases found so hard as to require picking, in the under half at least; and as it is highly necessary to make the pits as near the exact dimensions of the wood to be put in as possible, in order to have the more solid ground about the posts, it is often a work of considerable difficulty to make them without proper implements. This I wish to draw particular attention to, having frequently had occasion to see a man work half a day in the making of a pit for a post with improper tools, who, had he had proper ones, could have done the same work in one hour. The implements I use in the making of the pits for wire-fence posts, as also for gate-posts in general, are the common garden-spade, for digging off the surface turf and upper soil, and the *foot-pick*, Fig. 25, which I use instead of the common hand-pick. There being no sufficient room for a man

Fig. 25.



using the hand-pick but with great disadvantage in the making of pits, I in all cases of this nature use the foot-pick, which is a most efficient instrument in the hands of a powerful man, enabling him with great ease to loosen the hardest subsoil or stones in the making of a pit. The *horizontal spade*, Fig. 26, I in all cases use when eighteen inches under the surface, with a handle about two feet long. With this implement a man can work with great freedom in the pit, where he is much confined for the want of room; and with it he can do more than double the work, in such cases, that he could do with the common spade.

Fig. 26.

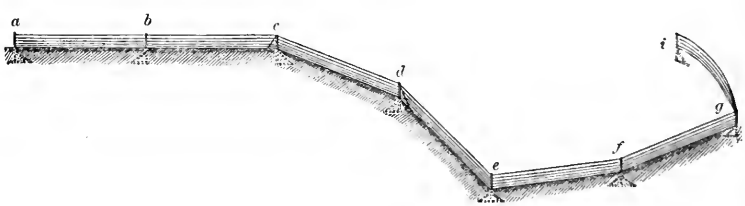
The pit having been thus made, and properly levelled in the bottom, put the straining-post down into its place, observing to place it perfectly upright. For the purpose of ascertaining this correctly, use a piece of cord with a weight upon the one end of it, (see Fig. 27,) which take in your hand by the one end, as at *a*; and holding it up hanging between your eye and the post, standing about three yards distant from it, allow the plumb *b* to settle, when you will in a moment observe if the post correspond with the perpendicular line or not: when taking this observation, have one man holding the post to the spot you desire him, and another putting in a little earth to keep it in its place. As soon as you have the post placed upright, have two wedge-shaped pieces of larchwood, something in the form of the pointed end of a strong stob — say about eighteen inches long. Beat one of these obliquely into each end of the pit, as at *e e*, in Fig. 23, between the solid earth and each end of the sole. This is meant to secure the stability of the sole in its place, and, consequently, they ought to be well driven home. Being satisfied as to the erect position of the post, have the earth which comes out of the pit

Fig. 27.

well broken down, and filled very gradually into it again. In this filling never put in more than three inches deep of the loose soil at once into the pit, without having it properly beat to a perfect solidity with what is termed a *rammer*, which is merely a piece of wood in the shape of a common stob, about four and a half feet long, having an iron shod upon the under end in order to make it more heavy for beating the earth. By alternately laying in about three inches of loose earth into the pit, and beating it firmly as directed, and observing at intervals, by the plumb-line, if the post stands right, and is not put out of its position by the beating, the securing the necessary resistance to the strain of the wire is attained. I may observe here, that previous to putting in the post with its sole, all that part which is to be under ground, if the natural bark be not upon it, should be well painted over with hot tar, which has a great tendency to preserve the wood; but by no means char the wood, as many do. I must say that the charring of larchwood, in particular, is injurious to its duration; and this I have had many proofs of. It carries off the resinous matter, which is so plentiful in this wood, and which resists the action of the water. Charring, again, makes the wood more porous, retains the water, and of course encourages rot.

Having got the first straining-post put in, observe next if the ground upon the line of the proposed fence is level or unlevel; for a great deal depends upon this, and the manner of going to work must be regulated accordingly. In order to illustrate this clearly, we shall now be assisted by referring to Fig. 28, which is meant to represent a continuation of a line of wire-fence both upon level and unlevel ground.

Fig. 28.



We shall now suppose that the first straining-post *a*, in Fig. 23, is represented by the post at *a* in Fig. 28, and is now properly secured into the ground, agreeably to the directions given. Now, the ground from the post *a* to the post *c*, being perfectly level, we shall suppose to be about one hundred and sixty yards in length; therefore this space is too great in order to be properly tightened up between the two posts *a* and *c;* we must therefore have another post between them, as at *b*. I beg to observe here, that in all cases of putting up wire-fences, never have straining-posts, if possible, wider than eighty yards from each other. If they are wider, the proper tension of the wire cannot be attained so as to make a secure fence; consequently the next step in the progress of the work before us is to put up another post at *b*, nearly half distance between *a* and *c*. This post is put in exactly in the same manner as has already been described for the first one; only it must be observed to put the underground stay of the second post in such a position as to resist the strain of the wire from the post at *a*. This is effected by placing the stay the contrary way of the first one, as seen and represented in Fig. 28 at *b*, the stay upon the post there not lying in the same direction as at the post *a*, but the contrary, thus making each pair of posts complete in themselves, and independent of another, which is the point required. This second post being secured, the next thing to do is to have the intermediate uprights or standards brought forward, which are represented in Fig. 23, *b b*. These should be of the best larchwood, six feet long, and three and one half inches, by two and one half. Before putting them into the run of the fence, have one line stretched tightly between the bottoms of the two straining-posts upon the surface of the ground, and another between the tops, or in the exact position of the intended top wire, running each end of it through the upper hole in each post, which has been prepared for the reception of the upper wire: and upon having both lines stretched as a guide for top and bottom, in putting in the intermediate uprights, have them put in five feet apart, upon the opposite side of the line that it is intended the wire shall be put on; or in other words, let it be understood that the hempen line is in the exact place where it is intended the upper wire shall be; and upon a due consideration of this matter, it can at once be decided upon which side of the line the stobs ought to be placed. Another point necessary to be considered at this stage of the work is, to put the wires upon that side of the stobs where it is known there will be most necessity for strength on the part of the fence; for if heavy cattle be upon the opposite sides of the wires, they are very apt to press out the staples which hold the wires to the wood; while upon the other side they can have no effect whatever upon it: therefore it is that this point must be considered.

With regard to the method of putting in the intermediate uprights into the ground, some make holes for them with the spade, and place them in. Some years ago, I adopted the same plan, but found that uprights put in in this way were very apt to become loose afterwards, seeing that it is not an easy matter to have men always so faithful as to attend to beating them firmly into the ground. Besides, I have found this method very expensive, occupying much useful time; and, in fact, I never found it preferable to beating in the uprights in the same manner as I do stobs in a common paling. And now, after ten years' experience in the putting up of wire-fences, I in all cases drive them into the ground by the *paling mell*, using the borer in order to open the ground for their points. By this method I in all cases find the uprights stand more firmly than when put in by the spade entirely. In putting in the uprights, I have them well painted with tar in the under part before putting them in, more particularly about six inches under and above the surface.

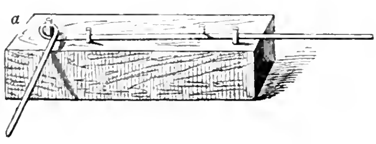
In order not to spoil the heads of the uprights in beating them into the ground with the mell, I have an implement made of iron, the exact shape of the top of the uprights, three and one half inches by two and one half inches inside measure, which fits exactly, and indeed rather tightly, upon the tops. (See Fig. 29.)

Fig. 29.

In beating in the stobs or uprights, a man lays hold upon the top of each by the article as shown in the Figure; by using it, the stobs are not hurt upon the top by the action of the mell; and, besides, the man holding them by this instrument at the top has a great power over them, and can turn them whichever way he pleases if they happen not to go in right: on this account I term it the *stob guide.*

The stobs or uprights having been put in five feet separate from each other the whole length of the line between the two first straining-posts, very exactly with the run of the line both at bottom and top, and three inches of the top of each upright being left above the line or run of the upper wire, in order to strengthen the fixature of the wire at top, as may be observed by glancing at Fig. 23, where it will be seen that the top of each upright is a little above the top wire, the next thing will be to have the wire prepared or drawn for putting on between the two posts now in readiness to receive it. The wire, as it comes from the manufacturers, is in general rolled up into bundles, each containing from forty to eighty yards in length; in these bundles the wire keeps its circular form, and consequently will not answer the purpose of lying along between the posts until it be drawn out in the form of a straight line, and that in such a manner as to make it keep the straight form when it has received it. In order to do this, an instrument containing a set of *pegs* is used, in the form of Fig. 30, which consists of a block of hardwood, about two feet long by six inches broad and three deep. Upon the upper surface of this are set two rows of iron pegs, about two inches long, well driven in, and about three inches separate from each other in the line. I have said that there were two rows of pegs set into this instrument, but these two rows are set in a particular alternate manner; and, to a person unaccustomed to it, my explanation, as above given, may not be explicit enough. The following sketch will, however, make it clear: the two rows of pegs are set alternately upon the piece of wood thus:— . ˙ . ˙ . ˙— the distance between the two rows of pegs being exactly that of the diameter of the wire to be drawn through between them, which is represented in the above cut: consequently, in making the instrument, a piece of the wire which is to be straightened should be laid upon the wood, and

Fig. 30.



the pegs driven in upon each side to answer it. In the act of straightening the wire by the use of the pegs, the instrument is laid upon a small bench about two and a half feet high, of any rough description. Let this bench be placed close to the side of one of the straining-posts, and lay the peg-block flat upon it; and, by a piece of rope passed through a staple which may be inserted at *a*, attach it firmly to the post. Then bring forward one of the bundles of wire; loose out one end of it, pass it round the small upright, as seen upon the face of the block, and bring the end of the wire through between the two rows of pegs as represented in the Figure. On having the end of it passed through, make a turn upon this end, and pass a good strong stick through it, by which two or three men may pull and draw the whole length of the wire through; as the men pull at the first end of the wire which was put between the pegs, another man must attend to unroll the bundle before it passes through the staple; or, if this is not strictly attended to, the wire will not come out from between the pegs straight; and in this manner draw out as much wire as will be required for six lengths between the two straining pillars, which is the number required for the fence now under our notice. Before taking down the line which was stretched between the tops of the two straining pillars for the purpose of regulating the tops of the uprights, and which of course will be in the exact place where the top wire of the fence is intended to be, have it stretched very tightly; when properly tightened, mark with a piece of *black coal* (as used by carpenters) the exact track of the line along the top of the uprights, and then take the line down. On its being removed, have staples prepared for nailing the wire to the posts or uprights: they are made of the same material as the wire itself; are about two inches long, (see Fig. 31,) and generally made without points.

Fig. 31.

Have one of those staples nailed or driven into each upright upon the mark made by the black coal, and right in the middle of the wood; and upon having them driven in about half length all along, one upon each post for the upper wire, have the latter then run through the upper hole of the first pillar, and through each of the staples in the uprights. One end of the wire is fastened to the post *a*, Fig. 23, by being brought half round it, and twisted by means of the *turnkey* (see Fig. 32) round the wire inside of the pillar or post. Should it be too short to reach the next straining-post, it must be joined to another piece of wire of the same description, and brought up to it. In joining one piece of wire to another, it is done by forming an eye or loop upon the end of one of the wires: in forming this eye, the end of the wire is held by means of the *clams*, (see Fig. 33;) and while one man holds the wire by means of this instrument, another assistant turns or twists the end round the wire, in the same way as at the post, by means of the turnkey, which has holes in it for receiving the end of the wire. An eye being made upon the end of one of the wires, the end of the other wire which is to be joined to it is then passed through it, and twisted in the same manner as the other; thus completing the joint or knot, which, when finished, will have the appearance shown in Fig. 34.

Fig. 32.

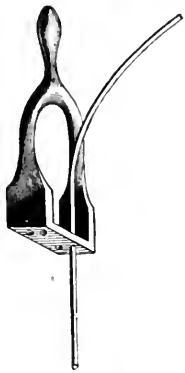
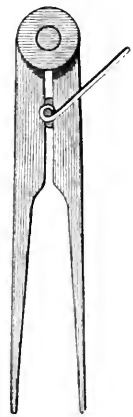


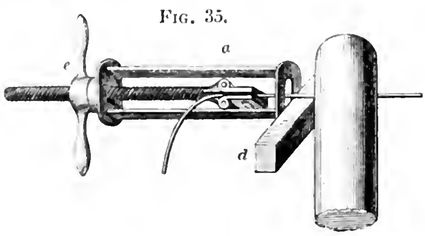
Fig. 33.



The joining being finished, and the wire brought up to the second straining-post, it is then cut a foot beyond the post, where it is now to be finished. In fixing the wire upon this second straining-post, pass it through the upper hole prepared for it, corresponding to that on the first post; then attach the *straining-screw* (see Fig. 35) to it. This straining-screw is attached to the wire

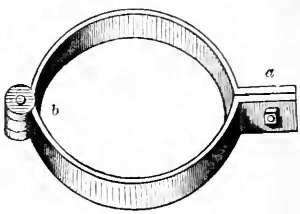
Fig. 34.

Fig. 35.



by means of a jointed *vice*, as at *a*, which is opened or closed at pleasure by means of a *screw* and *nut* wrought by a screw-key, and can be made to hold as tightly as if it were all a solid piece; the wire being passed through the upper hole of the post, as already directed, it is taken hold of by opening the *vice* at *a* and screwing it tight upon the end of the wire. But before beginning to tighten or screw up the wire, place a piece of wood, (see Fig. at *d*,) about two inches thick, between the end of the screw and the post, close to the under side of the wire: this, after the wire is sufficiently strained, allows the *collar vice* (see Fig. 36) to be applied. Having the straining-screw all in readiness, screw up the wire by turning round the handles *e*, till the desired tension is gained, which may be known from the wire in its whole length between the straining-posts being tight as a string upon a musical instrument.

Fig. 36.



The collar vice, Fig. 36, is now opened by unscrewing the vice at *a*, when it opens freely before the joint *b*. It is then put round the post, close to the upper side of the wire, and screwed again upon the wire inside of the pillar, the part *b* resting upon it. The straining-screw is then slackened and removed, the *collar vice* holding the wire in its position. The wire which projects or hangs out behind the post is now taken half round the same, the end being passed over the upper side of the wire between the jaws of the collar vice and the post. It is then fastened in the same manner as at the other end, when the collar vice can be removed.

In putting up our wire-fences upon the estate of Arniston, instead of tying the wire round the second post as I have described, which is the usual way, I have it attached to a screw-bolt, through an eye upon the one end; and passing it through the hole in the post, I have a *screw-nut* upon it outside the post. By this means I can at any time, when the wire becomes slack, tighten it up; whereas when it is tied at both ends, it cannot at any time be made tighter without undoing the tie and tightening it up anew by the aid of the straining-screw. These screw-bolts I get made sixteen inches long, which leaves, after passing through the thickness of the post, five inches next the wire, and three inches behind the post where the screw-nut is upon. There should be at least five inches of the end with a screw upon it, so that the wire may be either slackened or tightened at pleasure as necessity may require. In putting on these screw-bolts upon the wires, the same operation as above stated is gone through until the collar vice is fixed; and then, instead of tying the wire round the post as has been directed, attach it to the screw-bolts, and secure them by means of the nut, when the collar vice can be taken away.

This is represented in Fig. 24, which is meant to represent the one end of a wire-fence tightened up by the screw-bolts and nuts; and in this case Figs. 23 and 24 represent the two ends of one wire-fence, the wires upon the post in 23 being tied, and those upon 24 being secured by the screws.

In the same manner as has been detailed for the putting on of the upper wire of a wire-fence, all the others also are put on; in all cases observing to keep the distance between the wires closer at bottom than at top. In general, where sheep or lambs are, I keep the distance of the two lower wires five inches, widening them gradually to ten inches between the two upper ones.

Fences of this description can be made of any convenient height. We have them at Arniston, for deer, six feet high; those having ten wires in depth, instead of six as is generally allowed for sheep and cattle. But, however high those fences may be erected, the work is all done upon the same principle, save with this difference: In erecting a wire-fence above four feet, it is always necessary to have an iron stay put to the straining-posts above ground, as well as a wood one under, in order to secure them the more perfectly against the strain of the wire. These stays are sunk into stones and batted with lead; the stone for one of such stays ought not to be less than eighteen inches cube, and sunk about three inches under the surface.

The higher the fence the deeper also ought the post to be sunk into the ground. In erecting a fence of this description six feet high, the sole of the ground stay would require to be four feet under the surface. Where the wire is tightened by the aid of screwed eye-bolts at the one end, the staples should not be driven home in the uprights; but there should be room left for the wire to move through them, else the screw will not have the effect of tightening the wires when it is found necessary. As soon as a wire-fence is finished, the posts ought to be painted with hot tar, and the wires with common oil-paint; for if it is allowed to remain any time without being painted, the wire will soon become rusted, and will be apt to break if weakened by being corroded.

What I have now said relative to the putting up of wire-fences, is only applicable to a length between two posts, and that upon level ground; and in order to make this branch of fencing more properly understood, I shall continue my observations a little further. When I last referred to Fig. 28, I said that from the post *a* to the post *c* was all level ground, being one hundred and sixty yards in length: we have now finished the half of this space—namely, from *a* to *b*—in the above details of the manner of erecting the wire-fence. We shall now suppose that we are to erect the other stretch, from *b* to *d*: in this part it must be observed that the posts *c* and *d* are erected upon points from which the ground falls away suddenly; and in this case it is necessary to have either double wood stays under ground, as shown at *e* and *f*, or an iron stay to each above ground, upon the sides of the posts opposite to those upon which the under ground wood ones are. The reason for having these extra stays at these two posts is, that supposing the wire were to be suddenly broken between *c* and *d*, the great strain acting upon these two posts, from *a* on the one hand, and from *e* on the other, would very likely pull them suddenly backwards, and disarrange a considerable part of the fence. Now, the simple precaution of having another stay put up at each, prevents this from taking place under any ordinary circumstances; but, in every other respect, the wire-fence is put up in the same manner as has already been detailed. In all hollow parts of the ground upon which a wire-fence is erected, the posts at such parts should be sunk deeper than upon level or prominent parts; and the soles used there should also be much heavier than those commonly used, and with heavy ground stays, one on each side of the post, as shown at *e* and *f*, where these posts are in hollow parts of the line of fence. The reason for this is, that were these posts put in in a manner which would answer perfectly well at *c* or *d*, the great strain of the wire upon each side of them would not only endanger their security as a permanent fence, but it would draw them entirely out of the ground—a result I have witnessed several times. On a little reflection, it will appear evident that the strain of the wire at *c* and *d* tends to press the posts downwards into the earth; while, on the contrary, at *e* and *f* the strain tends to lift them out of the earth; which at once points out the necessity there is for attending to this point very minutely.

We shall now suppose that we have the fence finished as far as the post *g*, from which it takes a bend. Now, all the difference in erecting a wire-fence upon a bend from erecting it upon a straight line, is, that the posts forming the angles of the bend *g* and *i* require to have an extra stay above ground upon the inside of the curve; and every intermediate upright must also have a stay either under or above ground, in order to resist the pressure of the strain inwards; but if the curve be moderate, a stay at each second or third upright may be quite sufficient. In all cases where a gate occurs in the line of a wire-fence, that should be made to have the same appearance as the fence itself, putting in the same number of horizontal wires in it that there are in the fence.

We now come to speak of the cost of erecting wire-fences upon wooden posts; and of course the price must in all cases vary according to the strength of the wire used, as well as according to the height of the fence to be erected. There are five sorts of wire used in the erecting of those fences,—those wires being known according to their number respectively, thus: No. 4 is fully 3-12ths of an inch in diameter, and is the sort used for red deer or horses; No. 5 is exactly 3-12ths of an inch in diameter, and is the sort generally used for fallow-deer, heavy cattle, and horses; No. 6 is fully 2-10ths of an inch in diameter, and is the sort generally used for sheep and small cattle; and Nos. 7 and 8 are nearly 5-24ths of an inch in diameter, and are used for sheep and lambs only.

I shall here give the cost, as I have put them up myself, of three kinds of wire-fences upon wooden posts; the latter being of the best larch timber, cut at a saw-mill to the exact sizes.

Cost of erecting a wire-fence six feet high, for deer, with No. 4 wire, per eighty yards in length.

To 2 straining-posts, 10 feet long, 9 by 9 in., at 8s., .	£0	16	0
... 2 soles for do., 6 feet „ 9 by 5 in., at 3s., .	0	6	0
... 2 underground stays, 5 feet long, 7 by 4 in., at 1s. 6d.,	0	3	0
... workmen's time putting in the above, . .	0	3	0
... 48 uprights, 8 feet long, 3 by 3 in., at 8d., . .	1	12	0
... 80 yards of 10 horizontal wires, at 1s., . .	4	0	0
... 2 additional iron stays for pillars, at 10s., . .	1	0	0
... painting wire, at 2d. per yard, . . .	0	13	4
... men's time erecting fence, ...	0	6	0
... tarring posts and all wood-work, . . .	0	3	0
Total cost of erecting 80 lineal yards, . .	£9	2	4

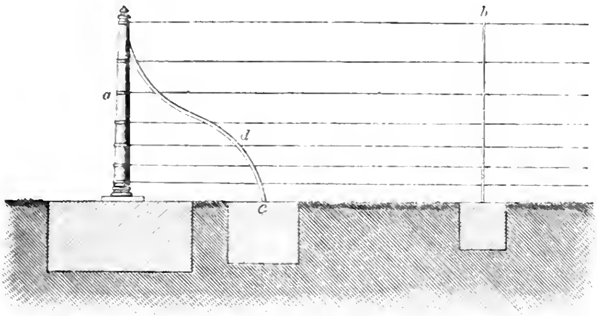
Being about 2s. 3d. per lineal yard.

The cost of erecting a wire-fence upon wooden posts, six wires deep, for sheep and cattle, of the same description as I have detailed in the former part of this section, being three feet nine inches high, and calculating upon the same principle as above, is about 1s. 2d. per yard; and the cost of one erected with No. 7 wire, for sheep only, three feet high, will be about 10d. per yard.

We now come to refer a little to the putting up of wire-fences upon iron posts or uprights. But having said so much relative to putting up those with wooden posts, it will not be necessary for me now to enter minutely into detail upon the erecting of iron ones, seeing that they are both put up upon the same principle. I will therefore only state under this head what I consider peculiar to it as compared with the other.

Fig. 37 represents a wire-fence upon iron uprights, having seven horizontal wires, and four feet high. The straining-posts or pillars may be made of either round cast-iron, or of square wrought-iron, according to taste. The straining-post *a* is sunk and batted well into a large stone at least three feet square on the surface and eighteen inches deep. The stay *d* is also well sunk and batted into a large stone eighteen inches square and fifteen inches deep; and in putting in these stones, they should be firmly bedded into the ground, so as not to yield afterwards by the strain of the wire. The straining-post *a* is generally made of two-inch-

FIG. 37.



square iron, and the stay *d* of double iron, each piece half an inch by one inch, allowing the wires to pass through between. The upright *b* is generally one inch by a quarter or half inch, according to height or strength required, and is also sunk into a stone about twelve inches cube, well batted with lead. These are the only differences worthy of notice between the erecting of a wire-fence upon wooden posts and one upon iron; for in the actual erecting of the one as well as the other the same implements are used, and the same method of working from beginning to end is pursued. Having said, therefore, so much upon the method of erecting the fence upon wood, it is unnecessary for me here to say much more, as it would merely be a repetition of the same thing; the only difference being, that in the erecting of a wire-fence upon iron posts, these are sunk in stones, the surface of which must be covered by three inches of earth, whereas with wooden posts these are merely driven into the ground. I may, however, remark, that instead of the horizontal wires upon the iron fence being fixed by staples upon the side, as is the case in the wooden uprights, they are run through holes bored in the centre part of the iron uprights; and in order to prevent strong animals from pressing the iron uprights to a side, they are what is termed *wedged*: this being done by inserting a small iron wedge, or nail without a head, into two of the holes in each standard—say one at the top wire, and one in the middle and immediately above the wire; but this should not be done until the standards are made perfectly plumb and the fence finished, when the wedges should be driven as firmly as possible. In a wire-fence upon iron standards where curves occur in the line, it is also necessary to have stays of iron put to the standards on the inside of the curve and against the strain.

It now only remains for me to state the prices of wire-fences upon iron posts: in this case, as well as in the other, much depends upon the strength of the fence required, as well as upon the price of iron at the time; and moreover, much depends upon the conveniency of getting stones. Indeed, where stones are not to be had conveniently, I have used blocks of larchwood instead. These may be round timber, about eighteen inches long by nine inches diameter; but in all cases stones are preferable if they can be got conveniently. The following quotations are the prices per lineal yard, including all expenses of stones, labour, iron, &c., of three different heights of wire-fence upon iron posts, as I have had them made in the neighbourhood of Edinburgh:—

		s.	d.		s.	d.
Cost of fence	6 feet high, for deer, from .	4	6	to	5	0
Do.	4 feet high, for sheep and cattle, from	2	6	to	3	0
Do.	3 feet high, for sheep only, from	1	9	to	2	3

In giving the above quotations as to the prices of wire-fences, whether upon wood or iron uprights, I am aware that many do them more cheaply; but, at the same time, I presume to say, not nearly so efficiently. Many, with the view of erecting a cheap fence, put in their posts from seven to nine feet apart, and the consequence is, that the whole soon becomes slack and unserviceable. I never have the distance more than five feet, and in all cases endeavour to make efficient work: in proof of this, our wire-fences at Arniston may be referred to.

I may further add, that all wire-fences, whether upon wooden or iron posts, should have the iron-work painted each year for the first two years after being erected; after that period, each second year will be enough. In the summer season the wires of all these fences are apt to expand in warm weather, and consequently become slack: in such cases the screwed eye-bolts, formerly referred to, are most useful for having them tightened up again. In the winter season, particularly during frost, the wire always contracts to a considerable extent, causing the wires to become over tight, and consequently in such cases they require to be slackened; and this I have experienced so often, that I think it proper to refer to it here; because if these points be not attended to, the wire will break in the winter and allow cattle to escape, and become too loose in summer.

SECTION XIII.—THE PURPOSE AND SITUATION FOR WHICH EACH SORT OF FENCE IS MOST PROPERLY ADAPTED.

Having now given in detail the method of erecting the seven most useful fences for country purposes—namely, the thorn hedge, the whin hedge, the stone-and-lime wall, the dry-stone dyke, the turf dyke, wooden paling, and wire-fence both upon wooden and iron uprights—it still remains for me to point out in what situation, and for what purpose, each of the above-named fences is most suitable. In the present section I shall endeavour to do this; and shall commence with the first in order—namely, the thorn hedge.

The thorn hedge, with a mixture of beech plants, is of all other fences the best adapted for a situation where a neat and clothed appearance is the object; and this it always has unless carried to a situation more than one thousand feet above the level of the sea, and unless at such an altitude planted in a mossy or very light soil; for there it will not live long unless upon a sandy loam.

In high and exposed situations, hedge-fences are not the best adapted for surrounding young plantations, which require a fence that will produce shelter in the first instance if possible. It is, however, there excellently adapted for the division of fields; and even in such situations, where immediate shelter for the rearing of young plantations is not a primary object, no fence ultimately answers better; for such a fence, under good management, will keep good and be an ornament when dykes and palings of the same age are tumbling down and useless. I am aware that many object to the raising of hedges with beech and thorn in high parts of the country, asserting that they will not succeed. As to this I can assert thus far, that upon the estate of Arniston we have good hedges of beech and thorn more than nine hundred feet above the level of the sea, and at the same time in excellent health. I am not an advocate for planting hedges about the home-grounds and parks of proprietors' seats, because there they are in a considerable degree unsightly and out of character: there, in short, no fence ought to be prominent, and for these sites the wire-fence is best adapted; but in all cases without the bounds of the policy walls, no fence looks better, or is more worthy of a prominent place, than the hedge, whether as a fence for a plantation or a field; but where it is desirable to have them thrive well, avoid planting them in a very light soil, else disappointment will be the result; and this cause of unhealthiness has often been attributed to too high a situation.

Second,—The *whin or furze hedge* is unquestionably one which should be kept out of all cultivated districts. There is no situation where the whin is found growing as a fence, in which the thorn and beech would not thrive much better. I am aware that many are of the opinion that whins are more hardy than thorns; but this I never could find. Upon the west coast of Scotland, between Portpatrick and Stranraer, I have seen the whins most severely cut down by a hard winter's frost, while the thorns were not in the least injured; and I have witnessed the same thing in Aberdeenshire.

Whins for a hedge-fence may, indeed, be recommended by those who have a regard for old customs, but in my opinion they are decidedly inferior in every respect to the thorn and beech; therefore, I in all cases recommend the latter in preference to them.

Third,—The *stone-and-lime wall* is of all others the most substantial fence that can be erected; but as it is an expensive one, it cannot properly be carried to any great extent. However, no gentleman's policy grounds can be said to be complete, as regards general security, unless they be surrounded by a stone-and-lime wall of from six to eight feet high. In fact, a gentleman's park surrounded by a good high wall gives us a confident feeling that there is something within the bounds of it worthy of being protected; and we always find the best of seats surrounded by such. But in no other case is it necessary to erect a stone-and-lime wall as a fence, unless we except the case of sunk fences. In a former section, when referring to the making of sunk fences, I said that they were only adapted for a particular situation—namely, upon the slopes of rising ground; and by no means upon level ground, for there, if it is meant to have an invisible fence—as the sunk fence is meant to be—the wire-fence is infinitely superior in every respect, and is now at the present day what sunk-fences were a hundred years ago. A sunk fence is excellently adapted for any purpose whatever, when built upon the slope of a hill or brae, as shown in Section VIII.; but in any other, I am not aware of its utility.

Fourth,—The *dry-stone dyke*, of all other fences, is the best adapted for giving immediate shelter to young plantations and other crops upon high and exposed parts of the country. Unlike any other fence, it is both a fence and a shelter at once; hence the reason that it is so much in request in all bare uncultivated districts. I have had frequent occasion to observe, that in high and bare districts, young plantations surrounded by a good dry-stone dyke were ten years in advance of others which had been surrounded by a young hedge with paling to protect it; therefore it is that in all cases upon high parts, where stone dykes can be had at all conveniently, I recommend them for young plantations, and for every other rural purpose.

I have heard many assert that it would be a great improvement to build dykes upon high situations altogether with lime, making them, in short, stone-and-lime walls; but I beg to observe that this would by no means be an improvement; for a dry-stone dyke will give more shelter to trees, or any other crop growing inside of it, than a wall of the same height built closely with lime. A dry-stone wall sifts the wind and softens its power for a great distance; whereas the wind striking upon a close stone-and-lime wall is at once resisted; and the consequence is, that the wind, when it rushes over the top of the wall, has gained strength, and strikes with greater force upon the ground beyond; and this is the reason that a hedge is in all cases a better fence than a wall for shelter: the hedge sifts and softens the force of the wind more than a wall of any kind does. Dry-stone dykes are, from their outlandish appearance, not to be recommended as a fence where fine taste is meant to be kept up; therefore they should not be built near the home-grounds of a gentleman's property; but upon high-lying parts of the country where improvements are in infancy, no fence is more commendable, both as regards security and shelter.

Fifth,—The *turf dyke* is next in importance to the stone dyke, in high-lying districts, as a fence; that is to say, in so far as regards immediate effect in the producing of shelter to young plantations or land under any other crop. Upon the estate of Arniston we have a considerable extent of turf dykes, both as fences for young plantations and division fences upon the farms: these fences, let it be understood, are upon the high-lying part of the estate, where stones for a fence are not easily got; and, as a fence for the protecting of young plantations, I find them answer very well indeed. They should not be put up where heavy cattle are to be grazed alongside of them, for they are always inclined to burrow about them with their horns, which tends much to injure the fence; but in all cases where stone dykes are not easily attainable from the want of material, and where heavy cattle are not grazed, they form a very good fence, and will last for a great many years by a little attention to mending when any break occurs.

Sixth, — *Wooden palings* are, in general, only considered as temporary or assistant fences. In all cases where young hedges are planted, and where cattle of any description are to be grazed in the fields adjoining, they must be protected by a wooden paling until they have attained a size and strength sufficient to insure their being exposed with safety; and this is one use for which palings are in continual demand.

In high-lying situations, palings are not often used as a fence alone, because they produce no shelter; and where they are erected in such a situation, it is merely to answer a temporary purpose, or to act as an assistant fence upon a turf dyke, or along the side or sides of a young hedge. But in low-lying situations, where shelter is not deemed of great importance, the wooden paling is extensively used for all purposes, both as a useful and ornamental fence. The horizontal paling is used principally for agricultural purposes; such as the protecting of hedge-fences in their young state, or for the mending of gaps in old hedges, &c.; but the upright paling, as well as an endless variety according to the taste of the proprietor, are mostly used as ornamental fences about gardens, cottages, &c., and they form excellent and useful fences when made of good larchwood, which will last longer than any other sort for this purpose.

Seventh,—The *wire-fence* upon wooden posts has often been recommended as a substitute for other materials where those are scarce; but I can by no means agree with those who recommend wire-fences for young plantations or any field crop upon a high and exposed situation, where shelter is of primary importance. No fence is better adapted for ornament than the wire-fence; therefore it is that I recommend it for all purposes without exception within the policy walls of a gentleman's property; and it may even be very properly extended beyond this where the estate is in a sheltered part of the country, and where artificial shelter from fences is of little importance; but as a fence where shelter is an object, the wire-fence is by no means to be recommended. Even where wood is scarce, the wire-fence may very properly be used instead of palings upon the top of turf dykes; for this, if put on with good larch stobs, will last much longer than any common paling could do. Where the greatest possible degree of invisibility is wanted, as well as the greatest possible degree of permanency as a fence, the wire-fence upon iron uprights is to be used; and this sort, when painted green, and as near the shade of the grass as possible, is not observable by a person till within a few yards of it; but where heavy cattle are, the wooden fence upon uprights is preferable, because the iron uprights are very apt to bend and be misplaced when a heavy animal comes in contact with them, while the wooden uprights are not apt to be disturbed in the least.

Having said thus much relative to the sorts of fences in most common use, both for the protection of young plantations and fields under agricultural cropping, I may further state, relative to plantations in particular, that the proprietor who plants extensively must judge for himself how far he is to adopt one sort of fence in preference to another. This of course must always be decided by the nature of the soil and situation, and the conveniency as regards materials; observing in all cases to erect a fence that will combine shelter with durability upon high and exposed situations; and where the situation is low and naturally sheltered, the taste may more reasonably be consulted. In all cases of fencing for the protection of young plantations, the work should be particularly well done; for if it be badly executed, and a part of the fence be broken down by any slight accident, cattle may get in, and do more damage in one night than could be well recovered in the course of some years. This I have experienced so frequently, that I here beg to advise all proprietors to be most strict in the executing of such a piece of work, where, in fact, no small part of the wealth of their estate is at stake. In the case of erecting stone and turf dykes by contract, as is the general way of having these done, the contractor should be bound to keep his work good for at least three years after it is finished. Under this engagement he will, for his own sake, be anxious to do his work well.

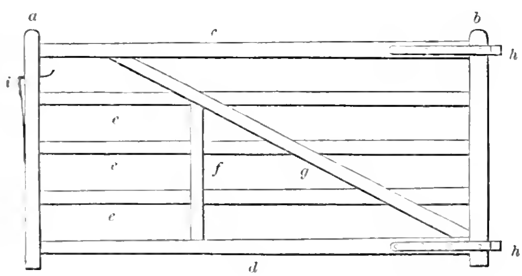
All wooden palings should be erected by the proprietor's own people upon the estate; as also all wire-fences, if possible, and the planting of hedges; and it is for the gaining of this end that I have written the above observations on the erecting of fences, that every forester may be as nearly as possible a complete erector of fences.

SECTION XIV.—THE MAKING AND HANGING OF GATES UPON FIELDS AND PLANTATIONS.

As the making and hanging of gates is a branch of rural economy most frequently devolving upon the forester, I consider it necessary, and of importance, to dedicate a section to the explanation of the most approved method of making and hanging of field and plantation gates; and moreover, having said so much upon the nature of fencing in general, this chapter will be incomplete without a few observations on this point.

Every field and plantation of any consequence must have one or more entrances into it in the form of one or more openings in the fence which surrounds it, and which again must be made to act either as a fence or as an opening as occasion may require. These openings are termed gateways; and whatever may be put upon them to act as a fence, as occasion may require, are termed *gates.* There are many forms of gates in use in different parts of the country, from the most rude horizontal spar, made to fall into a post at each end, to the fine massy iron gate hung upon hinges. It would be entirely out of place for me here even to attempt to enumerate the many different sorts of gates that may be considered of useful designs; I shall, therefore, confine myself to the description of one sort of field-gate, which is also, in my opinion, the best possibly adapted for a plantation-gate, and which I consider the most complete for all field and plantation purposes. Fig. 38 is a sketch of the gate referred to; upon the estate of Arniston we have all gates, both upon field and plantation fences, made of the same construction. These gates are all made of the best old larchwood, which, when painted, last for a great number of years; and as larchwood is very apt to twist in the heat of the sun, to which it is exposed when converted into a gate, it ought to be well seasoned before being used for this purpose. The following are the dimensions of the gate referred to in Fig. 38. The back post, *b*, is five feet high from bottom to top, and the

Fig. 38.



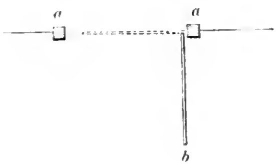
scantling four and a half by two and a half inches. The front post, *a*, is also five feet high from bottom to top, and the scantling three by two inches. The bottom and top horizontal bars, *c* and *d*, are each of equal dimensions—namely, length within the back and front posts about nine feet. These are four inches broad at the joinings upon the back-post *a*, and three inches broad at the joinings upon the front-post *b*, by two and a half inches thick. The horizontal intermediates *e e e* are of course of the same length as the bottom and top bars, and of the same breadth, but they are only one and a half inch thick. The diagonal bar *g*, which reaches from the heel of the gate to within two feet of the point of the top bar, is of the same strength as the upper and lower bars, and, like them, tapering from four inches at heel to three inches at point; and the upright piece, *f*, is of the same dimensions as the intermediates, and reaches from the bottom bar to the diagonal at its junction with the second bar from the top. This gate is furnished with double hinges, which greatly strengthen the back part by clasping the joints both at bottom and top, *h h*. See Fig. 39, which is a representation of this double hinge. The peculiar properties of this form of gate are, first, the back-post, *b*, is much heavier than the front one, *a*, which tends to throw the centre of gravity upon the hinges; second, all the horizontal bars, from bottom to top, are made heavier behind than in front, and all with the intention of lightening the gate in front, and throwing the centre of gravity as much as possible upon the hinges; and, third, the diagonal, *g*, is so placed that it acts completely the part of a lever against any weight that may be thrown upon the front part of the gate; and even its being lighter as it recedes from the heel, is a great means of supporting the whole of the gate, and of keeping it in a well-balanced state. It appears to me, that any gate made upon these principles must approach the model of perfection in such a structure; and it is upon this account that I consider the gate now described to be of the best description possible, seeing that it combines strength and lightness in a very perfect manner. In making the description of gates mentioned, it is necessary, in order to have them to last as long as possible, to have them very neatly jointed, planed smoothly,

FIG. 39.

and painted with two coats of oil-paint before being hung; and even after they are hung in their place, they are much improved by being painted at least once in three years. The wood and workmanship of a gate of this description may be valued at 10s.; the hinges generally weigh about 20 lb. weight, which, at 4d. per lb., will be 6s. 8d. additional; making the entire cost of the gate with iron mounting, 16s. 8d.

We now come to make a few observations upon the nature of hanging gates upon fences, both in fields and plantations; and as I have frequently seen a great deal of error committed in this branch of the business of fencing, I shall state the manner in which we hang our gates upon the estate of Arniston, which is considered, by all who have examined it, an excellent way of doing the work. The common way of erecting gates is to hang them right between the two posts put up for the purpose; and by this method, when the gate is set open, it stands at right angles with the fence upon which it is placed; (see Fig. 40, *b*;) consequently it is in this state always liable to be injured by carts, &c. coming into contact with it when going into or returning out of the field. Another evil which almost invariably attends this old-fashioned method of hanging field-gates is, that the gate being hung from centre to centre of the two posts,

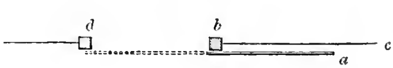
FIG. 40.



as indicated by the dotted line between the two posts *a a*, when anything goes wrong with either post, the gate must be left too slack between them, or otherwise confined too tight between them, according to the direction in which the post may have been driven. Consequently the gate has a great chance to be injured in some way or other; besides, the posts are seldom put into the ground with the addition of any simple fixture whatever, being merely put into a hole, and the earth again beat down about them; and, from this circumstance, if the earth has been put in about the posts in a wet state, the certain consequence is that they become slack in a short time, when the gate falls down in front, and, in consequence of coming in contact with the ground, it is soon either broken or much injured in the joints. Having seen this often happen from bad management, I beg here to recommend the following method of hanging plantation and field gates:—Let the post upon which the gate is to be hung be pretty strong—say eight inches on the side of the square, and let the part of it which is to be put into the ground be left round with the bark upon the wood, and have it put into the ground two and a half feet deep, and fixed upon a sole with a diagonal or stay, as has been already advised for wire-fence posts. Having the post made with its sole and stay on the under part, put it into the hole prepared for it, with the sole and stay projecting in the direction of the gateway, which will insure its stability against the weight of the gate or any other ordinary pressure in that direction, and have the post well firmed into the hole: if the earth taken out be of a soft nature, keep it out, and fill up the pit with small stones mixed with earth, or any other thing of a hard and binding nature; and be most particular not to fill in with earth in a soft or wet state, else the work will be insufficient, and will not give satisfaction. The post upon which the gate is to be shut may be considerably smaller, if thought necessary, than the other: it will not require to have any sole or stay attached to it, but may very safely be put into the earth at the same depth recommended for the other; observing to make it equally as firm, putting a very large stone or two into the pit near the surface, which will add much to the stability of the post.

Having put the posts in plumb, and at the desired distance, which should always be the exact length of the gate to be put on, next have the *crooks*, upon which the gate is to be hung, put into the post on the angle of the same, instead of on the centre as in the former case. See Fig. 41, where the gate a is hung upon the corner or angle of the post b; the effect of this being, that the gate, when hung in this position, has full play upon the hinge to fold back upon the fence c, and is not hindered in its motion by the corner of the post, as is the case in the other method; consequently,

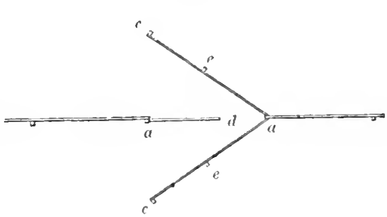
FIG. 41.



from the gate having room to fold back upon the fence, it is, when open, entirely out of the way of any cart coming into or going out of the field. Next, instead of the gate being made to shut right between the posts, it ought to be shut upon the face or outside of the shutting-post *d*; this is represented by the dotted line, which shows the position of the gate when shut: and in this case, whatever accident may befall the post upon which the gate shuts, the gate cannot itself be injured. The upper crook of all gates of this description should be made so long as to go through the post, and have about two inches of a screw upon the end of it, upon which a large nut, made to fit, is screwed; by this means the crook will keep its position, and will cause the gate to do the same.

It is often found convenient to have small wickets upon certain parts about gentlemen's seats, particularly upon the edges of plantations through which pleasure-walks are made; and as it is often inconvenient to have such wickets to open and shut in the same manner as common gateways, it is desirable they should be constructed so as to be what may very properly be termed *self-shutting*. Of this description of self-shutting wickets I know of none more simple and effective, both as a fence and a gate, than that shown in Fig. 42, which is generally termed the angular wicket. The opening in the fence, from *a* to *a*, may be about four feet wide; the angular part of the wicket, *a c c*, may be about three feet wide between *e* and *e*, and may be made up with any convenient sort of wood, according to taste; observing to have a post upon each of the extremities, one at *e* upon each side, in order that the wicket, *a d*, may hit upon one as it folds to either side in the act of opening or shutting. The wicket, *a d*, may be made of light wood, and hung with a hinge upon a post at *a*. The particular properties of this sort of wicket are, first, that it is of a most simple and easy construction; second,

Fig. 42.



it is easy for any person to have access through it, and that without the trouble of shutting or locking; and, third, whatever description of cattle may be in the adjoining fields, they can have no access through, seeing that if they do attempt it, the wicket as they go in shuts upon the opposite side before them.

CHAPTER II.

Preparing of Ground for the growing of young Trees—Draining of Plantation Ground—Laying out of Roads in new Plantations—Making of Close or Shot Drains in Land occupied by Trees—Season of the year best adapted for Planting Operations—Distribution of young Trees so as to suit different situations—Descriptive character of the Elm—Of the Beech—Of the Ash—Of the Sycamore—Of the Norway Maple—Of the Poplar—Of the Willow—Of the Birch—Of the Alder—Of the Oak—Of the Sweet Chestnut—Of the Horse Chestnut—Of the Lime-tree—Of the Scots Fir—Of the Spruce Fir—Of the Larch Fir—Of the Silver Fir—Of the Pineaster—Of the Weymouth Pine.

SECTION I.—PREPARING OF GROUND FOR THE GROWING OF YOUNG TREES.

SOME practical foresters have maintained that all ground, previous to its being planted with young forest-trees, ought to undergo a course of preparation by trenching or ploughing, and by having lime or manure in some way or other applied to the land. Such a course of preparation as either of the above may be very proper in some cases, but it is attended by the very worst effect in others. As I have been very often questioned by proprietors relative to the utility of trenching, ploughing, or manuring of land previous to its being put under a crop of young forest-trees, I shall here give an example or two from my own experience upon these points, with a few observations upon each head.

When I went to be forester at Craigston in Aberdeenshire, I found that some parts of the old woodlands, from which a crop of fir timber had been lately cleared, were trenched in the common way, and had again been planted with a crop of trees of various sorts about four years previous to my going there.

The ground which had been thus trenched was situated in a pretty sheltered part of the estate, and mostly surrounded by old plantations: consequently the situation was one rather favourable for such an experiment. Upon examining the nature of the top and sub soils, I found the former to be a dry sandy moss, well mixed with fresh vegetable matter, and in all from six to ten inches deep; the sub-soil was a tilly gravel of a dark brown colour, in many places several feet deep, and resting in many places upon a hard free-stone rock of a reddish colour, and in others upon a deep bed of pure gravel. In the act of trenching this ground, the surface had been pared off and thrown into the bottom of each opening, and covered by about a foot of the sub-soil: where old roots had been taken out, the trenching was no doubt in those parts deeper, but, on an average, the ground might be said to be twenty inches deep.

I said that this ground had been planted with another crop of trees about four years previous to my going there, and the kinds planted were ash, elm, Scots pines, and larch firs. When I first saw this crop of young trees upon the trenched ground, their appearance indicated that they had been planted only the previous year. They were alive, but had made no shoots of young wood since they had been planted; and upon learning the nature of their situation, I had the hardwood all cut over; but this of course I could not do with the firs, consequently I allowed them to do their best with the circumstances under which they were. I watched the progress of those trees minutely during the two years that I was on that place. The hardwood set up two and three sickly young shoots from each stock; but during the time I was there I found them very little improved, the whole of the plants remaining in a languid state. The firs were in a state very little better than the hardwood. When I first went to the place, I had the ground made up with many fresh plants of the fir tribe, because many blanks had occurred; and after watching their progress for two summers, I found that those which had been in the soil for six years were only making annual shoots of about two inches, and those that I had myself planted upon the same soil, being two years in the ground, had scarcely made any wood whatever.

Now, I had occasion to plant a few acres in the same old plantation the first year I went to Craigston, and I planted it with oak, ash, and elm, Scots pines and larch firs; but instead of trenching the ground, I planted them on the surface, and in the usual manner; and before they were twenty months in the ground, those trees were far superior to the others which had been six years planted.

Upon the estate of Dunskey, in Wigtonshire, the property of General Hunter Blair, there was a tract of ground trenched for a young plantation on a high and exposed part of the estate, and within one mile and a half of the sea. When I examined it, I learned that the trees had been planted upon it about six years; yet, generally speaking, they were not more than ten inches high, and standing at very wide distances. The greater half of the trees planted having died out, and the proprietor finding it a hopeless task, had abandoned the attempt of growing trees upon the ground; and in this state I found them.

The ground was a very light, sandy loam, resting upon a rough gravel of considerable depth, and it had been trenched much in the same manner as in the former case. The consequences were apparently much the same in the one case as in the other; that is to say, the trenching of the ground in both cases disappointed the views of the proprietors. Here, now, we have two examples of trenching ground for young forest trees both attended with bad effects, and I vouch for the truth of both the examples given. The blame could not be attributed to the soil itself, seeing that trees grow well upon the same nature of soil when planted on the natural surface: the failure was altogether attributable to the trenching of the soil; for the best of the soil was thrown undermost in the act of trenching, and the bad soil brought up in both cases; but had this soil been simply trench-ploughed, and the top and subsoils mixed together and allowed to rest for a year or two, the results would no doubt have been very different. These two examples have quite determined me as to the effects of trenching light land for young trees upon any situation; and in no case of forest management do I ever attempt trenching, knowing that the young trees are more sure of doing well when planted in the soil in its natural state.

Now, even allowing that those who advocate the trenching of forest land have in many instances been so far successful in their management, upon a good soil, as to grow trees rapidly, the expense necessary to be incurred is too important a point to be passed over.

It is evident that, however much good might arise to trees from the trenching of the ground upon which they might be planted, it could not in practice be carried to any useful or great extent. In ordinary cases, land cannot be trenched under £8 an acre; and where trees have been formerly, and huge roots have to be taken out of the ground, even £15 an acre would not be too much for the trenching of ground in such a condition. Therefore in general practice it is entirely out of the question.

The trenching of ground as a preparation for young trees may be very proper, and even necessary, upon a small scale, near or about a proprietor's policy grounds, in a good heavy loamy soil, and in a sheltered situation, particularly where large trees may have been newly taken down, and where, for the sake of appearance, it is desirable to have old roots taken out previous to replanting; but it is only in such a case that trenching, in my opinion, ought to be recommended in the cultivation of forest trees; and even then, only if the subsoil be naturally good. There is no advantage gained by the trenching of ground for forest trees which is not decidedly better attained by a well-conducted system of drainage.

The *ploughing* of land has been much recommended as a preparation of the ground for young trees. In my opinion, where the subsoil is naturally open and easily drained, there is no necessity for the ploughing of it previous to its being planted; but where the upper stratum of soil is naturally thin and poor, with *moorband-pan* under, a deep ploughing is absolutely necessary, in order to break the pan and mix a portion of the subsoil with the upper. The fact is, that a soil of the nature of moorband-pan is naturally unfit for the growing of forest trees; but where the proprietor of such a soil, in the general arrangement of his improvements upon his estate, may wish to plant such a piece of ground with forest trees, the trench-plough must first be used in order to open up the soil and break the pan. I am not aware that ploughing is advantageous to the growth of forest trees in any other case. I am aware that *fir trees*, planted and growing upon land which has been frequently ploughed previously, seldom live long, or attain to any considerable size free from disease; which at once points out that nature wishes no interference of the kind. A few months ago, when passing along the Lammermoor hills in Berwickshire, my attention was much engaged by observing a young plantation at a distance having a strange chequered appearance; and when I came up to it and examined the cause of such an appearance, I found that each five yards in breadth of the ground had been ploughed previous to the trees being planted, and other five yards in breadth left unploughed alternately. It appeared to me that the trees had been planted about seven years, and they consisted entirely of larch and Scotch pines. Those on the ploughed land were about five feet high, and those on the unploughed were not more than two and a half feet. In the unploughed land, the Scotch pines were proportionally stronger than the larches; and upon the ploughed parts, the larches were by far the strongest, and had made generally great progress, the situation being very high and exposed—more than a thousand feet above the level of the sea; and the Scotch pines giving a dark colour to the unploughed ridges, and the larch firs giving a light colour to the ploughed ones, was the cause of the appearance which first attracted my attention and led me to examine the plantation.

Here, now, we have an example of the effects of ploughing land for the reception of young trees; and it is decidedly remarkable, in the first instance, as compared with trees grown on the natural surface. In this case, the trees upon the land which had been ploughed were twice the height of those planted upon the unploughed; and it is the same in almost all cases of ploughing moorland for forest trees: this is occasioned by the decomposition of the grassy turf, and also by the roots of the plants having free and unchecked scope for the spread of their roots in search of food, which they cannot so readily do when the turf is of a close and compact nature, and in an undisturbed state. Upon all our woodlands upon the estate of Arniston I have had occasion to observe, when thinning and cutting among them, that wherever the land had been under the plough previous to its being planted with trees, the wood there is of greater dimensions in a given time than it is where the trees had been planted upon the undisturbed soil; but it is not nearly so sound in quality, and does not live nearly so long, more particularly the larch timber. Therefore, from my own experience, I beg to say, that all artificial cultivation of the soil ought to be avoided where it is desirable to have healthy and long-lived timber trees; for the quicker that any sort of wood is made to grow, the softer is its structure, the more liable to become decayed, and the less valuable the timber.

Liming and otherwise manuring the soil for young trees has been recommended by some and disapproved of by others. In my opinion—and I speak from experience—all artificial excitement of a young tree by the application of manure is ultimately injurious to it. I have seen small plantations grown upon the system of trenching, liming, and otherwise manuring; and in such cases I have generally had occasion to observe that the trees grew rapidly for a few years at first, but as soon as the exciting influence of the manure had begun to fail, the trees fell into a bad state of health, and seldom attained that confirmed state of maturity which is found when Nature has her own way. However, I cannot say as to what state of perfection trees might grow were manure added to their roots at stated intervals; nor do I think it necessary that we should know the results of such a system of management, seeing it would be of no real use to grow trees upon such an expensive system, and one which would cause the timber so raised to be of an inferior quality.

SECTION II.—DRAINING OF PLANTATION GROUND.

There is no preparation of the soil so advantageous to the welfare of young forest trees as draining. Draining not only dries the soil from all superfluous moisture, but it also cleanses it of many bad ingredients, which might otherwise prove injurious to the health of trees and prevent their full development. To the want of draining may be attributed most cases of unhealthiness in plantations for forty years past. The disease in the larch, which has been so prevalent in Scotland for some years past, may be almost entirely ascribed to the neglect of this precaution, as shall be particularly explained when I come to treat upon that subject. I have, within these last ten years, seen very many plantations in Scotland fast going back from the want of draining; and having been often called upon to give my opinion relative to the unhealthy state of such plantations, I have, in almost all cases, found damp to be the principal cause, and therefore recommended an efficient course of open draining as the only means by which they could be recovered; and wherever my plan for the recovery of the health of such plantations has been put into operation, restoration has been the result, excepting in some cases where the trees were too old and stunted to indulge any hope of their recovery. Since I came to be forester at Arniston, I have, by draining alone, brought several young plantations into health, which before that operation were fast going back; and from experience I find, that if the constitution of trees under twenty years old be not too much injured by the effects of dampness, they will show signs of recovery the second year after the ground is drained about them; that is to say, as soon as the young roots begin to draw nourishment from the dry and improved soil.

Draining is quite as necessary for the profitable rearing of young trees as it is found advantageous in the profitable growing of corn, which we now see so much improved everywhere by that most excellent art. What our corn-fields were fifty years ago, such are the most of our plantations of the present day.

Twenty years ago it was considered superfluous to drain land where young trees were to be put in; therefore it is not to be wondered at that we have at the present time so many unhealthy young plantations. During my apprenticeship I have planted young trees in ground where, when I made a pit for a young tree, I had to plant it immediately, for fear of the pit filling with water; yet the person who had the management did not appear to think that draining was necessary. And such was the case with foresters generally at that time. However, the foresters of that period are not to be blamed for not draining their ground previous to its being planted, any more than farmers were to blame for the same neglect before they became aware of the advantages of draining. But the case is altogether different now. Every farmer and forester is now aware of the advantages of draining land, whether it may be for the growing of corn or of trees; yet we have often occasion to see this knowledge taken no advantage of, both among farmers and foresters.

Any farmer who now sows his fields without first draining them, is by his more intelligent neighbours considered unworthy of holding his land; so, in like manner, the forester who would attempt planting a piece of ground naturally wet, without first having it thoroughly drained, would certainly be unworthy of holding a situation as forester in any gentleman's establishment.

The land intended for a new plantation being all well fenced, the next important step to be taken, in order to fit it for the reception of young trees, is the draining it, which draining must be executed in such a manner as to free the land from all superfluous moisture, and to keep it in a free, open, healthy state. I may here remark, that all drains made in plantations among trees, whether these may be old or young, ought to be left open. To cover drains where the roots of trees have access to them is the most effectual way of ultimately rendering them useless. They might, indeed, answer the purpose for a very few years; but as soon as the roots of the trees began to spread themselves firmly into the soil, they would collect about the drains more than any other part, and the consequence would be, that in a very short time covered drains would be entirely choked up with the roots, and rendered useless.

It is seldom found necessary to drain every part of the ground that may be laid out for a new plantation. There are, it is most reasonable to suppose, many spots quite dry enough for the rearing of healthy timber trees in almost every district of any considerable extent, which spots the experienced eye can at once detect by the general appearance of the plants growing upon the surface; but for the guidance of those who may not have had experience enough for this purpose, it may be necessary here to lay down something like a rule, by which they may distinguish land in want of draining from land not requiring it. Attend, then, to the following hints:—At certain distances throughout the whole of the intended plantation, say at twenty yards, cast pits rather more than twelve inches deep: if in those pits water should appear to gather within ten hours after being made, the land there is unfit for the growing of healthy trees without being drained; and where no water appears in the pits, the land there may be reckoned dry, and may be safely planted with forest trees without draining.

The distance at which drains should be put on the ground, depends entirely upon the nature of the soil to be dried; that is, if the soil be a stiff clay or a retentive moss, the drains may require to be laid on as close as twenty-five feet apart; and if, on the contrary, the soil to be dried be of an open sand or gravel, through which the water can pass freely, fifty feet distant may not be too far separate. In all cases where I drain for the planting of forest trees, of whatever nature the soil may be, I never now put on drains closer than twenty-five feet, nor wider than fifty, if the soil require draining at all. If the soil for a plantation of trees be drained more frequently than at twenty-five feet, the trees are very apt to be blown up by the roots when they come to be heavy topped, particularly if the drains are not kept in a clean state; and if land requires draining at all for the growing of trees, it is my opinion that fifty feet should be the greatest distance; for beyond that distance between drains, land cannot be said to be drained efficiently.

The depth and general size of the drains must in a great measure be regulated by the nature of the soil to be dried. In a heavy clay soil I have found that wood drains should be at least twenty-four inches deep; upon a light friable soil, fourteen inches may be quite deep enough; and according as the soil may be inclined to be light or heavy, any intermediate depth between the two extremes above specified may be fixed upon—always observing, that the more the soil is inclined to clay or moss, the deeper the drains should be made.

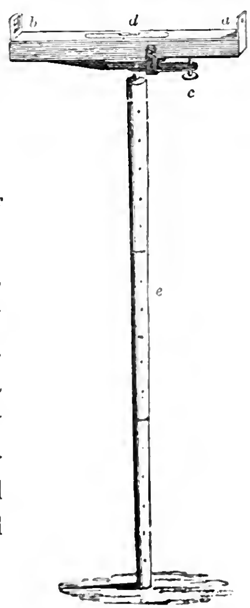
The breadth of all such drains, at the surface of the ground, must of course vary according to the depth required. The rule which I have laid down for my own practice as regards this is, to make all open forest drains one-third wider at the top than the depth intended; that is, if the depth of a drain be fixed upon as fifteen inches, the breadth of the opening at top will require to be twenty inches; and so on with any other depth. The breadth of all forest drains at bottom ought to be sufficient to allow a common spade free room to pass along for the purpose of cleaning.

The cost of making such drains as have been above specified, must always be regulated by the nature of the soil, and the price of labour in the neighbourhood where the work is to be done. In Mid-Lothian I have got drains fourteen inches deep, and requiring to be picked in the under-half, done for one farthing per yard; and drains twenty inches deep, requiring extra picking, for two farthings per yard. A particular point to attend to in the draining of moor or waste land, for the planting of young forest trees, is the manner of laying on the drains upon the ground: they must be laid on in that position which is found to be the best adapted for drawing off and intercepting the superfluous water in its natural descent. I have seen several plantations of late, and those of considerable extent, drained in a very inefficient manner, the drains not having been properly laid down upon the ground. To those who may be unacquainted with the art of making open drains upon moor or waste land, the following hints may be useful:—It is a very simple process to drain any piece of land having a moderate natural descent to one side. In such a case nothing is necessary but to make the drains in that direction which is indicated by the fall of the ground; but where the ground may be what is termed a *dead level*—that is, having no perceptible fall to any side—the case is altogether different, and requires both experience and consideration to drain such a piece of ground properly. Again, where the surface to be drained is a steep slope with many inequalities, much caution and consideration is necessary in order to lay on the drains upon the ground in that position which is most likely to be effective in intercepting the water as it falls from the various high parts into the various hollows; and in order to make all this as plain as possible, I shall illustrate the manner of going to work by reference to a few figures.

The operator, in making open drains upon moorland, must be provided with common tools as generally used for that purpose, —namely, the line upon *a reel*, with iron pin attached to the other end, for marking off the drains; a flaughter spade, (see Fig. 17,) for the purpose of cutting up the surface or turf; a common pick, (see Fig. 43,) for loosening the subsoil and taking out stones where they occur; and the common spade, for throwing out the earth and clearing up the bottom of the drains. The most necessary implement for the superintendant of draining operations is the spirit-level, (see Fig. 44,) which no drainer ought to be without, and which can be bought for 15s. This is an instrument that I use myself in the case of taking levels for drains; and in using it I put the instrument, with appendage, into a hole bored by a gimblet in the top of my walking-staff, as shown in the Figure. When in use, the spirit-level is placed into a frame of brass, a part of which operates by pressure against the bottom of the instrument, as a spring to adjust it to the level position *d*, by turning the large headed brass screw *c*.

Fig. 43.

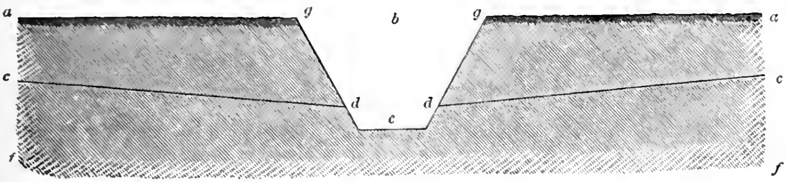
Fig. 44.



A perpendicular stud is fixed to the under part of the framing, and placed firmly into the gimblet-hole in the top of the staff *e*, which is pushed into the ground at the spot from whence the level is desired to be taken. There are two eyesights, *a* and *b*; *a* being merely a small hole for the eye to be placed against, and *b* a square opening, with a hair-wire crossing it in the middle.

Being furnished with the implements above mentioned, and having a spirit-level of the description referred to, if it is required to drain a flat bog for the purpose of planting trees in it, the drainer will proceed as follows:—Look for the lowest part of the ground to be drained, and if this cannot be decidedly ascertained by the eye, set up the spirit-level about the centre of the flat ground, and take sights from it all round in order to find out this point. In using the instrument, it may be unnecessary for me to observe, that the height of the eyesight *a* from the ground must be deducted from the point observed—that is, if the object-pole used be marked in feet and inches, and the hair-wire, in taking a sight, hit the same at six and a half feet—then, if your eyesight be three feet from the ground, the difference of level between the two stations will be exactly three and a half feet; that is to say, there would be three and a half feet of descent from the spirit-level station to that of the station where the object was placed. On the other hand, if, in looking through the eyesight, the hair-wire hit the object-pole at twelve inches from the ground, this twelve inches must be deducted from the height of the eyesight; and supposing that to be three feet, then the ground at the station-pole must be two feet higher than that at the spirit-level. Having ascertained, by the use of the spirit-level, the lowest part of the ground to be drained, and being aware how deep a main drain can be got made there in order to carry off the water from it, cut a main drain along the lowest part of the ground all through, and make it empty itself at the lowest point possible. This main drain must be made of a size correspondent to the quantity of water it is likely to be required to contain, which must depend upon the extent of ground to be drained: in the present case, the main drain must be deeper than ordinary, in order to give fall to the smaller ones into it; but, in a moderate case, we may say three feet deep, and five feet wide at top. Now let Fig. 45 represent this main drain upon a flat piece of ground: from a little expla-

FIG. 45.



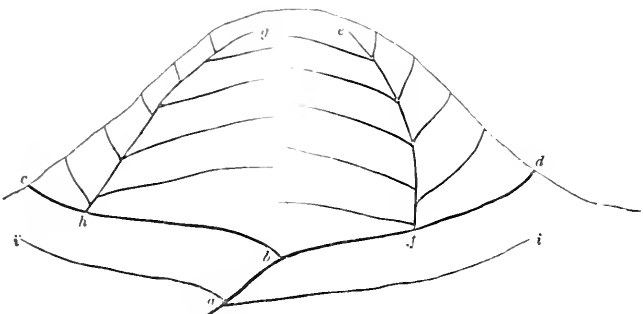
nation on it I will be better able to make myself properly understood in reference to the smaller drains which are to be led into it.

Having made the main drain of the form shown in the Figure, lay off your smaller or common drains at proper distances—say thirty feet from each other, and at nearly right angles to the main drain; and in making these—say that you wish to have them twenty inches deep, make them that depth at the top, or the end furthest from the main drain, as at *c c*, and proportionally deeper as you approach it; and when you finish the small drains into the main one, you can have one foot and a half of descent between the two ends of your drains, which is quite enough for a drain of any ordinary length in a plantation, where they are left open, and of course can be scoured in order to keep a clear run. The run of these small drains is represented by the two lines *c d* on each side of the main drain *b* in the Figure. From the surface at *a*, to the bottom of the upper end of the drains at *c*, is twenty inches; and from the surface upon the side of the main drains at *g*, to the bottom of the lower end of the small drains at *d*, is thirty-eight inches; giving eighteen inches of a fall upon the small drains from *c* to *d*. It will be observed that the small drains at *d*, the lower end, are kept a few inches above the bottom of the main drain at *e*: this precaution should in all cases be used where there is not much descent for the water. Were the smaller drains made to terminate in the very bottom of the main one, the accumulation of mud from the different small ones would soon be so great as to check the progress of water at the ends, and cause the main drain to become stagnated; but by keeping the bottom-level of the main drain a few inches under the bottoms of the small ones, although mud should accumulate in the former to a considerable extent, the others are not affected by it; and if the main one be cleaned once a-year, all is kept right with regard to the small ones.

It is a point of wisdom in draining not to have too many smaller drains running into a main one, unless, indeed, it be of very great dimensions; but if it should be found necessary to continue all small drains into one main drain for a great length—which will depend upon the nature of the ground—the main drain should be made larger as it increases in length, with the view of containing the increase of water from the small drains upon its sides. When water increases to a great quantity in a main drain made upon soft soil, it is very apt to be injured, and to have its sides broken down or wrought in upon; in order to avoid this, it is a better plan not to allow the small drains to run above one hundred and fifty yards without falling into a large one, which, if possible, should be made to have an outlet for itself without the bounds of the plantation, or into a stream, if the ground contain one; for a natural stream or burn makes at all times the best outlet for water from main drains; and, if possible, this should always be done.

In putting open drains upon land having a steep declivity, they should be run nearly at right angles with the descent of the ground; but, at the same time, care must be taken to make every drain with a slight fall downwards; for if they have not at least one foot in a hundred of descent, they will be apt to become choked up with mud and other vegetable matter, which is sure to accumulate if not carried away by a brisk run of the water in the drains. I have already said that where the ground has a slight natural fall—say of about three or four in the hundred—the drains may very properly be made to run in the direction of the same; but beyond this the fall would be too much, and would certainly prove injurious to drains. Caution therefore is necessary upon this point, in case of overdoing the thing; for if the drains were to be made with the natural fall of the ground, that being say six in the hundred, the effect of such a rapid descent of the water during a flood would ruin the drains; and if the soil were of a sandy or gravelly nature, the undermining of their sides could not but take place, and the whole work would prove a ruin. It should in all cases be observed, where the soil is of a light, sandy, or gravelly nature, to give no more descent to the drains than will carry the water briskly along and prevent stagnation; and where the soil is stiff, a quicker descent may be given without doing damage so quickly as in light soil. In order to make the method of draining upon steep slopes as easily understood as possible, I shall illustrate the same by reference to Fig. 46, which is a representation of my method of draining a hill-side with open drains for a young plantation, and which

FIG. 46.

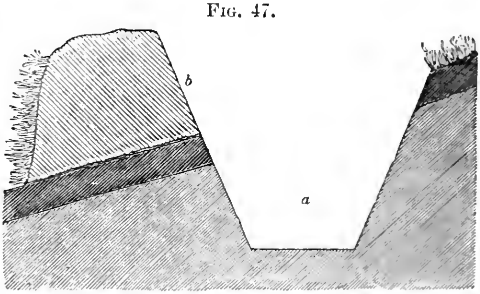


I consider the best method possible for intercepting water in such situations; and as I find that Mr Stephens, in his *Manual of Practical Draining*, has an illustration of the same kind, I shall here give the same, with his explanation. In speaking of making open sheep-drains upon hill-pasture land—which is equally applicable to plantation-ground in like circumstances—Mr Stephens says: "Open surface-drains in permanent pasture (or plantation-ground) exhibit the form represented in Fig. 46, where the leaders (or sub-main drains) *e f* and *g h* are cut with the greater slope down the hill the steeper the face of the acclivity is, and the feeders (or small drains) are cut across the face, nearly in parallel lines, into their respective leaders. In this way the water is entirely intercepted in its passage down the hill. Where one drain enters another, the line of junction should never be at right angles, but always at an acute angle with the line of the flow of water, as at *b*. And where small drains enter a large, they should not only enter with such an inclination, but where they come from opposite sides, as in the case above, they should enter at alternate points, as shown by the three drains above *f*, and not as represented by the three pairs of drains above these towards *e*." The large drain *c b d* may either form a part of the lower fence of the plantation, or run along the bottom of the hill-ground; and the main drain, from *b* to *a*, be made to run out in the direction of the outlet; and other small drains, as at *a i*, be made into it upon the level ground, if required.

With regard to the method of making open drains upon hill-land, such as has been described above, I may add from that excellent author, Mr Stephens, upon this head as follows:—"There are various ways of making drains upon grass: one is to turn a furrow-slice down the hill with the plough, and trim the furrow afterwards with the spade. When the grass is smooth, and the soil pretty deep, this is an economical mode of making the open drain. Every line of them should be previously marked off with poles when the plough is to be used. But where the grass is rough and strong, and swampy places intervene, the plough is apt to choke and come out of the ground, by the long grass accumulating between the coulter and the beam; and it makes at best very rough work, while the horses are apt to strain themselves in the swampy ground.

"A better, though more expensive, mode is to form them altogether with the spade. Let *a*, Fig. 47, be a cut thrown out by the spade, nine inches wide at bottom, sixteen inches of a slope on the high side, and ten on the low, with a width of twenty inches at top along the slope

Fig. 47.



of the ground. A large turf, *b*, is removed by the spade, and laid with its grassy side down the slope, thus preserving the grass on the lowest side of the cut, the shovellings being thrown on the top of the turf to finish the bank neatly. Such a drain catches all the water descending the space between it and the drain above, and leads it to the sub-main drains, as *e f* or *g h*, Fig. 46, which are of similar construction, but of larger dimensions, running more perpendicularly down the hill, with their lower end joining the large main drains, *b c* and *b d*." Such is the method advised by Mr Stephens for the making of sheep-drains upon pasture-lands, and it is equally applicable to the draining of land for a new plantation, only with this difference, that drains for woodlands are generally made rather deeper than those for sheep-pasture; and I have quoted the above from Mr Stephens, as it exactly corresponds with my own method of going to work in draining for wood upon steep sloping banks. In conclusion upon draining, I beg to remark, that all main drains should be made in the lowest part of the ground to be dried: they should increase in size as they increase in length, and according to the quantity of water likely to be poured inte them; and this not only in the time of general rainy weather, but the time of a flood must be taken into consideration, seeing it is then that the drains are mostly required.

All sub-main drains should be made in a position between the main drains and the smaller ones; and as they are intended to collect the water from the smaller drains and convey it to the main ones, they should be of a convenient size between the two. All open drains in a wood ought to be examined and cleared out once in two years; for if they are not attended to in this respect, they are apt to choke by vegetable matter lodging in them, more particularly if the ground be level.

SECTION III.—LAYING OUT OF ROADS IN NEW PLANTATIONS.

In all plantations of any considerable extent, it is absolutely necessary to have vacant tracts left through them unplanted, in the form of roads; and in laying these off in a new plantation, care should be taken to see that no part of the wood is above one hundred and fifty yards distant from some one of such roads. The necessity of this precaution will appear evident, when it is taken into consideration that the trees, when grown to any considerable size, will have all to be carried from the interior to some one of such roads, in order to have them taken away in carts; and when the trees become large, and require to be carried a considerable distance, much valuable labour must be wasted before they can be laid down cart-free by the men.

The roads in a plantation need not be made more than fifteen feet wide. In all cases, however, they ought to be so broad as to allow two carts to pass one another with freedom when laden with wood.

When the roads are marked off, which of course ought to be done previous to the ground being planted, they ought to be divided from the rest of the ground by a drain of sixteen inches deep, running along each side of them throughout their whole extent, whether the ground may be wet or not. These are meant not only to keep those roads in a dry, firm state, but to give them an appearance distinct from the rest of the plantation; being thus drained on each side, they are not apt to be cut or damaged by a cart or any other wheeled carriage passing along them; and when thus kept dry, they form a fine ornamental green ride for the proprietor and his friends at all times, as well as answer the purposes of accommodation in wood operations.

If there be any particularly romantic-looking spot within the bounds of the plantation, the road should be made to take a turn in that direction; or if there be any particular height from which a distinct view of the surrounding country may be had, make a road to pass by it, with a narrow footpath leading to such a height. In short, in making roads through a plantation, as well as in making walks through pleasure-grounds, good taste and ornament should be kept in view; and it is as easy to do any piece of work well as otherwise.

In plantations where good taste is kept particularly in view, it is very requisite to have holly trees planted along the sides of the roads; as also privets, rhododendrons, Portugal laurels and bays, all which thrive well although a little shaded by trees; and in the winter season particularly, they give a fine effect when contrasted with the leafless hardwood trees. Indeed, those ornamental points in forest scenery are by far too little attended to. Our woods might be made even more interesting than the best-kept gardens, in the winter season, were this kept in view; for what is prettier than a holly, with its clustering red berries, in the winter months, when the birds delight to congregate and feed upon them? And even in the month of June, what is more beautiful than the rhododendron, with its dark purple flowers? Such objects, when found in a forest footpath, give rise to reflections unknown upon beholding the same plants in a flower-garden.

SECTION IV.—MAKING OF CLOSE OR SHUT DRAINS IN LAND OCCUPIED BY FOREST TREES.

Are there no means whereby drains in forest land can be kept shut, and yet be secure from the roots of the trees? is a question which has very frequently been put to me within the last twelve months; and on this account I have devoted this as a separate section, in order to answer this important question as far as my experience relative to this point will permit me to speak profitably.

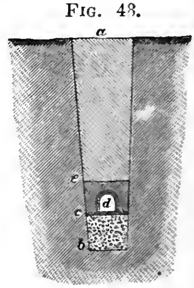
It often occurs about the home-grounds of landed proprietors' seats that open drains are an eye-sore, although they may be actually necessary for the welfare of the trees which may be growing upon the ground in such situations; and it is in cases of this nature that proprietors are anxious to be made aware of the best method for preserving shut drains in such situations.

It is a well-ascertained fact that the roots of all trees incline more to spread about the sides of drains than any other part of the soil they may grow in, whether those may be shut or open drains; and of this I have had ample proof in the case of covered drains in fields along the margin of woods. At Craigston, in

Aberdeenshire, a low-lying meadow of pasture land, which had been drained effectually, was observed to become gradually covered with rushes and several other plants which are found luxuriating upon damp soil: the cause of this was undiscovered for several years, until at last some particular parts of the meadow were covered with stagnated water the greater part of the winter months. The inefficiency of the drains was at once suspected as the cause of the water lying upon the surface; and as this was about the time that I went to be forester upon the place, Mr Urquhart, the proprietor, requested me to make an examination of the state of the drains in the meadow. On ascertaining from an old man upon the place, who had assisted in the making of the drains, the particular direction of the main or leading ones, I found that the principal drain ran along one side of the meadow, and the greater part of the smaller ones fell into it from the other side. This principal drain, into which the greater part of the small ones emptied, ran along the edge of a wood, there being merely a cart-road, of about eighteen feet width, between the main-drain along the side of the meadow and the edge of the wood, where several ash trees were growing. On being made aware of the position of this drain, my mind was at once made up as to the cause of the dampness in the meadow. I concluded that the roots of the ash-trees had penetrated into the drain and choked it up. After reporting this to Mr Urquhart, I had men immediately set to work to open up the drain, beginning at the lower end. We had not got far on with the opening of the drain, which was about five feet deep, until we found its conduit, which was made of stones, blocked up with the roots of the ash-trees; and so completely was it choked, that not a drop of water could pass along, the roots having the appearance of large balls of horse-hair rolled up confusedly into bundles. As soon as the main-drain was cleared as far as the roots of the ash-trees were, the drains were quite clear, and the water ran out from the field in every direction. And the main-drain being afterwards left open, the field soon became dry enough, although, indeed, the smaller drains had been considerably injured from the effect of the water having been pressed back upon them. Now, in this instance we have an example of the roots of trees proving injurious to drains at no less than five feet deep; and not only this—I have had occasion to observe the roots, both of ash and elm trees, coming through into a garden under the foundation of a wall in search of moisture, which they found in a drain about twelve yards from the wall in the garden. At Gogar House, near Edinburgh, I was witness to a case even more extraordinary than this. In the garden there, there was a well about fifteen feet deep, for supplying the garden with water, which was situated about thirty-five yards from the wall, and within the garden. On the outside of the garden wall there were several large elm-trees growing about the distance of ten yards from it: yet I observed roots of these trees lying upon the water in the well within the garden at eight feet from the surface; and we have thus an example of the roots of trees travelling nearly fifty yards in search of water, and which they got at the depth of eight feet from the surface. These two examples are, I think, sufficient to show that, in order to keep the roots of trees from injuring close drains, their depth will not avail; and this I observe, because I have heard several well-informed gentlemen state that they thought if drains were placed sufficiently deep, that the roots of trees will not prove injurious to them. But of the error of such an opinion I am perfectly assured, and could give more examples in order to prove this. Happening to meet with a very intelligent forester not long ago, and wishing to have, if possible, from him some information relative to the point in question, he mentioned that if drains were filled to the surface with stones, so as to cause a dry vacuum to exist in the ground, the roots of trees in the neighbourhood would not enter them. This I can by no means believe nor agree to; for it is well known that moisture will trickle along the side of a drain filled with stones; consequently the roots of trees in the neighbourhood of such drains will very readily seek in that direction, and will follow the moisture to the very bottom of the drain, however deep it may be made, seeing that air must be present among the stones and in the drain also; I accordingly at once condemn this plan as being without effect, and assume that some other method must be adopted. I am not aware of any description of drain which will act properly as such, and into which water will find its way, that will not be affected by roots of trees in its neighbourhood. I am well aware that where water, followed by air, will penetrate into the soil, the roots of the greater part of our hardwood trees will follow in search of food; and as the soil in the immediate vicinity of drains is in a more healthy and attractive state than any other part of the soil to which the roots may have access, they will, without doubt, congregate much in those parts: this is the cause of drains being injured by the roots of trees. Seeing that the roots of trees incline much to draw nourishment from drains, whether these may be open or covered, and knowing that the keeping of their roots from having access to such is injurious to their health, it is, in my opinion, bad management, in the growing of trees, to keep their roots from having that nourishment which nature has provided for them in the soil; therefore a plan must be adopted which will not hinder the roots of the trees from having access to the drains, but, on the contrary, one by which the roots may be encouraged, seeing that trees in such a condition are more healthy than in any other state.

The following is a plan which I beg to recommend to those who may have occasion to require shut drains among trees, which secures the safety of the drain, and allows the roots to have access to the water in it at the same time. This is the only rational method of proceeding, and will be understood by having reference to Fig. 48. The depth of this drain, from *a* to *b*, may be forty-eight inches, nine inches wide at bottom, and twelve at top. In filling this drain, I would first put in about eight inches of rough gravel into the bottom, as from *b* to *c*, above which I would lay a sole of slates, as at *c*, for the drain-tiles *d* to rest upon. Between each sole I would leave a vacancy of an inch, in order to allow the water to rise up into the tiles from the gravel. The tiles being laid, I would surround them with a puddle of good clay, three inches thick on each side, and the same on the top *e*.

Fig. 48.



This plan of making drains in ground occupied by trees, with the view of securing them from being easily injured by their roots, occurred to me on seeing an old drain opened in the garden at Craigton, near Glasgow. The garden there was a very old one; and on making some new drains in it, I came upon one of the description mentioned along the edge of one of the walks. When the walk had been made, some gravel had, no doubt, been flung into the drain to answer some purpose, and above the gravel a sole of flags had been put with an angular conduit of stones upon them. When I opened this drain in order to set the water from my new ones into it, I found the roots of the pear-trees, which were at least eighty years old, in excellent health, and in fibrous masses among the gravel under the stones; while among the stones above the gravel there were scarcely any roots whatever, but the drain was in good state.

Now, from what I have observed in the case of several old drains which I have had occasion to lift in gardens among apple and pear trees, the roots of which, it is well known, go down very deep, and travel a great length in search of food, I am perfectly persuaded that any drain made in the way I have pointed out will answer the purpose in question; and my reasons for being confident of this are—*first*, The roots of all trees in the vicinity of drains, when they come in contact with them, travel along the sides of the drains, following the descent of the water to the bottom. Now, when there is much gravel put into the bottom of a drain, the water will gather there from each side of the drain, and filter along through it; consequently the roots of the trees will lodge there also. Now, as this gravel would not in all cases be able to contain the quantity of water that might lodge in the drain, a provision is made for any extraordinary flow, by having the tile placed above upon soles set a little apart, in order to allow the water the more readily to ascend into the tile and find egress thus when it might attain this height. In general, however, the water would lodge at the bottom of the gravel, and seldom rise to the top; consequently the roots of the trees would not incline to rise upwards into the tiles, seeing there was no food for them there, nor any moisture to attract them. By placing a band of clay over the tile, the roots of trees are prevented from going downwards into the tiles; and before they can enter the drain, they must run to the bottom, where they are retained among the moisture. Supposing that the gravel were to become so full of the roots of the trees that the water could not pass through it, it could have a passage in the tiles which have been provided for this purpose; and as the water would still lie to a considerable extent among the gravel, the roots would be detained there, and would not increase upwards for a great length of time. In short, I am persuaded that such a drain, if well done, would keep good for a period of not less than fifty years, which is longer than many do with no roots of trees near them.

SECTION V.—SEASON OF THE YEAR BEST ADAPTED FOR PLANTING OPERATIONS.

Many practical planters have laid down that the months of March and April are the only proper months or season of the year adapted for planting operations. For my own part, I have planted extensively at all times between the months of November and April, both included, while the weather was fresh, and have had equal success from planting in all the different months. I may, however, say, that I always prefer the months of November and December for the planting of hardwood, and those of February, March, and April for the planting of the fir and pine tribes. If the ground intended to be planted be naturally dry, I put in both hardwood and firs in the months of November and December; but if naturally wet, and the drains only recently made, I delay planting such ground till the spring months.

Where planting operations are not carried on extensively, it may be an easy matter to delay till a certain time in the year, as the private opinion of the party intrusted with the work may suggest to him; but where three or four hundred acres are intended to be laid down in wood in one season, it is always found necessary to take advantage of the whole season from November till

April, whenever the weather will permit, in order to have the work all done before the growth of the plants begins, which is generally about the middle of April. Those who advocate planting in the spring months only, say, where planting operations are to be executed upon an extensive scale, "put on the greater number of men, and have the work done in the shorter time." But those who advise to put on a great number of men in order to have the planting of a piece of ground quickly accomplished, are not worthy of the name of practical foresters, and cannot have had much experience in the results of such operations as performed at different times and under different circumstances.

Every experienced planter who has had occasion to employ a considerable number of men, in order to get through his work as fast as possible, is aware of the difficulty there is in getting a large number of labourers, from any neighbourhood, properly qualified to conduct the operation well, and as it ought to be done. Common country labourers are seldom acquainted with planting operations, and require at least a few weeks' practice before they can be safely trusted; therefore it is, that when a number of inexperienced men are brought together to plant, the work is always badly done; and, consequently, is seldom attended with success in the end. In planting extensively, my method has always been, to prolong the season of operations, and with a few experienced men to do the work in a proper manner; and by so doing, I have generally been very successful.

In reading the above assertion, many may be inclined to say, that if the weather were to prove unfavourable, it would be impossible to get through an extensive piece of planting with a few men in one season; and at first sight there appears, indeed, some reason in this objection; but I answer, that very much depends upon the proper management of the work in hand. In planting extensively, with a few good hands, I do not generally begin at one end or side of the plantation, and make good all the ground as the work proceeds, as is the custom with many planters who employ a great number of men at once. In almost every piece of ground laid out for an extensive new plantation, there is generally a variety of soils and situations in it; and of this variety of soils and situations I always take the advantage thus:—When the weather is fine and fresh, I set the men to plant upon the most exposed sides or parts of the ground, and also to plant any piece naturally wet; and when the weather is cold or wet, I set them to plant upon the most sheltered parts, or where the ground is naturally dry; while in the case of frost coming on, I always reserve for this the making of pits for hardwood, which can be done during frost, and is still carrying on the work, and at the same time keeping the workmen in employment. In short, by conducting planting operations in the manner above referred to, ten good experienced men will do far more work in four months than twenty inexperienced ones in two months; and, what is of more importance, the work by the few hands will be much better done, and prove far more satisfactory in the end. Not long ago I had an interview with an old forester of fifty years' extensive and successful practice, who, while conversing with me upon the point now under consideration, told me, that his rules for planting, for the last twenty years, had been, to plant dry ground in autumn, either with hardwood or firs, and to plant ground naturally wet in spring; also to plant dry ground in wet weather, and ground naturally damp in dry weather: to the advantages of which method I can myself bear testimony from my own experience; and any planter who will go to work upon these principles, will find the happy results arising therefrom.

SECTION VI.—DISTRIBUTION OF YOUNG TREES SO AS TO SUIT DIFFERENT SITUATIONS IN A NEW PLANTATION.

Next to the draining of the soil, nothing is of more importance, in order to insure the future welfare of any young plantation, than the proper adaptation of the different sorts of trees to the various soils and situations therein. This is a point in arboriculture which has all along been too little attended to by planters in general; and the not attending to this point is in a great measure the reason that we at the present day see very many of our home plantations in Scotland mere eye-sores rather than ornaments. I have often regretted very much to see larch and Scots firs of thirty years' standing in an unhealthy and dying state; where if beech, or any other of the native sorts of hardwood trees, had been planted, they would undoubtedly have proved both useful and ornamental: and again, as often have I seen stunted-looking hardwood trees striving for existence, where if firs or pines had been planted instead, all would have been well; which at once shows the low state of arboricultural knowledge among us. Upon a little reflection, it must appear evident to every inquiring man interested in the welfare of our home plantations, that a forester, in order to be one profitably, must be perfectly acquainted with the natural habits, constitution, and peculiarities of every tree that he attempts to cultivate; for if he is not so, the ultimate result of his work must in a great measure be left to chance. I by no means wish to say anything lightly of the qualifications of foresters; but, at the same time, I feel in duty bound to say the truth, and that is, that taking foresters as a body of men, there is extremely little of useful practical information among them; and in order to prove the truth of this assertion, I may say, that foresters in general are not so able to cultivate the trees which grow under their notice, upon natural principles, as we find gardeners do the plants under their notice. And, admitting this, what is the reason of such a deficiency in their professional character? So far as I have been able to trace the cause of this defect among my brethren, I am led to think that it is the want of having proper sources of information upon their business. Gardeners have been assisted by the advice of many able and scientific men, who have written much for their instruction; while the forester has had very little indeed written for his information. It has often been observed, that gardeners make better farmers and foresters than any other class of men; and it is the truth; but the reason is, that they have, or rather are obliged to have, a closer acquaintance with the nature of plants than any other class of men. A gardener cultivates several thousand of distinct species of plants; yet he is generally able to adapt each species to that sort of soil which is found to be best suited to its nature.

The gardener, in cultivating a *heath*, for instance, gives it a light, sharp, mossy soil and a cool dry situation; he does so because he knows that the heath, in its native country, is an inhabitant of a light dry soil, and hilly or mountainous situation: and so on with every other plant he cultivates. Now, the principal thing to be observed here is, that the gardener who cultivates his plants with the most success is he who can by his art give his plants most nearly that soil and situation which is found to be their condition in a state of nature; which is just the point that the forester ought to attend to also.

Foresters, knowing that trees in the natural forest develop themselves to the greatest magnitude there, ought to make themselves aware of the particular circumstances which induce or assist that full development; and upon knowing the peculiar circumstances attending the full development of each species in the natural state, they ought to make their practice agree therewith; which is the only way that any man can arrive at perfection as a forester.

Before entering into detail upon the habits and peculiarities of the various species of our forest trees, which will be done in the following sections of the present chapter, it will be of importance to take a view of their geographical distribution over the continent of Europe. Such a statement I know to be necessary in order to a right understanding of the distribution of young trees in new plantations of any considerable extent, and will also prepare the way for a better understanding of the following sections of this chapter.

Indeed, every forester ought to look upon the estate of the woodlands on which he may have the management, with the eye of a geographer. He ought to consider it as a continent in itself: each plantation may be looked upon as a separate kingdom according to its altitude; and each of these, again, may, in the mind of the forester, be divided into provinces according to aspect or altitude, and planted with those trees which are known from nature's own rules to be the best adapted for it. This I in all cases do myself in the laying out and planting of ground with forest trees; and as I am aware that such a method of procedure is agreeable to nature, I think it of the greatest consequence in bringing forward healthy plantations: on which account I shall here lay down the rules by which I conduct myself in the case of suiting the young trees to the different situations in one or more new plantations.

All our forest trees of known worth are natives of the temperate or frigid zones. The temperate zones are inhabited by the various species of our hardwood trees, and in the extremities of the temperate zones, and under those of the frigid, we find the different species of the pine, fir, birch, and alder. The trees natural to each of these zones are not, however, always bounded by a certain degree of latitude; for the temperature of any given place does not always depend upon its distance from the equator. Various causes have a tendency to modify the heat both of the earth and the air; such as large extent of continent, nearness to the sea, and locality as regards the east or west sides of continents or islands. The height of any given place above the nearest sea-coast also greatly affects its temperature. Elevated situations are in all cases colder than others under the same latitude near the level of the sea; and the higher that we ascend upon any mountain or hill, the lower the temperature becomes, till at last we find its summit covered with snow. This may occur upon any part of the surface of the globe, provided the mountain rise high enough; and from this we see that a change of climate does not always depend upon the degree of latitude we may be in, much depending upon the elevation of the ground; consequently, in all these places a change of vegetation takes place. For example, about the base of the Pyrenees the vine and the oak grow luxuriantly; and on going a little way up those mountains, these disappear altogether; but the pine, the birch, and the alder are found. On proceeding still further up, the pines disappear also, and nothing is found in the shape of vegetation but dwarfish willows, heath, and mosses. And the same thing is observable in our own country, although not to the same extent. In all the lowland countries of Scotland, the oak, ash, elm, and sycamore thrive well, while upon the high mountainous districts of the northern counties they will not succeed;

at this height the fir and the pine tribes are found in excellent state; while there is an altitude beyond which the fir and pine will not grow to useful size, and in their place dwarfish birch, heath, and moss are to be seen. There is one point relative to the altitude of a place which is worthy of being noticed here; and that is—supposing two situations, each one thousand feet above the level of the sea: if the one situation is the top of a hill, and the other a flat table-land of some extent, the situation upon the top of the hill will be much colder than the other, although both are of the same height; and supposing the soil to be of equal quality upon both, trees would succeed much better on the flat table-land than they would do upon the top of the hill, although the one is as high as the other:—all this pointing out that the intelligent forester must not only take into consideration the altitude of a situation before planting upon it, but also the very shape of the surface of the ground, in order to succeed aright; or if he do not, he will be certain to commit errors in his profession. And as I have already said that much of the forester's success depends upon properly adapting the trees in a plantation to the different situations in it, the above observations are necessary to be kept in view.

The healthy growth of trees is also much affected by the peculiar locality of the part of the country in which they grow; for instance, in Norway, on the coast of the Atlantic ocean, the oak is found growing in latitude sixty-three degrees; while in the eastern parts of Europe, on the confines of Asia, it will not grow in latitude fifty-seven degrees; this showing out that the west of the continent of Europe is much milder than it is inland, and also that the sea-coast is much more temperate than a country inland upon the same latitude. Again, relative to the oak—in Asiatic Russia, upon the river Argoun, in the same latitude as London, the oak is said scarcely to exist from the extreme coldness of the country; proving the mildness of a maritime country such as Britain, and its better adaptation for growing trees as compared with the extensive regions on the north of the Asiatic continent, and that the west of Europe is much milder than the continent of Asia under the same latitude.

It is generally remarked that the west side of an island or continent is milder than its east side; but this does not always hold good in regard to our own island; for it is well known that the east coast of Britain is warmer than the west. The west coast may indeed be reckoned more equal in temperature throughout the year, but our principal corn-growing counties are situated upon the east side of the island, from the Lothians in Scotland to Kent in England. The east side of Ireland is much warmer than the west of Scotland which is opposite to it; and this is occasioned by the storms from the Atlantic beating upon the west side of Scotland; while the east side of Ireland is sheltered from them. Upon the east side of Ireland, about Donaghadee, the most tender of our forest trees grow with great luxuriance; while upon the west coast of Scotland, about Portpatrick, which is only eighteen miles distant from the latter place in Ireland, not a forest tree of any consequence can be made to grow for a considerable distance back from the the sea-shore; which proves that even in places of the same altitude, in planting trees upon them, the kinds to be chosen must also depend upon *aspect* and exposure to storm from prevailing winds.

With regard to the Pine and Fir tribes: In Norway and Lapland the Scots pine is said to attain the height of sixty feet in latitude seventy degrees; and Von Buch says, that in Tornea, at the head of the Gulf of Bothnia, the birches are *magnificent*. Now, let us compare this with the northern parts of Britain. In the Orkney islands, about latitude sixty degrees, scarcely anything having the form of a tree is to be met with but the hazel, which bears the winds of the Atlantic better than either the Scots pine or the spruce; this is occasioned by the extraordinary rush of storm passing along the Atlantic among the northern islands, which prevents trees from growing to any useful size. On the other hand, it is very remarkable that the spruce fir, in Sweden, is found eight degrees farther north than the hazel, and this occurs on the coast of the Baltic.

In Scotland we have extensive natural forests of the Scots pine, but none of the spruce fir, which at once points out to us that the spruce fir in our country is not nearly so hardy as the Scots pine;

and in order to grow it to advantage, it must be planted in a much more sheltered situation than the Scots pine requires. Now, this is the more remarkable, when we take into notice that there are forests of the spruce fir in Norway as far north as latitude sixty-seven degrees, which is much colder than the climate of Scotland; but this can be accounted for by the extreme humidity of the climate. In Norway the spruce fir is found at an elevation of two thousand feet, and the silver fir at an elevation of nearly three thousand feet, pointing out to us that the silver fir is more hardy in Norway than the spruce fir.

Again, in Norway and Sweden it is said that the larch is not found at all in a state of nature—just as the spruce fir is not found with us; yet we find the larch and spruce in Siberia, much farther north than either the Scots pine or the birch, which is a remarkable characteristic of the country in the north of the Russian empire, and points out the larch as being more hardy than even the Scots pine in inland districts.

In Asiatic Russia, the tree found farthest north, upon the Arctic ocean, is the larch; next to it, in progressing southward, is the spruce fir; next the Scots pine; and still progressing south, we meet successively the lime, the ash, the oak, the beech, the elm, and the poplar.

Now, if we will apply the above observations as to the natural distribution of our forest trees over the continent of Europe and Asia, we will at once see that the same natural laws, to a great extent, guide their development in our island; at least in so far as our experience leads us to form a correct judgment in the case of our artificial forests; with, of course, different modifications, according to the aspect of different parts of the country upon which they are planted. In many high-lying inland parts of Britain, the larch is well known to be more hardy than the Scots pine; while, again, in the northern parts, bordering more upon the sea, the Scots pine is found more hardy than the larch. The spruce, again, in Britain is more tender than either the Scots pine or the larch; but in this it is not so much affected by the degree of cold as by the situation it may be planted in; for example, it will bear more cold in a flat part of the country than it could do upon a high part, where it would be exposed to winds and sudden storms; and that is exactly its nature in the countries in which it is found growing natural upon the continent. The oak is also found to succeed much better in a moderately level part of the country than when exposed to sudden and frequent storms of wind: it is like the spruce fir, not so much hurt by any degree of cold as by exposure to high winds: therefore, in general, we are led to remark, that the more equal and level that any part of a country is, the farther north will the spruce fir and hardwood trees be found to succeed; and the more mountainous that any part of a country is, just in the same proportion will these trees be checked in extending northward. At the same time, however, in making calculations of this nature, it must be kept in view that the air upon any mountain one thousand feet above the level of the sea will, in the neighbourhood of the sea, be much more temperate than a height of one thousand feet upon a mountain far inland and away from the influence of the sea.

Now, what I desire to draw from these observations relative to the geographical distribution of our forest trees is, that a forester, in planting any part of an estate, must keep all these peculiarities of the different kinds of trees in view, and plant that sort of tree which is found to answer according to *altitude* or *aspect*. As I have already said, the forester should view the estate he may have to manage as a continent in miniature, and manage all his wood operations accordingly; planting firs and pines upon all the highest parts, and hardwood in all the lower parts: and not only should he view the whole estate in this light, he should view any single plantation he may have to make in the light of a kingdom, and plant the most prominent parts with pines, and all the lower parts, having a good soil, with the more valuable sorts of hardwood. As this is according to nature, it not only gives the best possible effect to the plantation as an object, but it adds also considerably to the healthy growth of the whole as a plantation; for when heights are planted with firs, the hardwood under them are sheltered by them; and from being sheltered they grow quicker, and come sooner to answer the end in view.

SECTION VII.—DESCRIPTIVE CHARACTER OF THE ELM: ITS HABIT AND PECULIARITIES.

The Elm *(Ulmus)* belongs to the natural order ULMACEÆ; and according to the LINN. SYSTEM, to *Pentandria Digynia.*

There are several species of the Elm, from the dwarf sort, *Ulmus Pumela*, a native of Siberia, which grows only two feet high, to the *Ulmus Campestris*, or English elm, which often attains the height of one hundred feet. There are also several species, natives of North America, which are timber trees of an inferior size, and are not cultivated in Britain for the sake of their timber, but merely kept in the shrubberies as ornamental plants.

Sir J. E. Smith enumerates five species of our British elms, namely, *U. Campestris*, *U. Tuberosa*, *U. Major*, *U. Montana*, and *U. Globra.* But as many botanists differ upon this point, it may be very proper to refer them to two distinct species—*Ulmus Campestris*, and *U. Montana;* the rest being merely varieties of these two distinct species. Therefore we will commence our observations with the *U. Campestris*, or English elm.

It is a timber tree of the first magnitude, and supposed by some a native of England, where it is found in great perfection, adorning the parks and lawns of proprietors. It is also a very common hedgerow timber in many parts of England; as, for instance, in the valley of the Severn, where it may be seen in great perfection. It is generally admitted to be one of the tallest and finest of our European timber trees for park scenery, and lives to a considerable age. There are a number of them upon the park at Arniston considerably above one hundred years of age, and some of them containing above one hundred and fifty cubic feet of timber. However, it appears to me that the most profitable age of the tree for timber is from seventy to eighty years: the wood of the tree is then in its best condition, and after that age it will not increase materially in the bulk of its timber. The English elm is of a tall, straight habit of growth, generally maintaining that habit to the very top of the tree, and by no means apt to spread out into large limbs, as is the case with the *U. Montana;* and this constitutes its fine effect when grown singly upon a lawn. However, I have seen instances of this tree spreading very much to branches, particularly if it be grown upon an exposed situation; and I may refer to one upon the lawn at Arniston, which contains nearly two hundred cubic feet of timber, which rises with a bole only about eight feet high and four feet in diameter, and then diverges off into branches of large dimensions, making a tree of most picturesque beauty and singular appearance, but out of character of the general habit of the species, and more resembling a massive oak at a distance than an elm. The English elm is a rapid-growing tree, and frequently reaches the height of eighty feet in as many years. I am surprised that this tree is so little cultivated in Scotland; indeed there exists a strong prejudice against the quality of its wood, which in Scotland is reckoned inferior and worthless as compared with the Scots elm, or *U. Montana;* and, for many purposes, this must be admitted to be the case. This year (1848) I sold some of it in Edinburgh, where I could not get more than 1s. 6d. per foot for it; while for Scots elm of the same age I readily got 2s. 3d. per foot. The reason that wood-merchants give for the low value set upon the wood of this tree is, that it is what they term *cross-grained*—or, in other words, it is not tough in longitudinal fibre: this is decidedly the case as compared with the Scots elm, and indeed constitutes the most striking difference between the wood of the two trees; that is, the wood of the English elm is particularly strong in what is termed lateral fibre, but deficient in what is termed longitudinal adhesion of fibre; while the Scots elm is the contrary; and in this peculiarity the Scots elm resembles the quality of the wood of the ash more than any other tree, being easily split up longitudinally. During my own experience as a forester in Scotland, I have never been able to sell this sort of wood to any extent, although I have frequently had it for sale; the only purpose to which it is applied in Scotland being in the making of blocks, and naves for wheels. From its great length it is very frequently used in England for the keels of large ships, as well as for country purposes in general; and, indeed, there it is a great favourite for its timber, as well as for its ornamental appearance.

The English elm is easily distinguished from the Scots by having the young shoots of a slender form, and those of the last year springing alternately upon each side of the preceding young shoots. See Fig. 49. The leaves also all spring from the young shoots in an alternate manner; and where these are off in the winter season, the weak, slender, and regular appearance of the young wood contrasts beautifully with the rugged appearance of the bark upon the old wood, and gives the branches altogether a light and airy appearance. The leaves (Fig. 50) are small as compared with those of the *U. Montana:* they are doubly toothed or serrated, rough and hard to the touch, and of a beautiful dark-green colour, and unequal at the base, which is a particular characteristic of all the different species of the elm. It is very seldom that this tree ripens its seeds in Britain, that occurring only in favourable seasons. For my own part, I have never seen it ripen its seeds in Scotland, which, to me at least, is an evident proof of its not being a true native of Britain, as many suppose. As the English elm very seldom ripens its seeds in Britain, the tree is propagated by suckers from the roots of old trees, which are had in

Fig. 49.

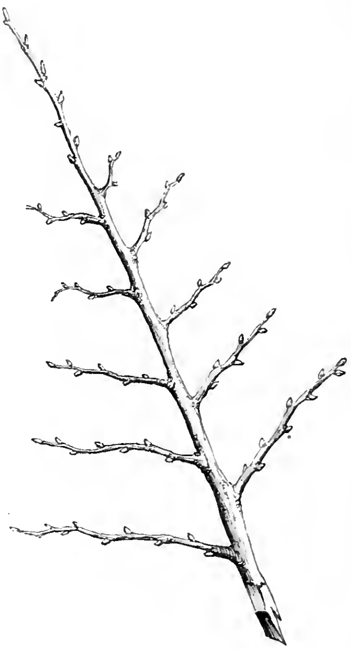
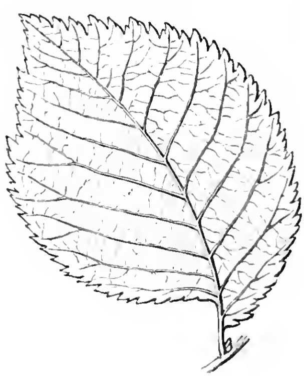


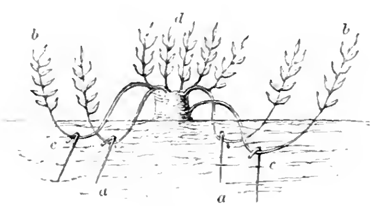
Fig. 50.



abundance, or by layers, which is the method by which the best plants are procured, and is the plan adopted in all public nurseries for the propagating of this tree. And in this place it may be proper to show how the work is done.

The process of layering consists in having, first, a piece of ground planted at about six feet distance with plants of the English elm, or any other tree that it may be desirable to propagate in this way. When these have stood for two, or perhaps three years, in order to gain sufficient strength, they are cut over to within three or four eyes of the ground, in the same manner as a bed of *osiers* when the eyes have pushed out shoots of one year's growth. They are in the autumn, when these shoots are ripe, fit for layering. In layering the shoots which are meant to become young plants or trees, all the ground round about the plants is finely dug, and made perfectly clean from weeds of every description, all stones being also taken out. When the ground has been thus prepared, the young shoots are bent down regularly round the parent stool (see Fig. 51) into the earth, and are kept in their place by small wooden pegs, *a a*, and covered with soil about four inches deep at the part bent into the ground. The top part of each shoot, *b b*, is turned up in an upright direction out of the soil, and in a few months the part which is buried in the soil, *c c*, takes root, when of course each shoot becomes a perfect plant in itself, and may be removed in the autumn following with all the fibrous roots attached, when they are planted out into nursery lines in order to gain more strength before being put out into the forest ground. Great care must be observed in cutting away the young and newly-rooted plants from the parent stem; and before the spade is put into the ground in order to loosen their roots from the soil, they should all be cut away from the parent by using a sharp knife, taking care not to pull up the shoot in the act of cutting. When the young plants have been all taken away, the stools should have all the

Fig. 51.



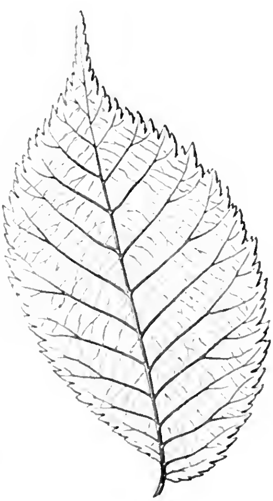
stumps of the branches which were cut off taken away, and young shoots will proceed from the cut parts the following spring, which again will answer for layers in the autumn, as at *d:* this process goes on successively; each summer's shoots which rise upwards are in the autumn laid down in order to become new plants; and while these are in the act of making roots, the parent stool is again employed sending up a new supply of shoots to succeed them. A particular point to attend to in the raising of young trees by layers is to keep the ground particularly clear of weeds; and when a severe drought sets in, the ground should be liberally watered, in order to encourage the rooting of the young plants. This tree, on account of not ripening its seeds in this country, is always sold at a high price as compared with our other forest trees; which is a great reason why it has never been extensively planted in Scotland, even laying aside the prejudice that exists as to the quality of its wood. It is seldom introduced as a forest tree into any of our profitable plantations in Scotland; for although it is of an upright habit, and would answer well as a nurse among others, its place in that respect is better and more profitably occupied by the larch, which is a wood much sought after, and which will pay the planter better than any other tree when used as a temporary nurse.

The English elm is not a tree that requires a rich soil to bring it to a large size. I have seen them of considerable dimensions upon a very light gravelly soil; and I have also seen good trees of this species upon a strong clay; but a strong sandy loam appears to be the soil in which the tree attains its greatest dimensions.

The *Ulmus Montana*, SCOTS OR WYCH ELM, is without dispute a native of Scotland, and, indeed, of Britain generally. This tree is found delighting in deep glens, among decaying rocks, by the sides of water-courses, where it forms trees of the first magnitude. This tree, when left to itself in an open park or lawn, forms one of the most picturesque and beautiful imaginable. It may, indeed, often be surpassed by its neighbour the English elm, in regard to its height and cleanness of trunk; but it cannot be surpassed in the general effect of its outline. It in all cases stands unrivalled upon the lawn, its appearance being altogether natural, light, and easy. The English elm has a stiff, unbending outline: the Scots elm is the opposite of this.

When not confined by its neighbours, the Scots elm forms a large-headed spreading tree, having its limbs strong and diverging, which gives it a magnificent appearance among other trees of a more stiff character; and when the tree has arrived at full maturity, the branches, from their great weight, incline to hang down in a drooping position at the extremities, forming rich festoons when in full life. This is the habit of the tree when grown upon an open park, with free air to develop its branches; but in such a position it seldom attains to its greatest height and magnitude as a timber tree. When grown in the forest, and where it has not so much free room to extend its side branches, its diverging habit is checked; but in such a position we almost always find it contains the greatest quantity of available timber, and forms a tree of first-rate magnitude. There is one particularly good tree of this sort upon the lawn behind Arniston house, which has arrived at full maturity, and has been rather drawn up in its growing state among other trees. It is eighty feet high, and three feet four inches diameter, six feet from the ground; and contains about two hundred cubic feet of timber.

Fig. 52.



The Scots elm is easily distinguished from the English by the greater size of its leaves: these are what is termed by botanists *broadly elliptical*, with a longer point, and are more deeply *serrated* than in the other species: the upper surface is also rough with small hairy *tubercles*, and the under surface *downy* (see Fig. 52.) The size of the leaves of this tree vary much according to the healthy state of the plant. I have very frequently seen them seven inches long from base to apex; and this occurred upon trees growing in a deep rich loam; but in general cases the leaves are not more than from three to four inches long, and, when handled, feel rough and rather bristly.

The young shoots are much stronger, and altogether more massive than those of the English elm, (see Fig. 53,) and are slightly downy. Another distinguishing character of the Scots elm is, its producing no suckers from its roots, which all the varieties of the English elm constantly do; by this it is easily known, independent of any other peculiarity. However, we often see trees of this species send up shoots from the junction of the bole and the roots; but these are not suckers, properly speaking. Suckers are shoots which are emitted from the roots at a distance from the bole of the tree; and I merely advert to this in order that my meaning may not be misunderstood. Those trees of the Scots elm which have shoots rising from the junction of the roots and bole, are generally in a bad state of health; such shoots are, in fact, a symptom of disease.

Fig. 53.

In Scotland the wood of this tree is much sought after for all country purposes; such as cart-trams, plough-beams, cart-naves, wheel-barrow and cart framing, &c. &c.; indeed, there is scarcely a purpose to which ash is generally applicable, for which elm is not used instead when that wood cannot be got conveniently; and for these it is well adapted from the toughness of its longitudinal fibre. At present, while so much handle wood is daily in demand for railway purposes, I have sold very much of it in the form of pick handles, for which purpose it is reckoned equally as good and as durable as the ash; except that, from the wood being hard and closer in the grain than the ash, the workmen complain of it, when made into handles, as being bad for their hands, the friction of the wood causing them to blister; but I have never heard any complaints from the contractors as to the wood not answering well as a handle in place of ash. When converted into this purpose at our saw-mill, we get 3s. 6d. per cubic foot for the wood, which, let it be understood, is only young thinnings of six inches diameter, cut up roughly at the mill for the purpose. The Scots elm, from the close adhesion of its longitudinal fibre, is well calculated for any purpose where a severe cross strain is necessary, such as beams upon which a great weight may have to be placed; and indeed it is often used for different purposes in ship-building, particularly for the floor timbers: but as a wood where long endurance may be required, it is by no means adapted; and however good it may be as a tough wood for many country purposes, it is by no means one that will last long, particularly if exposed to the vicissitudes of the weather. This deficiency of the Scots elm I have often had occasion to observe, more particularly in the case of gate-posts; and in this respect I am, from experience, now aware that it is much inferior to the *U. Campestris*, or English elm, taking the two at the same age. Again, as a stob for a fence, I have found the Scots elm, in its young state, very little superior to the beech, the wood of which is proverbially of short duration when much exposed. Still, however, the Scots elm is, when of good age, a very useful wood, and adapted for a great variety of purposes; and when used for a purpose where the wood can be kept painted, it will last a long time; but even when so treated, I am convinced that it is inferior to *U. Campestris.* As I am aware that there are many who say that the *U. Montana*, or Scots elm, is in every respect superior to the *U. Campestris*, or English elm, I may state farther, that the quality of both depends to a great degree upon the nature of the soil and situation upon which they may be grown.

When either of them is grown in a low-lying, sheltered situation, and upon a heavy, yet dry and deep soil, they attain their greatest bulk as timber; but then the wood of trees grown in such a condition is generally brittle, and is soon affected by *rot;* in fact, few elm trees grown in such a condition are found sound in the heart if they have attained any considerable age. Where the elm is found growing in a low sheltered situation, and upon a light, deep, and rather moist soil, the tree grows very rapidly, and attains its greatest perfection as a tall, spreading, ornamental tree; but under such conditions it seldom lives long, and generally is found to die suddenly when rapidly grown, unless, indeed, its roots may get into the banks of a water stream: in this case it will thrive well and live long in almost any soil, provided that there is no stagnant water about the roots. The Scots elm, in order to have it in greatest perfection as a timber tree, requires to be grown in a soil where it can have a constant supply of fresh and pure water percolating through the soil: such is the case upon the steep banks of rivers; and if the tree has been grown up to a large size under these circumstances, and the water be suddenly drained off the ground upon which it is growing, the tree will immediately fall into bad health, and will very possibly die suddenly; this I have frequently observed.

Another peculiar circumstance attending elm trees grown in a sheltered place and upon a light soil, is, that they are generally found what is termed "shaken;" that is, the heart wood of the tree is all split into longitudinal pieces; consequently the wood of such trees is of little value. In situations twelve hundred feet above the level of the sea, I have seen good elms growing upon a light and rather sandy soil; but at the same height, when the soil was inclined to clay, I have always seen the elm assume a low, spreading habit, and very apt to become knotty, and of little value as regards its timber.

The circumstances which appear most favourable to the healthy growth of the Scots elm are, a light loamy soil upon a dry bottom, rather deficient in vegetable matter, which would produce too keen an excitement in the growth of the tree, a free exposure to the air, and a situation upon a slope rather than upon a level, where a regular supply of moisture is likely to be. Generally speaking, the English and Scots elms will both thrive nearly alike under the same circumstances; but the Scots elm is more inclined to a light soil than the English is. The Scots elm is not a tree that should be planted among other hardwood trees in a forest, unless, indeed, it may be meant to stand as the ultimate crop. From its spreading habit it is very apt to hurt other valuable trees; therefore, in planting this tree in any plantation, either plant it in a mass by itself, with firs to act as nurses for a time; or if it should be wished otherwise, for the sake of young thinnings, plant it but sparingly among others, and cut it away timely as the others advance.

The Scots elm is propagated from seed, which is found very plentifully upon old trees from the middle of May to the beginning of June. The seed being very light, and easily blown about by the wind when fallen, it should be gathered by the hands from the tree, and not allowed to fall; and when it is gathered, it should be sown immediately, as it will not keep long. It should be sown in beds in the nursery, upon a fine light soil, and should not be covered to a greater depth than half an inch. The seeds spring up very freely and quickly, and will be ready for planting out into nursery rows in the following spring: in planting them into rows, there may be twenty inches between each, and the plants may stand in the rows about four inches one from another. When they have stood two years, they will be ready for the forest ground.

SECTION VIII.—THE BEECH: ITS HABIT AND PECULIARITIES.

The beech (*Fagus*) belongs to the natural order CUPULIFERÆ; and according to the Linnæan system, to *Monœcia Polyandria*. There are several distinct species of the beech, a few of which are very ornamental in our shrubberies—such as the purple, golden, and copper leaved varieties; but all these are merely for ornament; and the only species which is worthy of our notice here, is the common beech, or *Fagus Sylvatica*, which is generally reckoned a native of Britain; and, indeed, it is found growing naturally in many old plantations, particularly in Dorsetshire and Berkshire in England. In Scotland, its being indigenous is doubtful; but in old woods in Scotland where it has been planted, young trees rise up most freely. Large plantations of it have been made by the Earl of Fife in Morayshire, where it grows most luxuriantly. The beech is one of the most hardy of all our hardwood forest trees. In Devonshire, which is much exposed to severe west winds, no tree appears to stand better, and that in high exposed situations upon a poor thin gravelly soil.

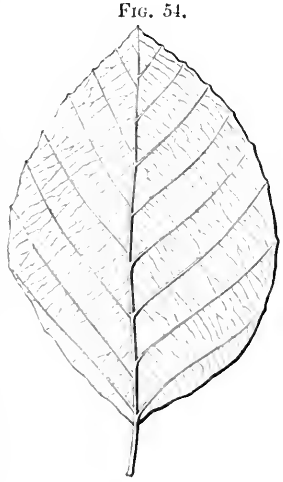
In many high-lying parts of Scotland, where even the Scots pine has failed upon a thin gravelly soil, I have seen the beech grow, and make an excellent shelter, and that near the sea-shore; which points out that it makes an excellent tree for planting along the sea-shore as a protection for the more valuable forest trees.

Besides the useful property of being a hardy tree, the beech is also an extremely ornamental tree, and is often found of dimensions far surpassing the oak. It rises generally with a clean stem or bole, with massy branches spreading almost horizontally; and when in full leaf, the tree has altogether a light and airy appearance, contrasting beautifully with the sycamore or horse-chesnut, which have a heavy sombre appearance. In duration as a tree, the beech is much inferior to the oak, sycamore, or chesnut; but in this respect it may be classed with the elm and ash; and I could point out many beech trees about two hundred years old still in good health. Upon the estate of Arniston there are now growing many fine old beech trees of large dimensions, several containing above two hundred cubic feet of timber.

The beech is not considered a valuable timber tree, although it has a strong massive appearance. The wood is very brittle and short-grained, and not well adapted for purposes where strength and durability are required. At one time the wood of the beech was much used for machinery, particularly by millwrights; and, indeed, a good deal of it is used by them still for cogs to water-wheels. But since the extensive use of iron in all machinery, the beech is little used for that purpose; and seeing that it is not a wood in demand, it cannot be recommended as a profitable forest tree. The wood of the beech, when in a young state, is proverbially of short duration. I have frequently used it for paling stobs, and found such not to last above two years; therefore it should never be planted as a nurse, to be cut down as thinnings in a young state, for no tree is then less profitable. However, the beech wood, when kept constantly wet, is remarkably durable; as is the case when it is made into water-wheels; but if it is kept constantly dry, as in the case of roofing in a house, it lasts but a short time as compared with many other sorts of timber.

Until within three or four years past I could not sell, in our neighbourhood, above from two to three hundred feet of beech in a whole year, and that at 1s. per foot; but since railway operations have been carried on to a considerable extent, I have been able to sell several thousand feet of beech per annum, at 1s. 6d. per foot. Railway contractors use this wood for making their waggons and temporary sleepers, for which it answers very well. Beech is yet much used for the following purposes:—Common bedsteads, panels of carriages, carpenters' planes, masons' mells, wooden bowls, granary shovels, and many small articles in turnery. It also makes excellent firewood. Upon the estate of Arniston I have made a considerable quantity of charcoal from the beech, which I sell to colour manufacturers. The tops or smaller branches are also much sought after for the curing of herrings; and I may also observe, that as a sole for drain-tiles in moss land, nothing is so suitable, it being extremely durable in moss.

Fig. 54.



The beech is a tree easily known from any other in the forest by its smooth bark and light-green silky leaves. The leaves are what is termed *ovate* and *obsoletely serrated*, being fringed on the margin. (See Fig. 54.) The beech in its young state keeps its leaves all winter, and they do not fall off till the sap rise in the tree in the month of April, when they are again replaced by the new leaves. I have observed that young beech trees generally retain their leaves all winter till they are from twenty to twenty-five years old, when they drop them in the winter in the same manner as any other deciduous tree; but if the beech be kept cut down in the form of a hedge, it retains its leaves all winter, so long as the plant exists in a healthy state. I could point out beech hedges fifty years old, which retain their leaves the whole year, while trees of the same species, and of the same age, and in the same neighbourhood, lose them; — a remarkable feature in the nature of the tree, and one which characterises the beech as the best of all plants for a hedge where shelter is the object.

The young shoots of the beech are numerous upon the larger branches, and are rather slender in appearance, and of a somewhat brittle texture. (See Fig. 55.)

Fig. 55.

The beech is of a slow growth for the first three or four years after being planted, and is indeed rather of a shy nature to come away at first, unless, indeed, the soil be particularly dry and favourable for it; and if there be much damp retained in the soil into which the beech is planted, the young trees will in most cases die altogether; but where the soil is dry and open, as soon as the plants have got their roots established in the soil, they grow with extraordinary rapidity, and soon become trees of considerable dimensions. The beech is propagated from the seeds, or *nuts*, which are well known: these are gathered when they fall from the trees in the months of October and November. Some foresters sow the nuts immediately in beds when they are gathered; but, in my opinion, this is a bad plan,—at least I have found it to be so; for when sown in the month of November, and lying in the earth all winter, the seeds are exposed to the attacks of mice and other vermin, which thin them very much, and of course cause a great deal of extra trouble in preserving them unhurt. My method is, to mix the seed, when gathered, with a quantity of dry sand, previously prepared, and allow it to lie in that state till the month of March, when it may be sown upon a light soil, and covered with about an inch of earth; and in this state the seeds will vegetate quickly, and be free from injury from vermin. The plants require to remain two years in the seed-bed before being transplanted out into nursery rows, which may be done any time from November to March when the weather is open. The distance between the rows in the nursery may be about two feet, and the plants may be put in about four inches one from another, if they are to be raised for hedges; but if meant for the forest ground, they should have six inches one from another, in order to make them more hardy and robust to stand upon an exposed situation. When the plants have stood one year in the nursery rows, they will answer well for mixing among thorns in a young hedge; but if intended for forest trees, they will require to remain in the nursery rows at least two years, by which time they will be well rooted and strong bushy plants.

The beech is a tree which, from its accommodating habits, is well fitted for growing in a forest among others: but, on account of the little value now set upon its wood, it is by no means proper that it should be extensively introduced among other more valuable trees, particularly if the soil be adapted for others of more value than it. However, few trees suffer less from bad management than the beech: although it may have been overburdened and crushed down among other trees, yet, when it is once relieved, it will shoot up again, and in a few years make good its position among its neighbours.

In modern forestry the beech is not a tree for a permanent crop, unless, indeed, upon a poor soil where nothing more valuable would grow: where the beech would at best make a respectable cover or shelter, and as a nurse, its place is always better occupied by larch, Scots pines, or spruce firs.

I have frequently had occasion to observe upon poor, thin, sandy soils, and upon a high exposed situation, where, indeed, scarcely any other hardwood tree could make any respectable progress, that the beech had attained a fair size of timber; and in such situations the firs, which had been intended to nurse them, had died out, the soil being almost a pure sand or gravel: this points out that the beech is more to be depended upon than even the fir on a poor soil and high site. In a moderately high-lying situation, upon a dry bottom, with a free circulation of air, the beech lives to its greatest attainable age; and in a low situation, with a good soil and humid atmosphere, the tree reaches its greatest size; but in such a state it generally dies quickly after attaining its full size.

The circumstances which appear most favourable to the healthy development of the beech, are a dry and rather light soil, having a considerable proportion of lime or chalk. Notwithstanding that we generally find the beech luxuriating and forming its best quality of timber upon a light and friable soil, I have often had occasion to remark healthy plantations of this wood in almost all sorts of soil. I could point out upon many estates excellent beech timber growing upon a stiff clay soil, and also good timber upon a very light sandy soil. This accommodating nature of the tree seems to be the reason why we so often see at the present day so many old beech trees about the seats of proprietors both in England and Scotland; and this is also the reason that I have recommended so much the planting of beech for hedges, particularly as a mixture among thorns.

SECTION IX.—THE ASH: ITS HABIT AND PECULIARITIES.

The Ash *(Fraxinus)* belongs to the natural order Oleaceæ; and according to the Linn. system, to *Polygamia Diœcia*. There are many distinct species of the ash, several of them being natives of North America, and others of the continents of Europe and Asia; but all of them, in our country, attain, under the most favourable circumstances, only trifling dimensions as compared with the *Fraxinus Excelsior*, or common ash, which is a native of Britain, and perhaps the most useful of our hardwood timber trees, for general purposes, if we may except the oak.

In duration, the common ash tree is superior to many of our hardwood trees, there being instances of them nearly three hundred years old in Scotland; and upon the estate of Arniston there are several ash trees known to be above two hundred years old, and yet in good health apparently.

Many object to the ash being introduced into modern landscape on account of the lateness of the tree in coming into leaf, that being generally about the first week of June, by which time most other trees are in almost full leaf, itself standing alone bare, and apparently in the midst of winter. This objection is, in my opinion, very superficial, and unworthy of being of any weight; for this very peculiarity of the tree gives it an interest in the eye of refined taste, which is not to be found in any other tree; for what is more pleasing than to see, at a time when all other trees are in full leaf, the ash first swelling its large black buds, and unfurling its leaves to the summer's sun? Another objection formed against the introduction of the ash into the park is, that it is the first tree to lose its leaves in the autumn. This is indeed true, for the first frost of winter causes its leaves to undo their hold and to fall to the earth; but in this also there is more pleasure than disappointment, for while most other trees upon the lawn have had their leaves deadened and hardened by the approach of winter, the ash retains the verdure of its foliage to the last, and throws it off at once, rather than submit to have it dangling of a sickly hue. And even when the tree is newly stripped of its leaves, its appearance here and there, as a leafless naked tree, contrasts well with the other different masses of sickly foliage upon the adjoining trees; therefore I must say that I admire the ash as a lawn tree for the very reasons that others object to it. Apart, however, from the lateness of the tree in coming into leaf, and its being suddenly stripped of its foliage in the autumn, the ash is admirable as a stately proportionable tree, and is well worthy of a place, to a certain extent, in every British landscape.

The natural habit of the ash is that of a tall tree of first-rate magnitude, but inclined to grow tall rather than to great girth of bole. In plantations of a very moderate thickness, this tree is extremely apt to run up to a great height without taking a proportionable girth along with its height; but when the plantation in which it grows is kept rather thin and airy, the side branches are easily checked, and excellent tall timber is formed. When growing in a park or open lawn, the ash forms a large-headed tree of imposing effect; and in this case a large bole is generally formed, quite in proportion to the massy top. At first the branches of the ash grow from the body of the tree at an acute angle; but the branches, as they increase in weight, incline gradually to hang down towards the extremities,—giving the tree, when of mature age, a very graceful outline.

There are instances of the ash attaining a very great size. There is one still growing at Carnoch House, in Stirlingshire, said to be about ninety feet high, with a circumference of thirty-one feet at the ground; and upon the estate of Arniston there are ash trees fifteen and sixteen feet in circumference. But trees of such large dimensions are not numerous; neither is it necessary that the ash should attain such a large growth, considering that smaller trees always yield much better timber. A peculiar characteristic of this tree is, that the quality of the wood is always the better from being rapidly grown; at least in so far as regards its immediate use, it being always increased in toughness of fibre by the rapidity of its growth, (but perhaps not in the durability of its timber,) the opposite of which is the case with most other trees. I have often had occasion to observe, in the cutting up of ash timber, that the wood of trees which grow upon very poor soils, and which of course had grown slowly, was brittle in the grain; and I have been informed by carpenters, that when such wood is used for any purpose, it is much sooner affected by rot than the wood of trees grown with moderate rapidity upon a good soil; but where the growth has been maintained vigorously throughout, the timber will be found tough, elastic, and durable; and this more particularly if it has been freely exposed to the air, and not drawn up too much in the heart of a plantation.

There is none of our forest trees, the wood of which can be applied to so many different useful purposes as that of the ash. As to its toughness and elasticity, no tree grown in our woods can be compared to it: as an example of this property, it is only necessary to look to the articles made from it by the sieve-wright and the basket-maker, in whose hands the ashwood bends like a piece of wire.

No wood can answer the purpose of handles for agricultural and other implements so well as the ash. The coach-maker and the wheelwright could not have it properly replaced in their business by any other of our home timber; nor is any wood so well adapted for boat-oars. For all these purposes tradesmen find the wood in its best state when from forty to sixty years old; but this of course must in a great measure depend upon the nature of the soil upon which the wood may be grown. In general cases, however, I have myself observed, that an ash tree much above sixty years old has considerably lost its toughness, and is not commendable for purposes requiring elasticity.

Next to the larch, I consider the ash the tree which comes in to pay the planter at the earliest date. I have myself cut down young thinnings of ash under thirty years of age, for which I received 2s. 6d. per foot for handle wood; and I may observe, that ash in its young state is equally answerable for handles as the tree of sixty years of age; this being a particular property of the wood. There is no sort of coppice-wood more profitable at the present time than that of ash. This season (1848) I sold young ash-suckers, of two years old, for 1s. 6d. per hundred: these were used for baskets, cretes, and barrel-hoops: and from a coppice of seventeen years old I have taken a vast number of pick-handles—which at once shows that the ash as a coppice-wood alone is a very profitable timber, in which form it is in many districts of England much cultivated, it being there cut over at stated intervals and sold for walking-sticks, hop-poles, hoops, cretes, hurdles, handles, &c. &c. In order to keep up a supply for these different purposes, which of course require different sizes, the coppice plantations are laid off into separate portions, each portion being cut over at a certain period as may be found to answer a demand for a certain purpose, the proprietor selling each portion to the highest bidder.

I have calculated that, upon the estate of Arniston, where coppice sells but moderately as compared with many districts in England, an acre of ash coppice at four years old, from the stool, is worth £12, making the value of the crop per acre, per annum, £3; and that upon a soil of very moderate capabilities. None of our forest trees make so good fire-wood as the ash; and, what is remarkable, it burns well, although wet and full of sap.

The foliage of the ash is of a beautiful light-green colour, and is what is termed by botanists *pinate*, or winged; and each leaflet is *lanceolate*, and *serrated* upon the edges. (See Fig. 56.)

The young shoots are *flattened*, of a very brittle texture, and are furnished with very prominent dark-coloured buds. (See Fig. 57.)

Fig. 56.

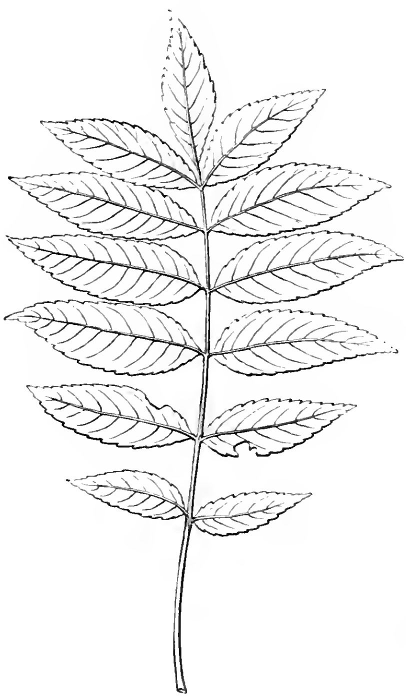


Fig. 57.

The ash is propagated by seeds, which are enclosed in what is termed *someras*, or keys, which are generally ripe for gathering in the month of October. When gathered for the purpose of sowing, the seeds should be mixed with a quantity of dry sand or light dry earth, in which they should be kept all winter, in order to rot off the outer coat; and in order the more effectually to insure the rotting of the outer coat, the whole mass of seeds and sand should be turned several times during the winter. In March, the seeds should be sown in beds rather thinly, as they are sure to come up thickly and confine one another if this point be not attended to. In the following spring the plants will be ready for being transplanted into the nursery-rows, which may be done at the same distance as has already been recommended for the elm. When the plants have stood two years in the nursery-rows, they will be ready for planting out into the forest grounds. The circumstances which are found favourable to the healthy and full development of the ash, are, as regards soil, a good strong loam, rather rich than otherwise, and rather moist than dry; that is, the ash does not disagree with a little moisture, provided that this moisture have free and ready access away from the roots, and is not liable to remain in the least degree stagnated. I have often seen the ash of considerable dimensions upon bare rocks: in such cases the roots of the tree get into the seams of the rock, and are watered by the moisture which descends between the strata.

Until lately, when I have turned my attention very particularly to the different soils most suitable to the growth of the different species of our hardwood trees, I used to think that ash, and indeed any other hardwood tree, would not succeed to any profitable purpose upon a moss soil. But now that I have examined plantations upon very many estates, I find that ash, as a coppice, succeeds well upon a soil of very deep moss. I have never, indeed, seen the ash attain a good timber size in a moss soil; but as a coppice, cut down at periods of from ten to twenty years, I have seen the ash in excellent condition; and when not allowed to remain uncut above fifteen years, the parent stocks keep in very good health, and will produce many crops in succession; but I have observed that, if the ash is allowed to grow uncut to a period much beyond fifteen years, the parent stocks are very apt to become exhausted, and fail to produce a profitable return.

Another point relative to this is, that I have observed that, if ash be planted upon a moss soil, in an exposed situation, it will not succeed well even as a coppice; but if the situation be one moderately sheltered, the success will be good. This suggests to us that, in order to convert a moss into a profitable ash coppice, it is only necessary to produce shelter by having the moss ground surrounded by other trees in order to produce this; and if a few spruce firs, which also grow well in mossy soil, be planted among the ash to act as nurses, the coppice will be got the sooner to succeed. The ash is fonder of shelter than most of our hardwood trees, although I do not mean to say that the ash is not a hardy tree: I mean that, in order to have it of tall and large dimensions, it is necessary to give it a sheltered situation; for when on an exposed site it is more apt to become branchy and large-topped; therefore, to grow it well, it is an advantage to plant in a glen or hollow, or in the interior of a large plantation. Many object to the ash being introduced into a forest among other trees, because they say that it is so apt to lash other trees by its branches and top; but from this I have never seen any evil arise. And it is my opinion, that even among oaks, which may be planted as a permanent tree, the ash answers well as a secondary—being, when thinned out from among the oaks under thirty years old, of infinite advantage for many purposes, and, moreover, paying well.

SECTION X.—THE GREAT MAPLE OR SYCAMORE.

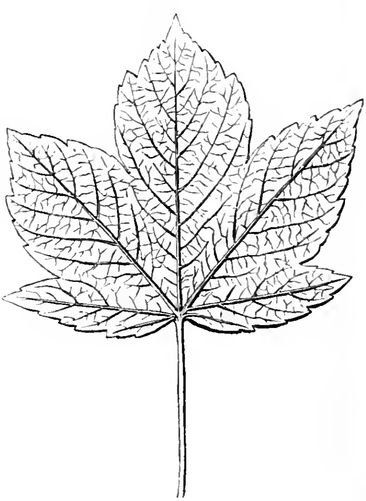
The Sycamore (*Acer pseudo-platanus*) belongs to the natural order ACERACEÆ; and according to the Linn. system, to *Polygamia Monœcia*. It is reckoned a native of Britain, and is a tree of first-rate magnitude, and lives to a great age. In Scotland it is more generally known by the common name of *plane* tree. This, however, is the *platanus* of botanists, and is originally from the Levant. When grown under favourable circumstances, few trees live to a greater age than the sycamore. There is still growing in the park adjoining the palace of Scone, in Perthshire, a sycamore said to have been planted in the time of Mary Queen of Scots. The tree is at present apparently in perfect health, and must be about three hundred years old.

Many consider the sycamore a tree of a heavy and gloomy aspect, and not fit to be introduced into a park where a lively natural appearance is desired. My opinion is quite of an opposite nature. Only let the fine effect that this tree has upon our lawns and parks about the end of April and 1st of May be considered: it is then that the sycamore appears to best advantage; its light green leaves have then a freshness and a lightness indescribable, and give the park upon which the trees stand quite an oriental appearance. The very circumstance of the sycamore coming into leaf earlier than almost any other tree upon the lawn, makes it a favourite with the lovers of natural scenery; and even in the midst of summer the tree presents a grand unbroken mass of foliage, which contrasts beautifully with other trees of a more airy character, particularly if the situation be prominent. The sycamore is not a tree that carries height along with its girth compared with many other forest trees; and this is particularly the case when it is found growing free in an open park or lawn. In such a situation it forms a short massive trunk, with a spreading head of frequently very great magnitude. Upon the lawn in front of Arniston House there is growing a sycamore tree with a trunk above five feet in diameter, four feet from the ground. The trunk is not more than eight feet high, when it diverges into limbs of large dimensions. The tree is not more than sixty-five feet in height, and contains about three hundred cubic feet of timber, and is at least two hundred years old, and in a perfectly healthy state.

The sycamore, when of large dimensions, is a very valuable tree. About ten years ago I sold it at 4s. per cubic foot; but this year (1848) I have sold a considerable quantity at 2s. 4d. per foot, being now little more than one half what it was ten years ago. At that time there was a great demand for this sort of wood for the print and bleach fields about Glasgow and other manufacturing places; but now that metal is introduced instead of wood for these purposes, it does not, of course, sell so well; but even yet, when of large scantling and clean grown, 3s. per foot can be had.

The wood of the sycamore is reckoned of excellent quality, and fit for many purposes; such as tables and other articles of household furniture, mangles, and wooden dishes; and a considerable quantity of it is still used in different parts of machinery. It is also well adapted for heading to herring barrels. For this purpose I sell a great quantity of it, sawn up into small boards five-eighths of an inch in thickness, and eighteen inches in length. For this purpose, however, a small price is given; but as wood of small dimensions answers the purpose—generally, indeed, the limbs of large trees—a large price cannot be expected. For the last four years the price of plane-tree heads for herring barrels, five-eighths of an inch thick, has not been more than 70s. per thousand superficial feet, laid down in Leith; and as it takes about sixty-five cubic feet of round timber to produce one thousand superficial feet of sawn heads for barrels, it will be observed that little more than 1s. per foot is received for the round timber, exclusive of the expenses of cutting up and cartage; and, according to calculations that I have made upon this point, even with a good saw-mill, not more than 8d. per cubic foot can be calculated upon for the round timber, after deducting every item of expense in converting it into heading. But, as I have already observed, wood of small dimensions answers the purpose: it generally pays much better for this purpose than selling it for fire-wood. The sycamore is very easily distinguished by its beautiful five-angled leaves; or, as botanists describe them—*palmate*, with five acuminated, unequally serrated lobes. (See Fig. 58.)

Fig. 58.



The sycamore is propagated entirely by seeds, excepting, indeed, the variegated sorts, which are increased by budding or grafting. When the seeds are ripe, they should be sown immediately after being gathered, because they are extremely apt to lose their vegetative powers: this may be done about the middle of October; or, if it should be preferred to keep the seed till spring, it should be mixed up with a quantity of dry sand, and sown as early as possible in the spring. When the seedlings are one year old, they should be planted out into the nursery rows, where they should remain two years before being removed to the forest-ground; and for the distance at which the plants should stand in the nursery rows, see that already given for the ash and elm.

One particular point to attend to, in the rearing up of healthy sycamore trees, is the proper pruning of the plants; that is, if the young trees be cut and pruned in the winter or spring months, they are sure to bleed profusely at the wounded parts, and will very probably remain stunted, miserable-looking things for many years after: therefore, when it is found necessary to prune the sycamore, let that be done in the summer months, or in the growing season of the tree, when, instead of being injurious, judicious pruning becomes beneficial to it, because the sap at this season is quickly formed into proper woody matter, and the wound heals up in a very short time, causing the stem to become strong and healthy by having the sap directed towards it.

There are few trees more hardy than the sycamore. Mr Loudon speaks of it growing as high as three thousand feet above the level of the sea in Switzerland, where it much abounds: of this hardiness of the tree there is no doubt, for I have myself seen the sycamore in this country attain a considerable size upon elevated spots along the sea-shore, where scarcely any other tree could exist along with it but the pineaster; therefore I recommend it as a most useful tree in all exposed situations, if the soil be dry, and not too much inclined to stiff clay or moss.

The circumstances which are found most favourable to the healthy development of the sycamore are — as to soil, dry sandy loam, with a free exposed situation, as in the open parks about gentlemen's home-grounds; and, as a general rule, this tree may very profitably be planted in almost every situation where the beech will thrive.

The sycamore, from its being easily checked in the side branches, is well adapted as a nurse for other more valuable trees in a forest. It also makes an excellent coppice-wood, the young shoots growing exceedingly rapidly from the stock, and making from three to five feet of length in one season. Being an exceedingly hardy tree, and of a peculiarly stiff and unbending habit, it is well adapted for hedge-row timber; and, moreover, being a tree which comes very early into leaf in the spring, it has the advantage of producing considerable shelter to the fields by its large leaves, as well as giving a healthy and clothed appearance to the country. Many, indeed, object to it as a tree adapted for hedge-row timber, upon account of its wide-spreading branches; and, no doubt, it must be confessed that its wide-spreading branches will, under careless management, cast a great shade upon the land on each side of the hedge-row; but if it be properly trained up by judicious and early pruning, it may be made not a wide-spreading tree, but a tall closely-branched one, of the best description possible for producing shelter to the adjoining fields. (See chapter upon hedge-row timber.)

SECTION XI.—THE NORWAY MAPLE.

The Norway Maple (*Acer Platanöides*) belongs to the same natural and Linnæan orders as the preceding. It is not a native of Britain, but is found very plentifully upon the continent of Europe. Loudon, in his *Arboretum Britannicum*, page 410, says that he observed it "in all woods bordering the public road from Wilna to Mittau, and from Moscow to Gallicia;" and again he says—"Next to the birch and trembling poplar, it seemed to us the most abundant tree in the Russian woods." From the tree being named the Norway maple, it would appear to be found plentifully in that country also, making it equally as hardy as the pines which are found there: and this is indeed the case; for there are few, if any, of the forest trees introduced into Britain so hardy as the Norway maple. It is a tree of first-rate magnitude, attaining equal dimensions with the sycamore in a given period, and is by far too little cultivated in Britain. The Norway maple, as a lawn tree, is perhaps not surpassed by any other: a particular recommendation of it is, that it comes early into leaf; and in the autumn the leaves of this tree give an extremely rich and varied effect, from their bright yellow colour contrasting with the dark-green and russet tints of the other trees. The form of the tree, although much resembling that of the sycamore, is more open and light, and it does not form so heavy nor so massive an appearance, being easily distinguished at a distance by an outline more natural, easy, and light, than the sycamore. I have never as yet had the opportunity of seeing the wood of the maple cut up under my own observation, it being by no means plentiful enough in Britain to be used for common purposes, as is the case with the sycamore; but, from the specimens of the trees that I have seen pruned, and from articles of furniture that I have seen made of the full-grown wood, it appears to me to be a wood of far more real value than the sycamore, being more close in the grain, and taking on an excellent polish. I am therefore inclined to think that, taking it simply in the light of a timber tree, it is of more value than the sycamore, and may be adapted to many more purposes. The leaves somewhat resemble those of the sycamore, but are more acute in the angles. (See Fig. 59.)

Fig. 59.

They are also fully as large as those of the sycamore, but of a lighter green, and more transparent in the texture; and a particular character of the leaves is, that they are never apt to be eaten or injured by insects, as is the case with most other trees; hence they always present a sound healthy appearance. The young shoots of this tree are at first of a greenish colour; but as the season advances, and the wood becomes more ripened, they become of a brown colour, with white spots upon the surface of the bark. In the winter season this tree is easily distinguished from the sycamore by the bark upon the old wood or body of the tree, which is of a brownish-grey colour, the buds being of a deep red, very prominent and large.

The Norway maple is propagated by seeds in the same manner as the sycamore, and in every respect the method of culture stated for the sycamore is applicable to this tree; and I may add further, that this tree bears seed at a very early period. I have gathered good seed from trees of thirty-five years of age.

Being a native of the colder regions of Europe, it is well adapted, as a useful timber-tree, for British plantations. It is found growing in Norway down to the very sea-shore, and is there found to stand the blasts of the sea excellently—so much so as to become timber of large dimensions; it is, therefore, remarkable that it has not been more cultivated in this country, particularly upon estates along our sea-coast. Upon the west coast of Scotland—as, for instance, along the Galloway shores—I have seen it thrive well; and from specimens that I have seen growing there, I am convinced that, were its cultivation extensively put into practice, the Norway maple would there supersede every other forest tree; and instead of that barrenness which at present characterises the coast of Galloway all along from the mouth of Loch Ryan to Maidenkirk, a beautiful woodland aspect might be given to the whole, were this valuable tree introduced there as its merits demand. In order the more quickly to bring about this state of things there, the Norway maple should be planted at about twelve feet apart, and the ground made up with the pineaster to the thickness of four feet. By this method, the pineaster being an exceedingly hardy tree in withstanding the sea-breeze, the

Norway maple would, from being sheltered by it, assume a rapid growth in a very short time; and as they advanced, the pineasters which nursed them could be thinned out gradually, and made use of in fencing purposes, in order to give the more space to the maple, it being meant to remain as the permanent crop.

That the Norway maple is a rapid-growing tree is beyond dispute, although many deny this property of it. I could myself, upon the estate of Arniston, point out shoots of this tree, and that of the present year's growth, (1848,) three feet long, with a diameter of half an inch, and that upon young trees not more than twelve years old, which is equal to growths of the sycamore upon trees of the same age. Being well aware of the hardy nature of the tree, I here beg to advise proprietors to plant it plentifully, not in the form of a temporary nurse, but in the form of a permanent tree; for I am persuaded that, ere many years pass by, its usefulness will be appreciated, and it will become a very prominent tree in our forests, and more particularly upon high and exposed parts along our sea-coasts.

The soil most favourable for the growth of this tree is found to be a free, open, sandy loam; but although under such circumstances it does, no doubt, grow most rapidly, and develop itself to greatest advantage, it will, nevertheless, grow freely upon very inferior soils, provided that such be dry and properly drained; and upon the estate of Dunsky, in Wigtonshire, I have seen young trees make good progress upon a surface of rock, with here and there a little soil, into which the plants were put.

SECTION XII.—THE POPLAR.

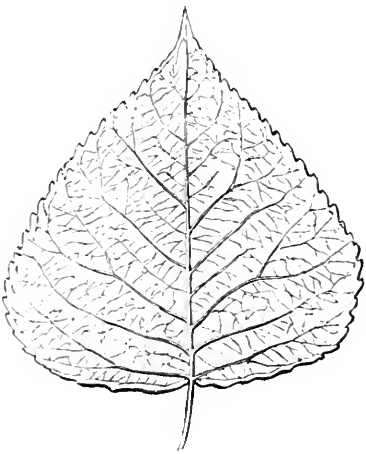
The Poplar (POPULUS) belongs to the natural order AMENTACEÆ; and according to the Linnæan system, to *Diœcia Octandria.* There are several species of this tribe which are well adapted for forest timber trees: the sorts which are most worthy of our notice here, are the black poplar, *Populus nigra;* the white poplar, *Populus alba;* and the gray poplar, *P. canescens;* and we may also mention the aspen poplar, *P. tremula;* all which are found natives of Britain. There are several species from North America and the continent of Europe, which are allowed to be good timber trees; but as our own native species yield more valuable timber than any of them, we shall here confine ourselves to a description of the four above-named species, these being, strictly speaking, British forest trees. They are all rapid-growing trees when found in a soil congenial to their nature, and attain very large dimensions.

The P. Nigra is a tree which attains large dimensions of timber in a very short time, but does not endure long when it has arrived at maturity, which may be reckoned at fifty years of age. When planted in a low-lying situation, where it has the advantage of shelter, it forms a very prominent tree in the landscape; but if planted among trees of a slow growth, it soon overtops all others, and has by no means a fine effect; but where it is planted in a situation adapted to its rapid growth, it forms a magnificent tree, having a large spreading top, with an extremely massive trunk. Upon the estate of Arniston I cut down a tree of this sort the other day, which was only thirty-five years old. It was, when stretched upon the ground, seventy-eight feet in length, and three feet in diameter at the base of the trunk; and, altogether, this tree contained sixty-six cubic feet of timber. It was sold for 2s. per foot; thus giving, as the produce of a single tree in thirty-five years, £6, 12s. This example is enough to point out the advantages arising from planting the black poplar in a good soil and situation. The soil upon which this tree was growing was a sandy loam, in a sheltered situation upon the lawn; and it was cut down in consequence of interfering with an oak near it.

The wood of this tree is much sought after by cart-wrights for bottoming, and is also used for light turners' work. It is said to be much sought after upon the continent of Europe for wooden shoes. I have sold a great deal of it this year for *drags* for railway waggons.

Many of the poplars much resemble one another in the appearance of their leaves, but the black is easily distinguished from the others by having its leaves of a pale-green shining colour; their shape is termed by botanists *deltoid*, or trowel-shaped, pointed and *serrated*, and smooth on both sides. (See Fig. 60.) The leaf-stalks of this sort are thin and slender at their insertion upon the leaf, which gives them a vibrating motion upon the tree from every breath of wind.

Fig. 60.



This species is generally propagated by cuttings of the young wood, (see Fig. 61,) which are rooted in the nursery-ground with extremely little attention; and after remaining one year in the cutting state in the nursery, they are fit for transplanting out into the forest ground.

Fig. 61.

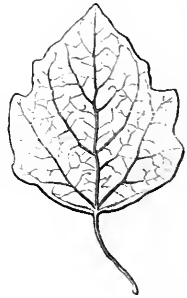
In order to grow this species profitably, they should be planted in a good strong loam, having rather a tendency to dampness, though I have seen trees of a very large size growing upon a poor and sandy soil, situated upon a sloping bank, where water percolated freely down the slope; but none of the poplars will succeed profitably upon a dry, thin, high-lying soil. The *populus nigra* is well suited as a forest tree either in a mass or mixed among spruce firs in any low-lying part of forest ground; and as a coppice-wood tree, few are more profitable. When cut down, the stools in a few years send up shoots of great size, which may be used for basket-rods, flower-sticks, crate-stuff, or poles of any description; but when cut young, they do not last long.

The Populus Alba, or *Abele tree*, is another of the tribe which, under favourable circumstances, attains large dimensions. This is a tree of a beautiful upright habit, and upon a lawn or park it makes a very fine contrast by its white, waving, downy leaves, glittering among others of a darker colour: like the *P. nigra*, it delights in a sheltered situation upon a dampish loamy soil. The wood of this species is very light and spongy, but is as durable as the former when cut up. I have cut up a considerable quantity of it for planking, which is used for flooring, cart and waggon bottoms, &c., and it sells for these purposes readily; in fact, I have never been able to supply the demand which I have for this sort of wood, which is much sought after for cart-bottoms, and all such purposes; and, considering its rapid growth, it is a tree far too little planted in our home forests. I have begun to plant it in damp hollow parts upon the estate of Arniston, in situations such as I used to plant with spruce firs formerly; and I find that, next to the black poplar, it is the most rapid-growing of the genus, and well worthy of extensive culture for country purposes.

Fig. 62.

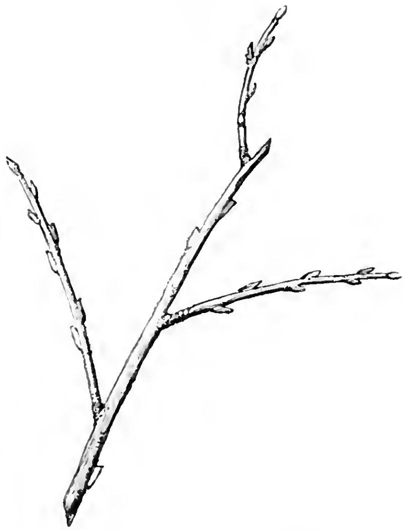
The leaves of this species are upon young plants almost *palmate*, and larger than those taken from an older tree. (See Fig. 62, which shows them as taken from a coppice of the second year's growth.) In the young state the leaves are covered with a white down beneath, and on the upper surface but slightly. Upon plants a few years old the leaves are much smaller, and also dark-green, and smooth on the upper surface, and not palmate, but merely lobed, and somewhat toothed. (See Fig. 63.)

Fig. 63.



The young branches are also thickly covered with down, and are of a more spreading and ramifying habit than those of the last-mentioned sort, (see Fig. 64,) and also more slender and tough. The young plants of this species are furnished by cuttings, layers, and suckers, which rise freely from the roots wherever they are growing; and if put into the nursery-ground in the spring, they will be ready for transplanting out into the forest ground in the autumn or spring following.

Fig. 64.



This species, as well as the *P. nigra*, thrives best in a loamy dampish soil; but I have frequently seen good large trees cut down upon a rather dry and poor soil; and in any moderately sheltered situation, where it may have the advantage of a supply of fresh running water, as upon the banks of a stream, it forms a very profitable forest tree, and might be turned to advantage in many places where the elm has been planted and is not succeeding well. I could point out many plantations upon estates in Scotland, where the ash, elm, and firs have been planted, which, on account of the soil and other circumstances being unfavourable to them, are at present in a very unhealthy and unproductive state, upon which, had the Abele poplar been planted, a tenfold return would have been realised, independent of proving a most pleasing object to look upon.

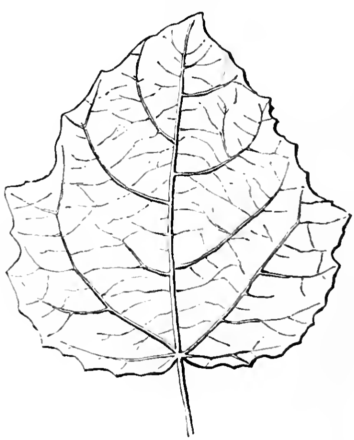
This is a most excellent tree for coppice-wood, and produces a crop very quickly; and the young shoots, when arrived at from ten to twelve years old, are extremely useful for many country purposes; such as paling-rails, stobs, gates, &c. In 1843 I cut down a coppice of this description upon the estate of Arniston, and this year (1848) the shoots have risen to the height of fifteen feet, and stout in proportion; this showing the fast-growing nature of the tree when treated as a coppice.

The Gray Poplar (*P. canescens*) very much resembles the last-mentioned species, but is easily distinguished from it by its greater propensity for sending up suckers, and that at a great distance from the tree. In favourable situations it grows as rapidly and to as great a size as the *P. alba*, but has its branches thrown out more uprightly than it; and, in my opinion, it forms a very ornamental tree in a low-lying situation upon a soil adapted to its nature. Upon the home-parks about Arniston we have several trees of this species of a considerable size, upon a rather dry soil, and rather an exposed situation. It is a very hardy tree, and attains a timber size upon a greater variety of soils and situations than any other of the poplar tribe. But, notwithstanding, its favourite locality is upon a good loam, near to a supply of running water. In such a situation it forms a very large spreading-topped tree, frequently rising to eighty and ninety feet high.

The quality of the wood very much resembles that of the last-mentioned species, and is sought after for the same purposes. I have this season cut up a considerable quantity of it into planks for millwright purposes, it being considered very durable for water-wheels; and, as a timber tree, it pays the planter well—I having got this year 2s. 6d. per foot for the squared timber, which is a higher price than I can get for larchwood. This arises from the scarceness of the poplar tribe as a timber tree; and this is to be regretted, as I am aware that, were it more cultivated, it would be much sought after, and make a very profitable return.

The leaves of this species are easily distinguished from the *P. alba* by their lobes not being so deep, and the down being almost awanting upon the under side of the leaf. (See Fig. 65.)

Fig. 65.



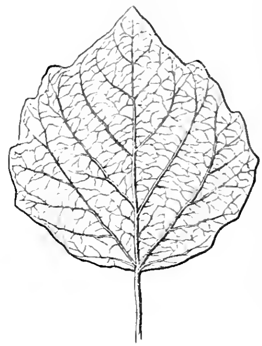
This species also makes an excellent coppice, and is very productive in young shoots, which rise up freely in a very indifferent soil, and might be made very profitable if cultivated to a good extent near any market for hoop-wood, for which it answers well when young. Coppice of this description is also much sought after for crates and other coarse basket manufacture; and as a coppice it is very easily kept up, on account of the great tendency the tree has to throw up suckers all over the ground upon which it grows.

It is propagated in the same manner as the last-mentioned sort, but very seldom from cuttings; the suckers in all cases making the preferable trees: therefore these are almost in all cases preferred for a supply of young trees. And when they are lifted from the roots of the parent plant, and put into rows in the nursery ground for one year, they will then be ready for transplanting out into the forest.

The ASPEN, or *P. tremula*, is a very interesting species of this family, on account of its leaves being put into motion by the slightest breeze; and, indeed, few objects are more attractive in nature than the motion of the trembling poplar in a calm evening. Upon the end of the house which I now occupy, there stands a group of fine aspen poplars, about sixty feet high, with their clean grey stems and rugged horizontal branches stationary as the earth upon which they stand; with leaves all in motion, like an agitated sky, without a breeze of wind below. I have not indeed, hitherto, entered into feelings of a poetical nature in describing the character of the different trees; but when I now come to speak of the character of the aspen, I am, as it were, involuntarily led to say, that as regards my own private feelings, it is the only tree that recalls to my mind "days bygone," and makes me forget that I am writing a practical work. With the aspen there are associated scenes of early life; and at the present moment, although the evening is so still that the sound of a burn a full mile off is easily heard, the leaves cannot remain quiet; and now and again, as the air rises into the most gentle breeze, and almost brings with it the sound of the very minnows' flip upon the surface of the water in the far-off pool, the leaves of the aspen vibrate to the sound, and their rustling falls upon the ear sweeter than any music.

Although this is a very interesting species of the poplar, and is worthy of a place in a well-chosen part upon the park, yet as a timber tree it is of a secondary rank, and does not produce timber of so good a quality as the other poplars already described. The wood when cut up is in all cases short-grained, and very easily broken when applied to any useful country purpose. The leaves of this sort very much resemble those of the gray poplar; but they are easily distinguished from them by being more round, and also smooth on both sides. (See Fig. 66.) This tree is propagated in the same manner as the gray poplar, being principally from suckers, and sometimes from layers in the nurseries; and from its tendency to throw up suckers, it also makes a profitable coppice-wood.

Fig. 66.



SECTION XIII.—THE WILLOW.

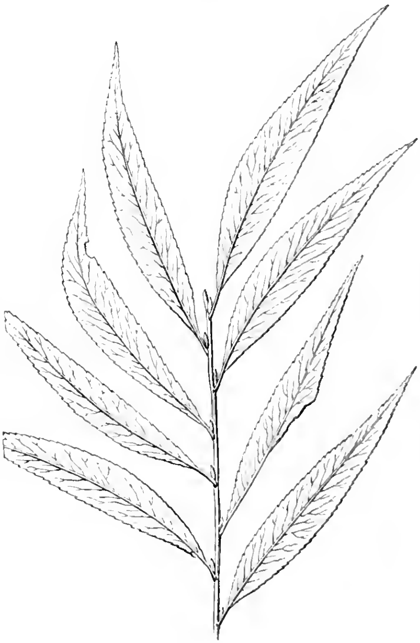
The Willow (*Salix*) belongs to the natural order Salicaceæ; or according to the Linn. system, to that of *Diœcia Diandria*. There are many species of the willow family, many of them not growing to a size yielding useful timber. We shall therefore at present confine our description to those sorts which are, properly speaking, forest trees. Of these there are three species deserving our attention—namely, The *Salix alba*, or Huntingdon willow; the *Salix Russelliana*, or Bedford willow; and the *Salix fragilis*, or red-wood willow. All these are timber trees of first-rate magnitude, and are well deserving of a place either upon a lawn, or in a forest where profit may be the object.

The *Salix alba*, or Huntingdon willow, in a situation congenial to its nature, attains the dimensions of a first-rate tree, with an outline as agreeable and as elegant as can be imagined; and it is a tree well worthy of a place in any extensive park or lawn, where the soil is not too thin and dry, nor the situation too exposed. Its growth is very rapid; and it is thus well adapted to plant in any situation upon the park where it may be wished to hide any disagreeable object. Upon the estate of Arniston I have planted this tree rather extensively, and find it grows well in almost any soil, provided it has a little shelter and moisture. I could point out young trees, only three years planted, standing from twelve to fifteen feet in height; and I believe that, were it introduced extensively into all hollow parts of forest ground, the planter would have a return from his crop which is but seldom realised by the planting of our common hardwood and fir trees in such situations.

The wood of all the tree willows is much sought after, and preferred in all cases to that of the poplar. It is reckoned more tough and durable than the latter, and is used for a great variety of country purposes. It makes excellent charcoal for powder manufacturers, and is much sought after for this purpose; but it is not easily procured in sufficient quantity. It is also particularly adapted for cleading to stone carts and coal-waggons; for which purposes I have cut up and sold a considerable quantity of it. When struck by a stone, or any other heavy body, the deal produced from the willow is not readily injured nor split as is the case with deals made from the fir and pine trees; and this quality of the wood makes it so valuable for the purpose. In making harrows for agricultural purposes, the wood of the saugh or willow is much used; and as a paling rail it will last much better than the young wood of the Scots pine or spruce fir. Its branches make excellent stobs for palings; but they are very apt to grow, and set out young shoots. In order to prevent this tendency of the wood, the stobs should be made and laid aside to dry for a few weeks before they are used.

In order to have the wood of the willow clean and tall for useful purposes, the trees should be planted in a mass, and drawn up considerably, either among themselves, or planted at twelve feet distance, with a few larch or spruce firs among them as nurses for a time. This is particularly necessary with the Huntingdon willow, which is extremely liable to set off into large branches if left to itself in any open part without confinement; but where planted close together, or mixed with a proportion of firs, it rises to a great height before branching off; and when timeously thinned, excellent timber is produced. As its wood is soft and open in the grain, the willow, and indeed the poplar too, should never be pruned except in the young state. If any branch of considerable size be taken from a full-grown tree, the wound never heals up; the weather takes effect upon the cut part at once, and soon produces rot, rendering the timber near it useless. Therefore, in pruning the willow, let them be put into proper shape while young; and in order to do away with pruning altogether, grow them for a few years closely together, which will prevent the side branches spreading to any undue proportion. The leaves of the different sorts of willows have a close resemblance to one another, and, indeed, can only be detected and distinguished by a careful examination of their texture, more than any difference of shape. The Huntingdon willow has the leaves *lanceolate* and *serrated*, the lower serratures bearing small *glands*. Both sides of the leaves are covered with very fine silky hairs, which lie close upon the body of the leaf, giving the leaves a whitish appearance, and causing a beautiful effect when they are slightly moved by the wind. Fig. 67 is an exact representation of the leaves and young wood, as taken from the plant

FIG. 67.

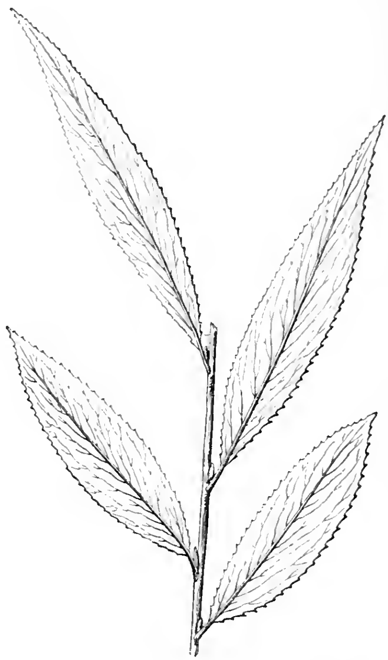


in the month of August. No plant is easier of propagation than the willow; indeed, this characteristic is proverbial among practical men. All that is necessary in propagating this species, is to put a cutting of young wood into the soil in the spring, and in the autumn following it will be ready for transplanting out into the forest ground. Indeed, many advise the using of pieces of the older wood for cuttings in propagating the willow; but, for my own part, I have tried both ways, and have always found the cuttings made from the last year's wood make the surest and best plants, and ultimately come to be the finest trees. Some foresters also recommend the putting of the cuttings at once into the forest ground without having the plants reared at all in the nursery; but, as regards this plan, there seems to be nothing gained by it in the end. The plants in such a state do not come away so quickly: they are generally two years behind those reared in a nursery, and they are more apt to become branchy. The best method is to raise the cuttings from the young wood, and, when they have stood one year in the nursery-rows, have them put out, and they will immediately grow freely, having roots to seek food for themselves at once.

I need scarcely say that the willow makes one of the best of all trees for coppice-wood. Every forester or gardener is aware of the nature of a willow bed, and there is scarcely one who has not a bed of this useful plant reared under his own notice for the making of baskets, &c.: for this purpose a great many varieties are in cultivation. In planting willows, whether for large coppice, to be cut over at periods of from three to twelve years, for poles of various sizes, or for cutting over every year for the basket-maker, the ground should be previously well cleaned by the plough, and a crop of some sort taken off it, in order properly to break down the old surface. Where it is intended to cut over the plants every year, the ground must be kept clean always; but where the plants are cut over at periods beyond two years, the ground may be cleaned at each period of the cuttings only.

The Bedford Willow (*Salix Russelliana*) is another tree which is well worthy of a place in pleasure-grounds of any extent. It is one which gives a much better effect upon a lawn than any other of the willow tribe, having a bold outline, and rather a rugged habit, which gives it, when viewed from a distance, the appearance of an ash more than that of a willow. In every other respect, what I have already said regarding the *Salix alba* is equally applicable to the one now under our notice. There is, indeed, so far as I have been able to notice, scarcely any difference in the quality of the wood of the two sorts. In similar circumstances they both appear to arrive at the same magnitude of timber, and the wood of the Bedford willow may be used for the same purposes as that of the Huntingdon. When planted upon an exposed situation, the branches of the Bedford willow are very apt to be broken down by high winds; but in other respects, it is, in my opinion, a more hardy tree than the before-mentioned one.

Fig. 68.

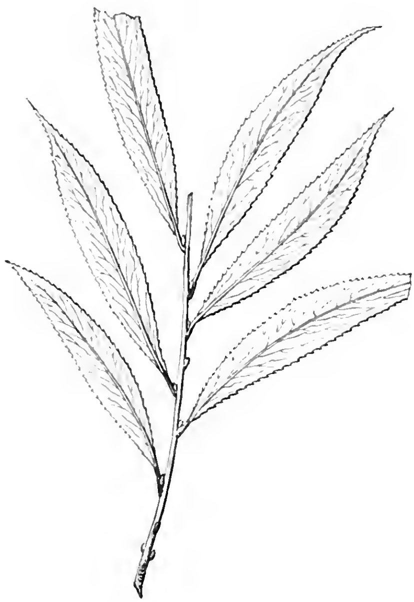


The leaves of the Bedford are also *lanceolate*, tapering at each end, and *serrated* throughout, but without hairs, being smooth on both sides. They are also larger than those of the Huntingdon. Fig. 68 is a representation of the leaves and young wood, as in the month of August.

The Red-wood Willow *(Salix fragilis)* is a tree more common in many parts of Scotland than either of the two former; and in the north of Scotland it prevails more than in the southern or midland counties. It is there much prized for the usefulness of its timber; and, indeed, in many cold damp parts of the north, it grows to a good timber size, and this too upon a very poor soil.

The wood of this sort is, in the estimation of most intelligent country carpenters, more durable and tough than that of either of the others; and I have found that I can sell more of it for country purposes than any other wood of the willow kind. Practical builders say, that as a timber for flooring it can scarcely be surpassed, being extremely light, and lasting for a long time. This is also a very fast-growing tree. Upon the estate of Arniston I have to-day measured a tree of this species, growing upon a good loamy soil, which is nearly seventy feet high, and eight feet in circumference four feet from the ground, though only about thirty-five years old.

Fig. 69.



The leaves of this sort very much resemble those of the Huntingdon willow, being slightly downy when young. Fig. 69 is a drawing of the leaves and young wood. It is propagated by cuttings in the same manner as the other varieties, and is, like them, very easy of propagation. There is one particular feature in this tree which I may here notice—viz., its aptitude to become what is termed *stag-headed* when found growing upon a soil not very favourable to its constitution. This is the principal reason that it is so much kept out of lawns and parks, as it thus becomes very unsightly. But as it is a tree bearing as fine a form, when well grown, as the Huntingdon willow, which we often find in extensive parks, it is an unfair estimate of the tree to keep it out of all park-scenery, even when the soil is capable of rearing it properly; and so far as my experience of it goes, I believe that, wherever it is planted upon a loamy soil, in which it can have a sufficient supply of nourishment, which is generally the case in hollow parts of a gentleman's lawn or home park, it will not only grow rapidly, but will maintain its health in all its parts as well as any of the two other species. It is only when found growing upon any thin, sandy, or gravelly soil that this tree is certain to become stag-headed. This I have often had occasion to observe, even when the tree was but young; and even in such cases I have also observed that, although the head of the tree did die, the lower part and all the branches, as far as healthy, continued to make wood as if nothing had happened to the head of the tree. In this case, when the tree is pollarded, the effect is by no means bad; it may, even under skilful management, be made an improvement in the scenery. I have also to observe, that where this tree is found as a hedge-row plant, and where the water is too much drained off the ground by any ditch running along the side of the fence, it is sure to become stag-headed at a very early period, in which case the tree is objectionable.

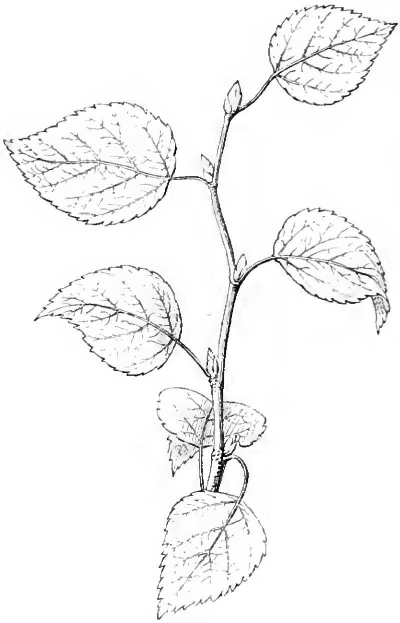
SECTION XIV.—THE BIRCH.

The BIRCH TREE (*Betula alba*) belongs to the natural order AMENTACÆ; and according to the Linnæan system to *Monœcia Polyandria.* This tree is indisputably a native of Britain, and forms, even at the present day, considerable natural forests in the north of Scotland. It is one of the most graceful of all our native trees, and is in consequence generally found in all well-laid-off landscape-scenery. As compared with many of our forest trees, it attains at best but very ordinary dimensions as a timber tree; but it is not so much on account of the value set upon its timber that the birch is generally a favourite as on account of its gracefulness; in which respect no forest tree surpasses it. This is particularly the case with the true weeping variety, which also is found wild in many of the higher districts, both in England and Scotland. A particular recommendation of this variety is, its being of a more rapid growth than the common sort; and on this account the generality of young plants are now raised from the seed of the weeping variety, which is easily known by the drooping tendency of its branches, and also by small white rough spots upon the bark of the young trees. In duration as a tree, the birch is not to be compared with the oak or sycamore; but in a good dry soil suited to its constitution, it lives to a great age. I could point out more than one tree about a hundred years of age, in perfect good health, and likely to live for many years to come. Upon the estate of Arniston we have one particularly good specimen, it being about two feet in diameter at bottom, and fifty feet high; and from its appearance it is likely yet to be much larger. This example shows that, under favourable circumstances, the birch attains dimensions of no mean character, being equal to many trees of the second rank.

The wood of the birch is by no means of great durability, in whatever situation it may be placed. I have seen it used in a great variety of ways, both for outside and inside work, and find it, in the open air, as in the case of a paling stob, of very inferior durability, not lasting more than three years;—in this respect resembling the beech. Even when used for furniture, it is very soon affected by rot. I have cut up a great deal of this wood for herring-barrel staves, for which purpose it requires to be from four to six inches in diameter; but since the price of barrel staves has fallen so low — they being in 1848 only 60s. per one thousand superficial feet—a better return is obtained for the wood by peeling it, and selling it to the powder manufacturers. From them I have this same year got 24s. per ton; and as they take the smallest size of wood as well as the coarsest or largest, this price gives a better return to the proprietor than having all the trouble of cutting the wood into staves, and only getting 60s. for the thousand feet of these.

The foliage of the birch is small; and in spring it has a peculiar sweet smell, particularly after a shower of rain. The leaves are what botanists term *ovate*, *acute*, and somewhat *deltoid;* unequally *serrated*, and nearly smooth. Fig. 70 is a representation of these. This tree is raised from seed, which is generally ready for gathering about the first week in October. When gathered, it should be kept in a dry and airy loft or room all the winter, and should be sown in the month of March. In sowing it, care should be taken that the earth upon which it is sown be very finely wrought by the spade and rake. The soil ought to be light, and the surface made as fine as oatmeal, before sowing; and even in the act of covering in the seed, great care is necessary to see that it is not covered too deep; in fact, the slightest covering of earth is sufficient; and this, too, should be of the finest quality. I have frequently seen in nurseries of rather a stiff soil, which could not be easily brought down fine enough to a *mould*, the surface made as smooth as the soil would admit of, and finer soil brought from another part for the purpose of covering in the seed after sowing. Indeed, when the soil cannot be got of a nature fine enough, a very good plan is to sow upon the prepared surface, and give the seed no covering at all, but merely a *clap* with the spade, in order to keep the wind from blowing it about. By this plan I have seen an excellent crop of young birches raised.

FIG. 70.



About the first week of June the plant will be seen to come up in abundant thickness upon the beds; and as they are easily hurt by weeds, they should receive very particular attention in the way of keeping them clean.

One year after the seeds have been sown, the young plants may be lifted and transplanted out into rows in the nursery ground; and when they have stood two years in that state, they may with safety be put out into the forest grounds.

The birch is a tree by no means particular as regards soil and situation; in fact, it is one of the most hardy trees we possess, being found to exist as a low tree in the mountainous districts of Scotland, at an elevation of fully three thousand feet above the level of the sea. But notwithstanding this hardihood, it does not attain respectable dimensions unless planted upon a fair soil, and at an elevation something under two thousand feet above the sea-level. This tree delights naturally in a dry sandy or stony soil, which is generally of the poorest quality; but the largest specimens of it that I have seen, grow upon a sandy loam, having a bottom by no means of the driest nature; and as far as I have observed the natural habits of this tree, it does not disagree with a little moisture, provided this does not remain stagnated about the roots.

As a forest tree, I have found the birch very profitable when mixed among Scots and spruce firs in any high-lying part inclined to moss, and which had been newly dried of moisture. In such places of a new plantation I generally mix from one-third to one-half of birch plants among the firs; and when, as is most likely to be the case, a number of the firs do go back, the birches, being regularly mixed among them, keep good to a certainty, and may be relied upon for a cover. Near to a powder manufactory I have seen a *hag* of birch of this description pay much better than the firs could do upon the same situation. In high situations I make it a practice, in the marking out of new woods, to plant along the most exposed margins birch among firs, where I suspect these latter have a chance not to succeed healthily. By doing so, I am sure to have ultimately something useful upon the soil, when otherwise there might have been complete failure.

As a coppice-wood the birch answers well; indeed, in several instances, I have found a hag of birch coppice more profitable than one of oak, at the present time when oak bark sells at £5 per ton. Where there is not much demand for small oak coppice-wood, a hag of birch at the same age is decidedly superior in value to one of oak; seeing that in the case of the birch we can sell both bark and wood, however small, to advantage.

SECTION XV.—THE ALDER.

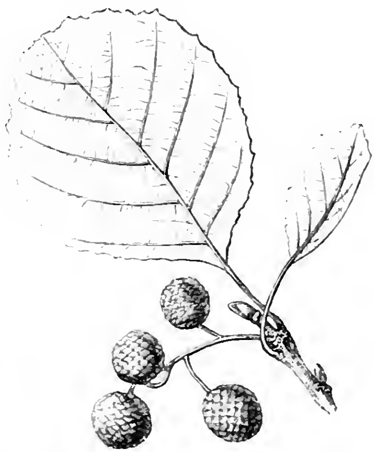
The ALDER *(Alnus Glutinosa)* belongs to the natural order AMENTACEÆ; and according to the Linn. system, to *Monœcia Tetrandria.* It is another of our truly native trees, being found wild along the banks of rivers and marshy parts of our waste lands. In these cases it is seldom found of large dimensions, but generally as a large bush, or at best as a small deformed tree; but where attention has been paid to it, and it has got the same management as other forest trees, it attains a size by no means despicable, being frequently found, upon a good loamy soil, from forty to fifty feet high, and of proportionable scantling; but in no case will it attain a large size unless it have a considerable degree of moisture for its roots, which is always found by it upon the margins of rivers.

The wood of the alder is by no means valuable, nor is it generally applied to many purposes. It is reckoned one of the most lasting of all woods for any underground work, such as piles for bridges; and it is even allowed to stand a long time when covered from the effects of change of dry and moist. So far as my own experience goes, this wood is the one which of all others I incline to reject in the making of any common out-door work, such as fencing; in fact, I have found stobs of this wood useless in less than one year, they being rotten at the part between the earth and air. Still, as a coppice-wood I have found it very valuable; and that either for the purpose of making charcoal for the proprietor's own use, or for selling for powder-wood, for which purpose it sells at the same rate as the birch,—that is, twenty-four shillings per ton for the peeled wood. But unless in districts near to a powder manufactory, I am not of opinion that it could be made profitable, even as a coppice-wood, for any other purpose, unless, indeed, for herring-barrel staves, which do not now pay well.

The leaves of this tree are roundish, and *cuneiform*, wavy, or obtuse-lobed on the margin, *serrated*, and sometimes of a clammy nature on the surface: they are also somewhat downy on the angles of the veins.

Fig. 71 represents the leaves of this tree, and also the catkins containing the seeds. The alder is propagated sometimes by cuttings of the young wood, but principally from the seed. Indeed, although the method of propagating it by cuttings is sometimes resorted to, the plants raised by such means are of little real worth, and never arrive at the character of a tree as those do which are raised from the seed. The young plants ought, therefore, in all cases where healthy young trees are desired, to be raised from the seed. The seed should be gathered in the month of October, or at least as soon as the scales of the catkins or seed-vessels begin to open a little. When the catkins are gathered, they should be well exposed to the sun upon a sheet for a few days, in the open air, when the scales will open widely, and allow the seed to be separated by a slight rubbing and turning with the hands. Many seedsmen, when they gather the seed of the alder, simply lay it past in a dry room, and turn it frequently till the seeds fall out of their own accord. It should be sown in the month of March, and slightly covered. When the plants have stood one year in the seed-bed, they may be planted out into rows in the nursery ground, and there they may be allowed to remain one or two years, according to the strength that the plants may be required to be. The alder is by no means particular as regards quality of soil, but moisture is indispensable. In travelling through the Highlands of Scotland, we often meet with large tracts of this plant, which is always found luxuriating in the swampy low-lying grounds; and this at once points out the circumstances favourable to its growth. The alder ought never to be mixed with other trees in a plantation, unless, indeed, we may except the spruce fir. These may, under peculiar circumstances, be planted together; that is to say, where it may be

Fig. 71.



intended to raise up a *hag* of alder coppice, spruce firs may be planted as nurses among them, and thinned out for paling, &c., as they advance. Wherever alder has been planted in the form of coppice, it is a tree not easily rooted out of the ground again, and it generally renders the soil upon which it grows more injured than improved; for it is always observable that the alder, if once it gets a footing upon a moderately damp soil, will very soon make it a complete morass. Therefore I am not in favour of planting alder at all, unless it be upon some waste unimprovable piece of land; and perhaps even then, under good management, the birch may be more profitable.

SECTION XVI.—THE OAK.

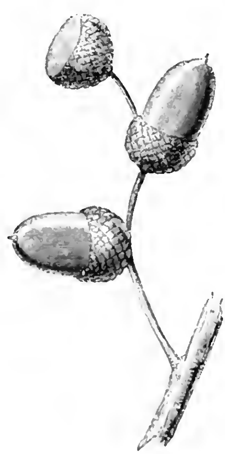
The Oak *(Quercus)* belongs to the natural order Corylaceæ; and according to the Linn. system, to *Monœcia Polyandria.* The oak is generally allowed to be the most durable of all our forest trees. Many have maintained that it is the most profitable tree that can be planted upon a fair soil and site; but as to this I am now convinced to the contrary. I at once admit that where the oak is allowed to arrive at perfect maturity, and cut down for use neither too young nor too old, but say at from eighty to one hundred years, it is the most valuable wood we have as to durability; but as to making a profitable return to the grower of wood, it is far surpassed by that most useful tree, *the larch.* This I am prepared to prove to any who may be of a contrary opinion; for having cut down both oak and larch at all stages of their growth, I have invariably found that, under good management, and giving both trees a proportionate number of years upon a given soil, the larch is by far the most profitable for the planter. There is an old saying among foresters—and it is indeed a true one—that "a larch will buy a *horse* before an oak will buy a *saddle.*" But notwithstanding that the oak, in point of profit, must yield to the larch, it is, and will be, an indispensable tree in British forests, and will likely remain so as long as the British navy has to be maintained, and as long as our landed proprietors retain a taste for the ornamenting of their grounds upon anything like a scale of grandeur and natural effect.

As to the oak being a tree well adapted for the park, it would be superfluous to attempt setting forth its merits in this respect. This has already been done by many able writers upon the subject; and I admit that the tree is indeed, in an ornamental point of view, worthy of all the praise that has been bestowed upon it; and as to grandeur and effect, it may indeed be styled "the king of the forest."

There are two distinct species of oak found growing in our forests, namely, the *Quercus pedunculata*, and the *Q. sessiliflora.* The botanical characters of each of the species are these: The *Q. pedunculata* has its leaves oblong, smooth, *dilated upwards*, *sessile*, or with very short petiols or foot-stalks; the lobes *obtuse*, with rather acute *sinuses*; the stalks of the fruit *elongated*, and acorn *oblong*. Fig. 72 represents the leaf of this species, and Fig. 73 the fruit upon its elongated stalks.

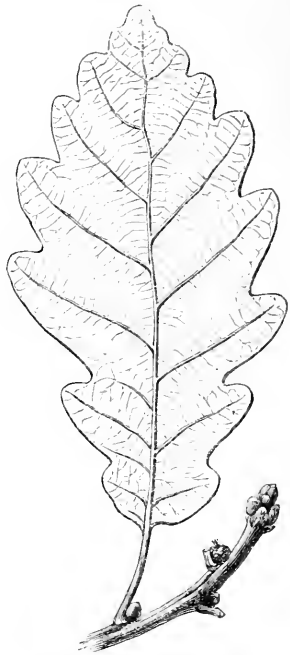
Fig. 72.

Fig. 73.



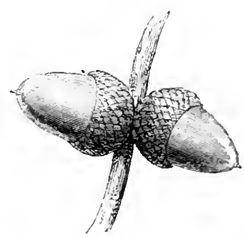
The *Quercus sessiliflora* has its leaves on *elongated* foot-stalks, smooth and oblong; the *sinuses opposite*, and rather acute; the lobes obtuse; the fruit sessile or *sitting*, and *oblong*. See Figs. 74 and 75.

Fig. 74.



The above are the distinguishing characters of the two species, as given by botanists; but such descriptions are not at all sufficiently distinct for the distinguishing of the two species, when laid before a person who may be unacquainted with botanical terms; and for the guidance of such, I shall here give the distinguishing marks of the two species, as observed by some of our most intelligent practical foresters who have for many years paid attention to the habits of each, and who, with myself, are decidedly of opinion that the one sort is unquestionably superior to the other.

Fig. 75.



It will be observed that the two most distinguishing characters of each of the two species of oak, as mentioned above, are—*Q. pedunculata* has no petiols, (see Fig. 72,) and the fruit has pretty long foot-stalks, (see Fig. 73;) again, *Q. sessiliflora* has its petiols pretty long, (see Fig. 74,) and the fruit is entirely without stalks, (see Fig. 75.) These, let it be understood, are the most prominent distinguishing characters of the two species, as generally given by botanists, but they are not always to be relied upon; for even in examining a number of leaves upon the same tree, we may find some of them that will answer to both species. But generally speaking, these differences between the two kinds do hold good to a great extent; and an experienced person, who has been long in the habit of examining the leaves of each species, can at once, even from the forms as already explained, point out the different sorts. But besides this, there is another mark of distinction, which is even more decided than the marks taken from the fruit and leaves —namely, that from the buds upon the young wood. The buds upon the *Q. sessiliflora* are more prominently brought out upon the wood than those of the *pedunculata;* and the wood at the base of the buds is also more fully developed. See Fig. 74, where a piece of the young wood is shown; and compare the buds as shown there with those shown upon the young shoot in Fig. 72, which represents a piece of the young wood of the *pedunculata.* As in Fig. 72, the young wood swells but slightly at the base of the buds, and this is generally the case with the *pedunculata;* whereas in Fig. 74 the young wood swells boldly at the same point; and this is generally the case with the *sessiliflora.*

There are, indeed, many who deny that there are two species of the oak found in our forests; for, say they, "the distinguishing characters of each do not always hold good." This I readily admit; for I am daily in the habit of seeing oak trees, and of examining them, and I daily see that, so far as the distinguishing characters that have been pointed out go, they are very often blended together in one tree. But this is easily accounted for by the two species having been long growing in the country together, from which have arisen many trees, which are no doubt what may properly be termed hybrids between the two. When, however, we do find the trees distinctly developing each its own characters, the marks given will hold good, and point out which are the true original sorts, and which are hybrids. And further, upon this point, the *Q. pedunculata* is, to appearance, not such a free or rapid growing tree as the *sessiliflora.* At all the stages of the growth of both trees, the *pedunculata* has always a more stunted, and, as it were, a more unhealthy appearance than the *sessiliflora;* in fact there is, to the experienced eye, an expression in each tree which at once distinguishes the one from the other, and which at the same time cannot be explained, although quite evident to the mind and eye of a practical man. I could, myself, at first sight of an oak tree, say which of the kinds it was; and yet I could not explain to a person with me the marks of distinction which led me to say that this tree was one sort and not the other.

With regard to the quality of the wood of each of these kinds, I am aware that many say that the wood of the one sort is as good as that of the other, and that it is superfluous to make any distinction between the two. Some have even gone the length of asserting, that the sort which is generally esteemed as the best in the quality of its wood, is in reality the most worthless; but this has been said by men who had no knowledge of the truth of the matter, and has been at all times contradicted by men who have had ample experience in the cutting up and using the trees of both sorts. For my own part, I am so thoroughly convinced of the superiority of the wood of the *Q. pedunculata*, that in planting I reject every young plant that has the appearance of the other sort; and this in order that I may decidedly introduce the *pedunculata*, and exterminate, if possible, the *sessiliflora*, the wood of which is decidedly of an inferior quality as compared with the other. As to the truth of what I have asserted, I shall state one example, among many others which I could give, of the comparative worthlessness of the *sessiliflora* oak. Since I came to Arniston to act as forester, I have cut down several of that species, of full age, and of pretty large dimensions. In the year 1843 we had occasion to cut up a considerable quantity of oak for colliery waggons, for which purpose I sent to the saw-mill, among several of the *pedunculata* sort, three trees of the *sessiliflora*, which were all cut in the month of June for the sake of their bark. In the act of cutting up the wood, the men remarked that there was a great difference in the quality of the wood in some of the trees as compared with that of others; and that those which had the greatest portion of *red* or *heart-wood*, were the trees which were easiest to saw. This was exactly what I wanted to ascertain. I wanted to see if the men, who were not even aware that there were two sorts of the oak, they being merely sawyers and not foresters, in their own simple way could detect the difference between the two species in the act of cutting them up; and they did so very readily. I stood in the mill and saw them cutting up one of the *sessiliflora*, and found that the saws went through it much in the same manner that they would do when cutting up a piece of elm. But when they put on a tree of the *pedunculata* sort, the saws became heated in a very short time; and before they could go from end to end of the tree, the men had to pull back the tree for a time, and allow the saws to cool. This at once points the hard and solid nature of the one tree as compared with the other. In the above example, the trees in question were distinct specimens of the two sorts, being very true to the general marks previously given.

It is, in my opinion, a point well worthy the consideration of all interested in the welfare of our home woods, to see that the *pedunculata* sort be introduced in a decided manner, and the *sessiliflora* rejected. It is, indeed, fortunate that the latter sort is by no means plentiful as compared with the other; but as it will no doubt have a tendency to increase if not watched, it will be wisdom in those who have the management of woods to see that it is kept as much down as possible.

It is well known that the wood of the oak is used for a great variety of purposes, even to name which would be superfluous; but the principal purpose for which the largest of our oak trees are used, is shipbuilding. From the Government forests in England a considerable quantity of oak is cut for the supply of the navy; but not the tenth part required is produced from that quarter. A large quantity is supplied from the different proprietors in the kingdom, who, of course, rear it upon their estates for sale; and, in addition to this, a large quantity is generally got from abroad; thus showing the great necessity there is for an increase in the extent of our home forests, in order that we may not be so much dependent upon other nations for a supply of timber to keep good our navy.

The quality of oak timber depends very much upon the nature of the soil and situation upon which it is grown. I have had oak timber cut up from situations near the sea, and also far inland, and upon a high exposed part; and my experience upon this point leads me to say, that the trees grown in a low situation and upon a light soil, do not produce such hard and durable timber as trees grown upon the same nature of soil on a high situation; but trees grown in a low situation, and upon a heavy clay soil, produce better timber than trees grown upon the same nature of soil on a high situation. This it is reasonable to suppose; for, upon a high exposed part, trees will not succeed well upon land of a cold bottom.

Upon the estate of Arniston we have a few full-sized oak trees yet growing upon an open sandy moss of two feet deep, which rests upon a subsoil of hard gravelly till. The trees are partly of the *sessiliflora* and partly of the *pedunculata* sorts; and the quality of the wood of each of those sorts is, upon that soil, very inferior to that produced by both kinds upon a stiff soil. Therefore, from experience, arising from observation of the quality of the oak as produced from different soils and situations, I am now convinced that, in all sheltered situations, the oak produces the best timber upon a heavy clay soil; and upon exposed situations, the best oak timber is produced from land of a loamy, or rather light dry nature.

Upon the estate of Arniston our best oak timber is produced on a sandy loam, resting partly upon sandy clay, and partly upon gravel beds. I may mention one particular tree, of the *pedunculata* sort, upon the Arniston grounds, which is still growing, and in good health, upon a loamy soil, situated on a sloping bank. It is between seventy and eighty feet high—is eighteen feet in circumference near the ground—and contains about two hundred and fifty cubic feet of timber. The size of oak timber most suitable for country purposes, is from six to twelve inches on the side of the square; and for shipbuilding, all sizes above twelve inches on the side of the square are used. A great part of the timber used for shipbuilding must be crooked; consequently, oak of a crooked or bent character sells at a much higher rate for that purpose than straight timber, although the one may be of as good quality and of as large a scantling as the other.

The oak forms an excellent hedge-row timber tree. Perhaps it is the best for that purpose of all the forest trees we have: for my remarks upon this, see Section headed *Hedge-row Timber.*

As a coppice-wood, the oak has long held a high place, more particularly on account of the bark it produces for tanning purposes; but now, since that article has fallen so very low in price, it is not such a profitable part of forest culture as it has been. For a more particular account of this, see Section headed *Management of Oak Coppice.*

The oak is raised from seeds, which are named acorns. These generally ripen in the month of November; and as soon as they are ripe, they should be gathered and sown immediately, because they are very apt to be injured by being long kept, more particularly if they be not kept dry and in a cool part. If kept perfectly dry and cool in an airy loft, the acorns may indeed be preserved all winter, and sown in the spring; but as they are extremely apt to be injured by careless keeping, the better plan is to sow them at once when gathered.

Some nurserymen are in the habit of sowing them in rows, and others in beds, covered with about two and a half inches of earth. My own plan is, as soon as I have the acorns at hand, to sow them in rows upon the surface of the ground, which I have previously dug and prepared, and cover them with from two to three inches of earth. In sowing them, I mark off the rows about two feet distant one from another. The breadth of the seed in the row may be about five inches, and the seed may average one to every three square inches. In covering the seed, I gather up the earth from the ground upon each side of the row that is sown, until it is the desired depth upon the acorns, taking care not to come too near the seed upon the sides of the row, but keeping it there rather heavier of earth than above; for it is generally upon the sides of the rows that vermin make their attacks upon the seed.

After the acorns have been sown, they must be paid attention to, to see that vermin of any description do not attack them. In the winter season, if mice or rats are in the neighbourhood, they will be certain to attack them; and if they do, traps must be used in order to destroy them. And in the spring months, if pheasants or any other birds commence upon the acorns, nets may be used in order to cover the beds or rows from them; or if these be not upon the place, and cannot be had conveniently, they may be covered pretty closely with the branches of trees, which will keep back birds, and at the same time allow a free circulation of air to the surface of the earth. This I have frequently had to do myself, and found them to answer the purpose very well. As soon as the young plants appear above ground, which will generally be about the end of May, the branches may be removed in order to give the young plants all justice. But about gentlemen's woods, where a home nursery has been established, pheasants are very often numerous; and I have seen them prolong their attacks upon acorns long after the plants were coming above ground. In fact, I have seen the pheasants, in the nursery at Arniston, prove as destructive to the acorns in the month of June as at any other time in the year; and that, too, after the plants were generally above ground. The plan which I found most effectual against them in such a case, was to have two boards, of about one inch thick by six inches deep, connected by spars of about one inch square and a foot long. These spars I had nailed across upon the edges of the two boards, two inches separate from each other, thus:—

and these frames or sparred boxes I had made in lengths corresponding to the lengths of the rows upon the ground, and had as many of them made as covered all the seed sown, keeping the open side, of course, resting upon the ground, and the sparred side uppermost. This kept the vermin off, and at the same time admitted free air about the plants; and as such frames will last for many years for the same purpose, they ought to be stored by in a dry shed when not in use.

The young plants, whether grown in rows or in beds from the seed, should be allowed to remain in the same state for two years, when they ought to be lifted carefully by a strong-necked and long-bladed spade, which is meant to go well into the ground, and bring up the plants with the roots as whole as possible. When the plants are lifted, they ought to be kept in two sizes, and about one-third of the length of the root of each cut clean off with a sharp knife. They should next be transplanted out into the open nursery ground, into rows about two feet separate, keeping the plants in the rows about four or five inches from one another; and in this state they may remain for a length of time, according to the size that the plants may be required; that is, if the plants are not wished to be large, two years in the rows may be enough, but in no case less; and if the plants are required to be large, three and even four years in the rows may be no more than sufficient.

The oak, the first year after being transplanted, makes very little progress, merely establishing its roots in the ground. The second year it sends out new shoots, and the third grows vigorously. Where it is intended to have plants of a pretty large size for any particular purpose, they ought to be transplanted rather widely in the nursery rows—say at from six to nine inches; and if, at that distance in the rows, they be allowed to remain for four years, they will be very good plants indeed. It is a good plan, in all cases of cultivating the oak, to prune the plants in the spring before lifting them; that is, if it be intended to lift plants from the nursery rows in the month of November, they should be pruned in April, which is a great means of preserving the health of the plants, and keeping them in proper shape.

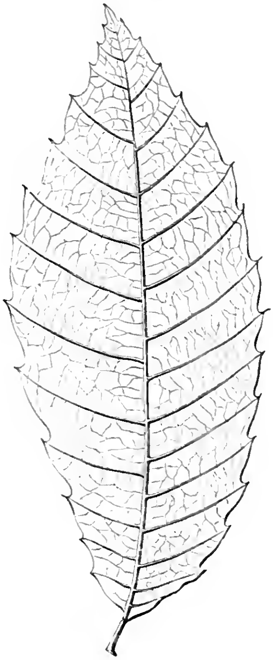
SECTION XVII.—THE SWEET CHESNUT.

The Sweet Chesnut (*Castanea vesca*) belongs to the natural order Amentaceæ; and according to the Linn. system, to *Monœcia polyandria.* This is a tree which, in a favourable situation, attains large dimensions, frequently surpassing even the oak in this respect; and when grown in an open park or lawn, it is a highly ornamental tree, its general bearing at a distance very much resembling that of the oak; and in the autumn, when its leaves take on a yellow colour, it has a beautiful effect among other trees of darker foliage. Cultivated in these circumstances, also, it lives to a great age. As a timber tree, however, it falls far short of even what we may consider as our secondary sorts. It does not even attain large dimensions, unless it have the advantage of a good loamy soil and a good situation, and is therefore not adapted for generally planting out as a forest tree in any exposed situation upon an indifferent soil.

When young, it grows very rapidly, and very soon attains a large size; but I have seldom seen one which had arrived at the age of fifty or sixty years, which was not *ring shaken* in the heart-wood, and, in fact, almost useless for any particular purpose. Knowing this to be the case with the tree in most situations, I am not inclined to plant it much myself, and of course cannot conscientiously recommend its cultivation to others—at least with the view of raising useful timber from it. The wood of the sweet chesnut is, however, generally found good for many purposes up to the age of fifty years; and as a secondary tree, or one which is grown for a time among others which may be meant to stand as a permanent crop upon the ground, it is very well adapted. But even allowing that this tree would do well as a secondary, or nurse, in many situations, I have, for my own part, never found an instance in which its place could not be more profitably filled by the larch, ash, or sycamore; and I never do introduce the sweet chesnut into any forest ground of which I have the management. In all cases where it might be planted as a secondary tree, and where it might be cut down in order to give room to others by the time it was from thirty to forty years old, I have found that the larch or ash is far more profitable; while, as a tree for a permanent crop, its place is infinitely better filled by the oak, larch, or ash. The wood of the sweet chesnut is undoubtedly very durable. For stobs and gate-posts I have found it answer most excellently; and even for cart-trams it answers well when from thirty to forty years old, and for many other purposes besides. I have cut a considerable quantity of this wood for herring-barrel staves, for which purpose it is well adapted; but at present it would pay a proprietor very poorly indeed to grow this sort of wood for that purpose. It is, however, excellently adapted for coppice-wood; and in all districts where there may be a demand for hoop-wood of various sizes, or for hop-poles, the sweet chesnut would pay well in the form of coppice. It readily throws up a succession of young shoots from the stoles when cut over, which grow very rapidly for the first eight or ten years, frequently at the end of that period producing shoots from three to four inches in diameter, and from fifteen to twenty feet high; and these, too, very numerous round the stoles.

The foliage of the sweet chesnut is full upon the young wood, and has a very fine effect in the early part of summer, as well as in the autumn, when it begins to take on the yellow tinge. The leaves are what is termed by botanists oblong lanceolate, acuminate, and mucronately serrated. (See Fig. 76.)

Fig. 76.



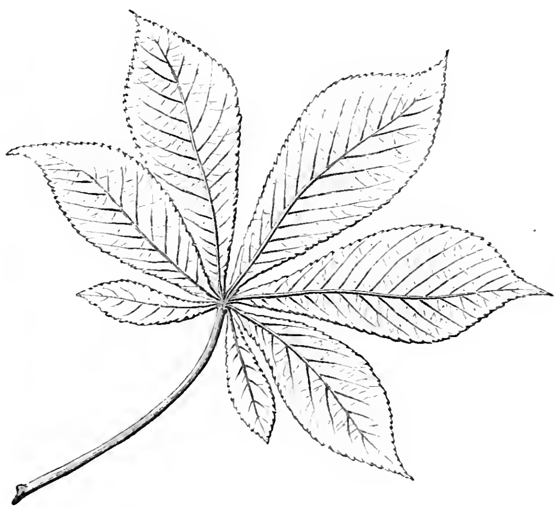
The sweet chesnut is propagated in exactly the same manner as the oak; and what has been said relative to the oak is equally applicable to the sweet chesnut; but with this exception, that the chesnut is generally transplanted from the seed-bed at one year old, and being, when young, of a more rapid growth than the oak, is generally ready for transplanting into the forest ground after having been two years in the nursery rows. In all cases where it is desired that they should grow to good trees, they ought to have a good loamy soil, upon a dry and rather sheltered situation.

SECTION XVIII.—THE HORSE CHESNUT.

The Horse-Chesnut (*Æsculus hippocastanum*) belongs to the natural order Hippocastaneæ; and according to the Linn. system, to *Heptandria Monogynia*. This is a tree of great beauty, and may properly be said to be the only flowering tree we have upon our lawns. It is of very rapid growth, and in a few years attains a considerable size. But in order to attain respectable dimensions, and to have the appearance which its massy foliage and heavy limbs are calculated to produce, it requires to be grown upon a good rich loamy soil, and in rather a sheltered situation; at least, it must be in a situation where it is not apt to be exposed to severe storms of wind. It is by no means a delicate tree, although a native of Asia: it is, in fact, a hardy tree, so far as regards the degree of cold which it can bear; but, from the short-grained texture of the wood, which is very brittle, it is not at all adapted to grow in an exposed situation. The wood of the horse-chesnut is of a soft nature and white colour, and by no means calculated for general use. On this account its general cultivation as a forest tree cannot be recommended; but as an ornamental tree, very few can surpass it. The leaves of this tree have a very fine massive effect when the tree is placed among others of a more light and airy character; and as they appear pretty early in the season, accompanied by the rich pink-white flowers, the tree is, upon that account, more worthy of a place upon the lawn. The naked tree is in itself of a stiff character, the young shoots being large, and not numerous. See Fig. 77, which is a representation of the young shoots, and Fig. 78, representing the

Fig. 77.

Fig. 78.



form of the leaves upon a reduced scale. This tree is propagated from the seed, which is termed a nut. These are generally ripe in the month of October, and they should be sown immediately when gathered, as they are extremely apt to lose their vegetative powers if kept long. They may be sown either in beds or in rows, in the same manner as has already been recommended for the oak-seed. The young plants make vigorous shoots the very first year, and are fit for being transplanted out into nursery rows when one year old; in which they may remain for one or two years, according as the plants may be wished to be small or large.

SECTION XIX.—THE LIME TREE.

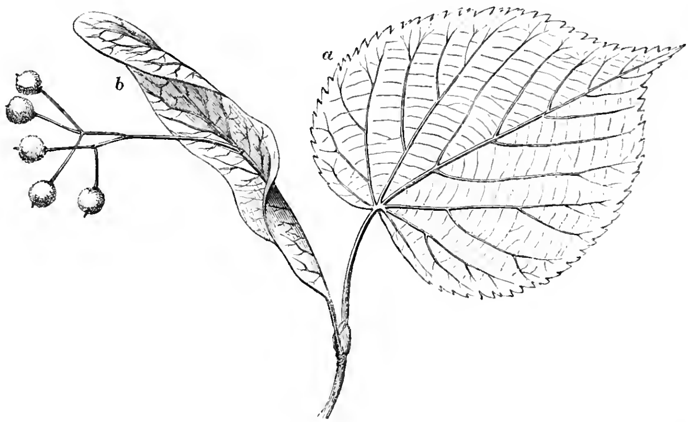
The LIME TREE (*Tilia Europea*) belongs to the natural order TILIACEÆ; and according to the Linn. system, to *Polyandria Monogynia*. This is one of the most beautiful and interesting of our ornamental trees in the month of July. Many object to it as being of a stiff and formal outline, and a clumsy habit, and as not presenting that shade and light which are required for picturesque scenery. This is no doubt true; but in certain situations, such as along the sides of walks or avenues, it is one of the most desirable of trees. Even when standing singly, freely exposed to the open air, and when contrasted among other trees, it forms a beautiful object when in full flower; indeed, as an ornamental tree, in almost any situation, few will object to its presence. This is a tree which, under favourable circumstances, attains very large dimensions, and lives to a great age. We have upon the Arniston grounds many fine lime trees; but there is one in particular, about ninety feet high, and four feet in diameter four feet from the ground, and, I believe, about two hundred years old. It is, in the end of July, and for some time in August, a perfect mass of flower, the sweet perfume of which is surpassingly agreeable for a good way off. In the sunshine, thousands of bees may be heard humming and busy gathering their store; and from the flowers of this tree it is said the best honey is produced.

The wood of this tree is white in colour, and of a peculiarly close and soft nature, being particularly well adapted for all turnery work. It is much sought after for boards upon which to cut leather. It is also used in the making of musical instruments, as in the case of sounding boards for pianofortes. In Russia and

Sweden, the inner bark of the lime tree is manufactured into the bass-matts which are so much used in this country for various purposes. It is also used in making charcoal for gunpowder.

The leaves of this tree are of a fine light green, and are described by botanists as smooth, *cordate*, *acuminate*, and *serrated*. (See Fig. 79, *a*.) There is a peculiar appendage attached to the petiol

Fig. 79.



or footstalk of the leaf of the lime tree, termed the floral leaf, out of which the flowers protrude, as it were, and which bears the seed. The seed very seldom ripens in this country, that only taking place in very fine seasons; therefore the tree is propagated by layers, by which mode it is very readily multiplied. It being a soft-wooded plant, it easily strikes root by layering. When the layers are one year old, they may with all safety be removed from the parent stock and transplanted into the nursery rows, where they may remain for one, two, or even three years, according as the plants may be wished to be large or small.

The lime tree is one which I have found very easy to transplant with safety at a considerable age and size. Hence it is very useful in filling up gaps, or for making groups to have immediate effect upon a lawn. In order to arrive at perfection in point of magnitude, it requires to be planted upon a good, rich, and rather dampish loam, and in a pretty sheltered situation; therefore it is by no means adapted as a useful forest tree for our woods.

SECTION XX.—THE SCOTS PINE.

The Scots Pine (*Pinus silvestris*) belongs to the natural order *Coniferæ*, and the Linn. order *Monœcia monodelphia*. This is the only one of the pine tribe which can be said to be a native of Britain; and in so far as regards the quality and usefulness of its timber, it is at least inferior to no other species which has yet been introduced; while it also becomes a tree of first-rate magnitude in favourable situations. It is one of the most hardy of our forest trees, being found in Scotland growing fully two thousand feet above the level of the sea.

At one period this tree must have been very plentiful in the Highlands of Scotland, and, no doubt, in many parts of the Lowlands, as is evident from the remains of trees yet to be seen growing. I may mention, in particular, the remains of the natural pine forests still existent about Invercauld and Rothiemurchus, where there are by far the finest specimens of this tree to be found in Britain. Although we give this tree the name of the Scots pine, it is by no means confined to this country: it is found growing naturally in most of the countries in the north of Europe and Asia, but it is said not to be found in America. It abounds very plentifully in the north of Germany, Sweden, and Norway; and from these countries we are in the habit of importing it under the name of *red-pine timber*, which is reckoned the best quality of pine timber imported from those countries.

In the natural forests yet remaining in Scotland, there are found trees of the Scots pine which have attained great dimensions. Mr Grigor, in his report, which may be seen in the *Transactions of the Highland Society*, says that he girthed many of the trees in the Duthal pine forests, and found them from six to twelve feet in circumference one foot from the ground. And upon the estate of Arniston we have a few trees of the Scots pine, from six to seven feet in circumference, with a clean straight boll of forty feet in height. These trees are growing among hardwood upon the lawn, and are, in my opinion, above a hundred years old. Their tall forms contrast beautifully among the rugged oaks and elms which grow near them. They are in perfect health, and are admired by every one who sees them. The quality of the Scots pine is much influenced by the nature of the soil and situation upon which it is grown, as well as by the age at which the tree is cut. The timber produced upon cold high districts in the north of Scotland, is found, when of proper age, superior to any imported from any other part of Europe; while that which has been planted and reared in the Lowlands of Scotland, as well as in rather rich soils in many parts of England, is not nearly so good, although the same age. Even within the Lowlands themselves, the quality cf the Scots fir is very much influenced by the particular situation upon which it is grown. As an instance of this, I may here mention, that upon the estate of Arniston, the Scots pine growing upon the high and exposed parts of the estate is of excellent durable quality, while that growing upon sheltered parts of the home plantations is extremely worthless and soft. This same observation is equally applicable to every other estate in the Lowlands, the best timber always being obtained from trees growing upon a thin dry soil and a high exposed situation.

Relative to the quality of the timber of the Scots pine, I shall make a few remarks as to how it is affected by the age at which the tree is cut. Being daily in the habit of selling home timber of all kinds, and of cutting it up for various purposes, I frequently hear carpenters and wood-merchants in general condemn our home Scots pine as worthless when compared with pine timber from the north of Europe. Now, as I am so well aware of the prejudice that exists against the quality of our home pine, I am anxious to point out the true cause of this supposed worthlessness.

I have myself cut down Scots pine trees in Scotland, which, when cut up into planks, were, by those who spoke much against the quality of our home wood, considered to be fully equal to any pine which they had ever seen imported from the north of Europe. But observe the reason. The trees referred to were above a hundred years old. The wood had got time to mature, and upon that account it was found of superior quality. Now, this points out the reason why our Scots pine timber, which is planted at home, is not considered of so good quality as that imported from the natural forests in other countries: it is not allowed to grow to maturity as is the case in the natural forests. I am decidedly of opinion that, where the trees in the natural forests are of the same age with those planted in our artificial forests, the quality of the wood will be equally as good in the one case as in the other,—circumstances of soil and situation attending each being equal.

In all situations, whether the natural forest or the artificial plantation, the Scots pine is slow in maturing its wood. In high and exposed parts, upon a rather poor soil, heart-wood begins to be formed when the plant is about twenty-five years of age; while, if the plant be growing upon a rich soil having some shelter, the growth of the wood will be carried on rapidly, and heart-wood may not be made till the tree is nearly forty years of age. Now, I am aware that this point is very seldom taken into consideration; and many upon this very account condemn the wood of the Scots pine as being useless, not thinking that every tree requires time to mature its wood. Even the oak itself is but comparatively worthless as a timber tree when young, and requires a time to ripen into proper heart-wood.

We are well aware that the pines growing in the forests of Rothiemurchus are considered as good in the quality of their timber as any of the red pine from the north of Europe; and we can easily account for the superior quality of this wood as compared with thinnings of Scots pine as generally cut in the Lowlands. Mr Grigor, who examined and reported upon the Highland fir in a very minute manner, says that he found the trees in the forests of Rothiemurchus to average from one hundred and twenty to one hundred and twenty-five years; and in the forests of Abernethy he found the trees from two hundred to two hundred and forty-two years. Again, in the north of Europe, those who cut down the pine forests in order to supply our market here, do not consider the wood full grown till it is considerably above one hundred years old. In the face of this fact, how can it be justice to the tree of which we are treating, to say that, because we do not find the Scots pine in this country excellent wood when under forty years old, it is to be condemned as a worthless tree?

Give it from eighty to a hundred years in order to ripen its wood, and the Scots pine will, in our home woods, produce as good timber as any got from foreign parts, if we but grow the tree in a soil and situation adapted to it.

There is another circumstance in the management of the wood of the Scots pine which very much affects its quality—namely, its being cut up immediately when felled. I can attest, from experience, that the wood of the Scots pine, when in a young state—and, indeed, this is the case with most other trees—if allowed to lie in the bark undisturbed for a few weeks or months after it has been felled, is sure to be worthless in the timber; but if cut up for any purpose immediately when felled, and the natural sap properly dried out of it, the wood will last three times as long as in the opposite case. Even in the case of making stobs for fencing from the wood of the young Scots pine, if they are made and driven into the ground immediately when full of the natural sap, they will last but a very short time indeed; but if made immediately when the trees are felled, and exposed to the sun in order to become properly dry — say for one or two months — such stobs will last double the time that they would have done otherwise. I have experienced the same thing as to wood for other purposes, having in all cases found the quality of the timber much improved by having it cut up, and the natural sap expelled as soon as possible.

The uses to which the wood of the Scots pine is applicable, are almost endless. There is, indeed, no tree, the wood of which is or can be used for so many different purposes: but the most generally applicable forms are those of boards and scantlings of various dimensions.

There are two varieties of the Scots pine—the *P. silvestris*, and the variety *Montana*, which is the true *Highland* or *Bonnet fir*. The late Mr Don, of Forfar, says, " that the *montana*, or true pine, is distinguished by the disposition of its branches, which are remarkable for their horizontal direction, and for a tendency to bend downwards close to the trunk. The leaves are broader and shorter than in the common kind, and are distinguished at a distance by their much lighter and more beautiful *glaucous* appearance. The bark of the trunk is smoother than in the common kind: the cones are thicker, and not so much pointed. The plant is also more hardy, grows more freely in almost any soil, and quickly arrives at a considerable size." Of the truth of this assertion of Mr Don's I am perfectly satisfied, although many botanists will not allow that these two species are really distinct. They say that soil and situation have the effect of changing, in a great measure, the external appearance of this tree; but those who so assert cannot have had much experience of them. I have myself seen, and that frequently, the two distinct kinds growing in the same plantation, and close to one another. Now, were it the case that soil and situation changed the external appearance of the trees, why were they found to have different external appearances, when growing upon the same soil and site?

There is another feature which is very remarkable in the true pine as compared with the common one; namely, the tree when young has a tendency to throw out its side branches pretty strongly, until it becomes fairly established in the soil, and has commenced to make strong and vigorous shoots upwards; then, as soon as it has its growth properly established upwards, the side branches gradually become less strong in proportion to height and dimensions of the bole; and when the tree has reached the meridian of its growth, and is growing more to heart-wood and girth of timber than to height, its top branches begin to enlarge considerably, and take a more horizontal direction, and incline to bend downwards at the points. When seen in this state unconfined, and with free room to spread out its horizontal limbs, the Scots pine is a tree of first-rate rank, even in an ornamental point of view. Even the oak itself is not more venerable and picturesque in appearance than a well-grown specimen of the true Highland fir.

The Scots pine is entirely propagated from seed. Nurserymen are fortunately giving great attention to procuring the seeds of the true or genuine sort—the *Pinus silvestris montana.* This is the more necessary, when we take into consideration that proprietors who plant depend upon the nurserymen giving them plants of a proper and valuable sort. They are in the habit of procuring seed from the trees in the native Highland forests. Some of the most spirited of them have of late procured seed from trees in the native forests upon the Continent, where the *Pinus silvestris* grows of excellent quality. Plants produced from such seed are termed *Riga pines.* Few foresters have time enough to devote their attention to the gathering of the seed of the pines as found in our native forests; and even although they had, I have found from experience that the young plants cannot be raised by foresters nearly so cheaply as they can be had from respectable nurserymen, to whom a fair price ought to be given, in order to enable them to send out trees of the most reputable sort. I am, indeed, an advocate for the rearing of young trees upon the same locality upon which they are ultimately to be planted. In order to secure this end, I buy the seedlings from a nurseryman whom I can trust as regards his giving me plants of the true sort; and after having them transplanted for one year into a nursery in the neighbourhood of the plantations in which they are intended to be put, I have them removed to their site. In saying that I buy my Scots pine seedlings from a nurseryman in whom I can trust, I beg to be understood that, in looking at the young seedling plants of the two varieties of the *P. silvestris*, it is not always possible to distinguish the one sort from the other, even by the most practised eye; therefore it is necessary to place confidence in some particular nurseryman to raise plants of the desired sort.

Relative to the manner of raising young plants of the *P. silvestris*, I may state thus far: The cones are generally ripe in the month of December, and at that time they should be gathered. When the desired quantity is gathered, the cones should be stored past in a cool loft having a circulation of air, where they may remain till summer, when the cones must be exposed to the heat of the sun, which will open their scales and cause the seed to fall out by a gentle thrashing with a stick. When the seed has been collected, it may be stored past in a cool place, and sown in the following spring. Another process may be used, when it is wished to have the seed sown as soon as convenient. When the cones are gathered, they may be put into sheets, and exposed to the heat of the sun every good day; and if the weather prove a little warm and sunny, the cones may be opened and the seeds thrashed out progressively by the end of March or beginning of April, when it will be time to sow. I have myself brought the seeds very quickly from the cones by subjecting them to a slight kiln heat; but as I am convinced that this is an unnatural method, and very apt to be overdone if left to an unskilful person, I in all cases object to it, and think it better to abide by the slower process of opening the cones by the heat of the sun.

In sowing the seed, a piece of very fine light ground should be chosen. It should be well dug, and properly cleansed from all stones, weeds, &c., as the digging proceeds. The ground being properly dug and made fine, it should be marked off into parallel beds of four feet in breadth, each bed having a path of a foot broad between it and the next. The seed should be sown pretty thickly: I may say, at an average, *four seeds to the square inch.* When sown, it should be covered by about a quarter of an inch of very fine soil. As birds are very destructive to the pine seeds, the beds should be watched for a few weeks in order to prevent their ravages. The plants are generally allowed to remain two years in the seed beds, at which stage they are termed *two-year seedlings*, and are then transplanted into nursery rows, in which, if they remain one year, the plants are termed *one year transplanted;* and if two years, *two years transplanted;* both of which sizes are planted out into the forest ground according to circumstances, which will be explained in the proper place.

The Scots pine is not a tree that can be said to be particular in regard to the quality of the soil upon which to grow it. The best Scots pine timber that I have ever seen, grew upon a gravelly loam resting upon a dry rocky bottom. I have observed some excellent timber of this kind in Perthshire, growing upon a very dry sandy loam. On the estate of Arniston, our best quality of Scots pine is growing upon a thin sandy surface soil, resting on a subsoil of gravelly till; and we have it also of excellent quality growing upon decayed rock. In short, I have seen the Scots pine growing on almost every variety of soil; but I am of opinion that a light sandy loam is, of all others, the most appropriate soil for this tree. In order to have its timber of good quality upon whatever soil it may be grown, it is absolutely necessary that it have a free circulation of air about it.

I have said, in the former edition of this work, that upon a mossy soil I had never seen good Scots pine timber growing. Since writing this, however, I have had a far more extensive view of the nature of the tree, and have here to state, that in Perthshire I could point out several estates upon which there is excellent and large Scots pine growing in a deep sandy moss; it having been, previous to being planted, well drained from superfluous water. Upon the estate of Scone, also, I observed very healthy young Scots pine trees growing in a mossy soil, it having been previously well drained.

SECTION XXI.—THE SPRUCE FIR.

The Norway Spruce Fir (*Abies excelsa*) also belongs to the natural order *Coniferæ*, and the Linn. order *Monœcia monodelphia.* This is a native of most of those countries which occupy the north of the European Continent, especially abounding in Norway, Sweden, and Russia. It is one of the tallest of the European coniferæ, except, perhaps, the *silver fir*, which is frequently found taller; but as a stately, well-formed tree, particularly when standing alone with full spread of branches, few trees are more admirable.

This tree grows in a peculiar pyramidal form, not like the generality of other pines and firs, diverging off into large limbs. The bole rises like a perpendicular stalk, clothed with proportionally small feathered horizontal branches from bottom to top. These, when the tree stands free and alone, gradually become smaller as they are found high upon the tree; thus giving the tree almost a perfect cone shape.

This tree naturally inclines to grow in what may be termed a dampish situation; and in Britain it is found to succeed best in a rather sheltered part. Indeed, upon a high site, if much exposed to cutting winds, the tree seldom attains anything like a respectable timber size in this country; more particularly if the soil upon which it is planted be of a dry, sandy, or gravelly nature, the tree generally becomes rotten at heart long before it arrives at anything like a useful size. To illustrate this point of situation more particularly—a point of great importance in the cultivation of this tree—I shall give an example or two from our spruce fir plantations at Arniston, showing how, by soil and situation, the spruce varies much upon the same estate. In a sheltered glen behind Arniston garden, there are spruce fir trees from eighty to ninety-five feet high, with a diameter near the bottom of from two to three feet; and generally these trees are in good health. The soil upon which they grow is in many places a stiff blue clay; in other places a clay loam; and in a few instances it is a sandy loam. These trees being nearly all alike situated as regards shelter, I find that the largest and healthiest-looking trees are those growing upon the clay loam; and next to them, those growing upon stiff clay; the least healthy being those growing upon the sandy loam. As these trees are all of the same apparent age, I conclude, from what I have observed, that, other circumstances being alike, the spruce fir will thrive best upon a loamy soil, and worst upon an open, dry, gravelly one. In other sheltered parts upon the estate of Arniston, we have large healthy spruce fir trees growing upon an open gravelly soil, where the roots have a supply of water oozing through the gravel. Upon another part of the estate are trees of good size growing on a deep mossy soil, which rests upon a bed of sand. These last-mentioned trees upon the mossy soil are growing most rapidly, the situation being on a sloping brae, and the roots have the advantage of a constant supply of water as it oozes up into the moss out of the sand below: therefore I am convinced that, in order to grow spruce timber of large size and healthy constitution, the soil must contain a good proportion of moisture, or at least be what is termed moist, but not stagnated. Again, higher up on our outer plantations, where there is not much shelter naturally, I find the spruce fir succeeds pretty well on any loamy soil, and even on a stiff clay, provided it be drained from surface water. In such situations we have trees fifty feet high, and eighteen inches diameter at bottom, at thirty-eight years of age, the trees being still in a vigorous, healthy state, and likely to become of much larger dimensions. Again, at the same elevation as that upon which the trees last stated are growing—namely, seven hundred feet above the level of the sea—spruce firs of the same age, but growing upon a gravelly dry soil, I find generally not more than thirty feet high, from eight to twelve inches diameter at bottom, and in general rotten in the heart; which at once points out that the spruce fir, in a high site as well as in a low, prospers much better upon a dampish soil than upon a dry one. Again, in our younger plantations, situated about nine hundred feet above the level of the sea, I find the same qualifications of soil relative to the tree hold good. At the elevation last mentioned, I could point out the spruce fir rotten at heart, and not more than twenty years old; and that occurs upon a dry gravelly soil.

The timber of the spruce fir is, next to that of the *P. silvestris*, the most useful for boards, planks, and roofing scantlings which we have in this country. It is of excellent quality when of mature age, being very light and pliable. The quality of the wood of this tree, however, is, like that of the *P. silvestris*, much influenced by the nature of the soil and situation upon which it is grown. When grown upon a dry soil, the wood is brittle and short-grained; but when grown upon a dampish loam, it is quite of an opposite character.

I must make an observation here, which I have often found verified by my own experience—namely, the spruce fir, when young and immatured, yields a far more durable timber than the Scots pine at the same age. In erecting paling-fences, I find that, taking the two trees for rails at thirty years old, the spruce will last two or three years longer than the other; and even as a gate-post or a stob, the same observation holds good. Notwithstanding this superiority of the wood over that of the Scots pine, country carpenters are always ready to recommend the Scots pine in preference to the spruce, even for such purposes as those mentioned above; and I make this observation in order that proprietors may be aware of the true state of the case.

The spruce fir is propagated in exactly the same manner as the *P. silvestris;* and the observations given regarding the gathering of the cones, and taking out and sowing the seed of it, are in every respect applicable to this tree. The spruce fir, however, is much slower in growth than the *P. silvestris* while in its seedling state. The seedling plants remain two years in the seed bed, but they generally require three years in the nursery rows before they are fit for being put out into their final situation in the forest. Many recommend the spruce as being an excellent nurse for hardwood trees; but I cannot assent to this opinion. So far as my experience enables me to speak confidently upon this matter, I must that I have found the larch and Scots pine far superior for this purpose. The spruce fir, as a nurse for hardwood, and for oaks in particular, is far too rapid in the early stage of its growth, often confining the oaks too much by the spread of its massy branches, as well as injuring the roots of the trees it is meant to protect. The spruce fir has very fibrous matty roots, which spread in every direction along the surface of the soil. Now these, from their matted closeness, keep the air from penetrating properly into the soil for the benefit of the hardwood, which send their roots deeper down; consequently much injury is often done by this means; and this I have frequently seen proved. The spruce fir, as also all the coniferous tribe, are best suited for timber when planted in a mass by themselves; but seeing that it is proper, and even necessary, to have a proportion of them planted for the benefit of nursing up our hardwood plantations while in a young state, I recommend planting the spruce but sparingly for that purpose, having found the Scots pine and larch answer mnch better.

SECTION XXII.—THE LARCH.

The LARCH (*Larix Europea*) belongs to the same natural and Linnæan orders as the coniferous trees already described.

There is one feature in this tree which distinguishes it from all others of the pine and fir tribes—namely, its shedding its leaves in the autumn of the same year in which they are produced. It is decidedly one of the most valuable of the coniferous trees yet introduced into this country, both in respect of the quick progress which it makes, and of the real value of its timber. It is a native of the mountainous districts of Germany, and is found to endure the climate of the north of England and the mountainous tracts in Scotland, as well as the Scots pine; but it is more particular with regard to the circumstances which favour its healthy growth than that tree. As an instance of the success of the cultivation of the larch in Scotland, may be taken the plantations of the Duke of Athol in Perthshire, which far surpass any others in Britain as regards both their magnitude and quality of timber. Upon the Arniston grounds, I the other day cut down several larches, one of which in particular, when lying prostrate upon the ground, measured, from bottom to top, ninety feet. We have others one hundred feet in height; and one tree yet growing upon the lawn contains about two hundred cubic feet of timber, and is apparently quite sound.

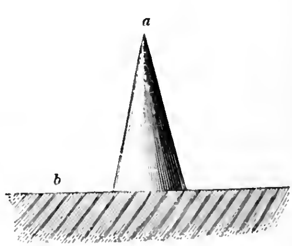
There are two varieties of the larch generally found in cultivation in the plantations in Scotland—namely, the white and the red. The white is the variety which attains the greatest dimensions of timber, and is the sort most generally cultivated, although they are both often seen growing together in the same plantation, and that by mere accident. It is said that upon the Athol estates the red larch does not attain to more than one-third the cubic contents which the white larch does; and this is observable in every plantation where the two varieties are found growing together.

As to the durability of the larch wood, it is allowed by all who are at all acquainted with the tree, and who have had occasion to use the timber, to be decidedly the toughest and most lasting of all the coniferous tribe we are yet acquainted with. There is also a peculiar feature characterising the wood—namely, its being durable and tough when only of a few years' growth. Of this I have had ample proof from my own experience in erecting fences with young larches. As the general result of my experience in erecting fences with the various sorts of pine and fir wood, I may state, that when I put up a larch paling with wood from fifteen to thirty years old, I reckon that the same should last from fifteen to twenty years; if of spruce fir, from seven to nine years; if of

Scots pine, from four to six years. These remarks, however, only refer to the wood forming the rails of a paling, not to the stobs which go into the ground. These do not last so long, as will be seen from the following estimates. If larch stobs are used, I expect they will last from eight to ten years in a fair state; if spruce fir, from four to five years; and if of Scots pine, from three to four years. Again, in putting up gate posts made of wood from thirty to forty years old, larchwood being used, I expect them to keep good from fifteen to twenty years; if spruce fir, from eight to ten years; and if Scots pine, from five to eight years: the difference of time in the above cases depending upon the quality of the wood and the nature of the soil in which the wood is placed. In extreme cases of durability in the larch which have come under my notice, I have seen the upright spars, as well as the horizontal bars, of larch palings standing quite good at thirty years of age. These were made from old wood of a matured quality; this indicating that there is ultimately a saving to the proprietor who makes his fences with good old wood. As, however, the young wood is generally cut down in the way of thinning the plantations, it is necessary and proper to use it, seeing a much higher price can be got for the matured wood for in-door and other purposes. Upon the estate of Arniston we make all our field-gates from our own home-grown larch; and when painted, they last for a great number of years, being more durable in this respect than those made from the best foreign timber; while for general use in all country purposes, no wood is more in demand than the larch. For roofing I sell a great deal of it; also for boards adapted for all purposes, sleepers for railways, &c., and for palings of all descriptions. A great quantity of young larch is now used for coal-pit purposes, or what is generally termed *prop-wood*. There is no description of larchwood which I have more demand for than the young thinnings, from ten to twenty years old, being from two to five inches in diameter. These are greatly in demand for fancy or rustic palings; and although we have a great extent of young larch thinnings cut every year, we are never able to supply even one half the demand for trees of that size; which shows how much this wood is in repute for fencing alone in the Lothians of Scotland. This demand is occasioned by the wood of that size being more durable than that of any other small wood of the same age. In England, large numbers of young larches are raised for hop poles, for which purpose no wood can answer better, both as regards its tall elastic nature and its durability. Full-grown larch timber is now much used for different purposes in ship-building. Of late, many vessels of considerable size have been built almost entirely of this wood. In short, the wood of the larch is daily coming the more into repute the more its properties are becoming known; and I believe that, ere long, it will to a great extent supersede all other trees of the coniferous tribe, if not in a great measure the generality of our hardwood trees also, in consequence at once of its rapid growth and of the great durability of its timber, more particularly when allowed to arrive at full age.

The larch is propagated from seed in the same manner as the Scots pine, and the observations stated with regard to that tree are equally applicable in the case of the larch. One point of difference relative to the larch, however, is: there is considerable difficulty in getting the seeds disengaged from the cones. Some people kiln-dry them in order to open the scales of the cones; but as I have formerly said this operation is dangerous, and cannot be recommended, the following is the way in which I have extracted the seeds from the larch cones. Having the cones collected in a dry loft, I set a few boys to pare the base of each cone *close* with a sharp knife, just so far in as to make the end of the little central pillar appear distinctly and level. After they are thus prepared, I have a few more boys, or it may be women, each with an instrument as shown in Fig. 80, consisting of a pointed cone-shaped piece of iron *a*, the exact size in the engraving as used, fixed into a small block of wood *b*. This instrument when at work lies upon the floor; and by placing the pared base of the pillar of the larch cone right upon the point at *a*, and giving the top of the cone a few gentle strokes with a

Fig. 80.



very small mell, or other piece of wood, it is split up at least into two halves. These being laid to one side as they are split, another party, with a sharp knife each, can subdivide them again, making each cone at least into four parts; and in this manner a few women and boys will in the course of one day open up a great quantity. The cones being thus opened up by the use of the instrument and the knife, they should in this state be exposed on sheets to the influence of the sun every day, when they will soon part with their seeds by a gentle thrashing with a small flail.

The seed when procured should be stored past in a cool part till the beginning of April, when it should be sown, and that exactly in the same manner as has already been advised for the Scots pine. The young plants should remain two years in the seed beds, when they are termed *two years seedlings.* Upon high, bare, exposed parts they are often planted out at this stage; but for general purposes of forest planting, the young trees are put into the nursery grounds in rows for one or two years. In collecting the seed of the larch, great care should be taken not to gather it from diseased trees; nor should it be gathered from trees of a small size; for the very fact of small larch trees having seed upon them, is enough to point out that they are not of sound constitution. The seed of the larch, as well as of all other trees, should be gathered from trees of large size, and known to be sound in constitution. Were this point more attended to, that disease in the larch termed the rot, might in a great measure be in future prevented; for it is well known that, if the parent be diseased, the seed of that parent will be in a degree diseased also. Moreover, as the most diseased trees generally bear the greatest quantity of seed, the seed-gatherers, who collect it for nurserymen by the bushel, will be most ready to take it where it is most plenty, and will of course pay them best. In order to prevent this, nurserymen ought to give a fair salary to a man in whom they can place confidence, who should superintend the gathering of all their larch seed; and he should at the same time be a man who is likely to know a healthy tree from an unhealthy one. The quality of the wood of the larch is, as well as that of most other trees, much affected by the nature of the soil and situation upon which it is grown. I have paid some attention to this point, and find that larch trees growing upon a rich loamy soil, and in a rather sheltered site, do not produce nearly such durable timber as trees grown in a more exposed site and upon a poorer soil. In cutting up wood at our saw-mill at Arniston, I have often observed that, in the case of larch, which has grown upon a rather rich soil and in a sheltered site, the saws go through it easily and without heating; an evident proof of the softness of the wood. On the other hand, in larchwood which has grown upon a poor or rocky part, having a free exposure, the saws go through it with difficulty; and this I consider an evident proof of the hardness and durability of the wood. Our best and healthiest larchwood, indeed, upon the estate of Arniston is growing upon decayed rock, or what may be termed *stone rubbish*. The larch is, from its upright habit, one of the very best nurses we have for hardwood trees. It does not, indeed, produce so much warmth to young hardwood trees in the spring and winter season as the pines or the spruce fir do; but notwithstanding this, where there is a mixture of larch among young hard trees, these are generally in better keeping than when over-nursed by the Scots pine and spruce fir.

The circumstances which I have found most favourable to the healthy development of the larch are—as to soil, it is not particular, but the roots must be in a soil which has been well cleansed by the free passage of water through it, and which has at the same time the benefit of being constantly kept clean and in a pure state by a good descent for the water that may fall upon it, either naturally or by means of well-made drains, as is particularly exemplified in the case of larches growing on all mountain slopes, where there is a continual descent of water from the higher to the lower grounds. In the cultivated forest, this can be imitated by good deep drainage.

SECTION XXIII.—THE SILVER FIR.

The SILVER FIR (*Picea pectinata*) also ranks in the natural order CONIFERÆ, and the Linn. *Monœcia monadelphia*. This is a truly noble and interesting tree, and by far too little cultivated in our home plantations. At a distance this tree has very much the appearance of the spruce fir; but upon a nearer inspection, the leaves are found more decidedly in two rows upon the branches, and silvery underneath. The cones of this tree are also placed upright upon the branches; whereas upon the spruce fir they hang downwards. This tree is also not so soft and pliable in its appearance, the branches having a more rigid appearance, and being generally much stronger than those of the spruce fir. The silver fir rises to a great height, carrying with it at the same time a proportional girth. There is one standing upon the lawn behind Arniston House, a hundred and ten feet high, with a bole nearly twelve feet in circumference near the ground. This is a truly noble tree, and contains about two hundred cubic feet of timber. On the pleasure-grounds about Hopeton House, the seat of the Earl of Hopeton, near Edinburgh, there are several specimens of this tree, apparently as large as the one I have mentioned above; showing the great dimensions it attains under favourable circumstances.

Were the silver fir more generally introduced into our plantations, it would become a favourite tree, it being more hardy than the spruce fir with us, and adapted to grow upon a drier soil. In situations twelve hundred feet above the level of the sea, I have seen the silver fir growing rapidly, and promising fair, and that too upon a dry gravelly soil of very inferior quality. The wood of this tree is generally reckoned of better quality than that of the spruce fir; at least when it has arrived at maturity. When young, it is rather short-grained, and does not last long when exposed to the changes of our climate; but if the wood be at or about fifty years of age, I consider it preferable to the spruce, and capable of being used for all purposes for which that wood is in demand.

This tree is propagated from the seeds in the same manner as has already been recommended for the spruce fir. The cones are generally ripe about the end of October, and the seeds are separated from the cones by the heat of the sun in dry airy days. It should be sown in the month of March upon beds rather thinly, as the young plants when they come up are rather spreading in their habit. The plants should remain two years in the seed bed, when they may be planted out into nursery-rows, rather thinly also, as they are when young of a bushy nature, and do not agree with confinement. They are also of slow growth when in their young state, and will require three years in the rows before transplanting into the forest ground.

The silver fir thrives best upon a sandy loam; at least I have seen by far the finest specimens of this tree upon such a soil. However, from having seen them of excellent and vigorous growth in very stiff clay soils, as well as upon soils of an opposite nature, I am inclined to think that the tree is by no means particular as regards the quality of soil; but it makes its most healthy development on a good sandy loam upon a dry bottom. I have planted a considerable number of silver firs in our woods at Arniston of late, being desirous to have it more extensively introduced than it has yet been.

SECTION XXIV.—THE PINEASTER, OR CLUSTER PINE.

The PINEASTER (*Pinus pinaster*) is another member of the natural order CONIFERÆ, and the Linn. *Monœcia monadelphia.* This is not a tree which can be recommended for ornament, nor for the value of its timber. As regards both these qualities, it is surpassed by our common Scots pine. There is, however, one point of superiority which this tree possesses in a high degree, and that is, its hardihood in withstanding the blasting influences of the strongest sea-breezes of our climate; and it is in regard of this that I recommend the cultivation of the pineaster.

During my experience as a forester, I have frequently had occasion to remark, that hardy as the pineaster is in withstanding the influences of the sea-breezes, it is but a tender plant when planted in a high elevated part of the country inland. It is, therefore, properly speaking, a tree not adapted for profitable culture in inland plantations, seeming, so far as I have been able to judge correctly of it, to incline to the neighbourhood of the sea. Upon the estate of Dunskey, which runs partly along the sea-shore from Portpatrick towards Stranraer, the pineaster has been plentifully introduced along the higher grounds bordering upon the sea-shore, in order to form a protection to the plantations of hard-wood growing inside. It has answered the desired end there, having grown rapidly and healthily, securing in a very few years an amount of shelter which could not have been obtained by any other sort of tree. These pineasters, however, were by far too thickly planted, and were not attended to in the way of thinning; hence I have no hopes of their attaining such size and value as they would have done had they been more thinly planted, and thinned as they grew up.

Upon more elevated parts of the estate of Dunskey, the pineaster was also planted; at, I should say, from four to five hundred feet above the level of the sea; but in such parts the plants did not succeed well, and, consequently, their cultivation upon these elevated inland parts was given up. When I left that place, General Hunter Blair, the proprietor, meditated planting the pineaster extensively along the sea-coast, having seen the advantages of it as a protection to his lands in that quarter. The pineaster being a tree which stands the sea-breeze with impunity, and being also of a branching spreading habit when young, it ought to be planted thinly, say at from four to five feet apart; and in forming plantations of it along the sea-shore, I should recommend the following method of going to work.

Line off a broad belt of land all along the length of coast to be planted, not less than two hundred yards in breadth; and as a fence to this, upon the side next the sea, erect a stone dyke if possible, in order the more readily to bring away the trees by having a little shelter from the sea. But if stones for this purpose are not to be got conveniently, erect a turf dyke of about three feet in height. The fence inside may be a hedge or otherwise, as taste or local circumstances may suggest. Care must be taken, upon all juttings of land bending out into the sea, to make in the line of fence a bold convex bend in the same direction, this being in addition to the general width. Having the fence erected, plant the ground all over with Norway maples and sycamores, of each an equal number, at about twelve feet apart; that is to say, if the land be of anything like a loamy nature, and adapted to the growth of those trees. Having the hardwood planted, make up all the spaces between them with good strong plants of the pineaster, till the ground all over have young trees averaging four feet apart. The hardwood plants will not come away rapidly, and will in all probability die down to the ground the second year after being planted. But the proprietor must not be at all discouraged upon this account, for it is quite natural that the young plants should do so, as they must suffer a very severe check by being at once transplanted from a nursery to the open ground upon the sea coast. In order to strengthen the young maples and sycamores as much as possible, when they have remained two years upon the forest ground, have them all cut over by the surface of the ground, and the year following they will set away young shoots, which will bear the climate they rise in; the more so as, by this time, the pineasters will be beginning to grow rapidly, and cause a little shelter over the ground. If the ground intended for the pineasters be of a sandy nature, it would not be advisable to plant either maples or sycamores upon it; therefore, in such a case, it will be much better to plant the ground all over with pineasters alone; for although the maple and sycamore both stand the sea-breezes well, still, if the soil upon which they are planted be not of a loamy nature, they have not much chance to rise to any good, but would remain small unsightly things. The pineaster, on the other hand, being a plant that grows in the poorest sandy soils, will, instead of being injured by being planted even upon the sea sand, actually flourish upon it. It must not be expected that the pineasters will rise high, or make fine-looking trees, for a number of years. On the contrary, they will spread rather low, and form a very bushy habit for at least the first twelve years. This habit of theirs is their security; for a tree that would incline to rise high in such a situation would be at once thrown into bad health; while the pineasters, spreading themselves, soon form a complete massive shelter to everything else near them; and by the time they arrive at about fifteen years old, they begin to rise upwards rapidly, being by this time perfectly established in their situation. Great attention is necessary, in the cultivation of the pineaster, to see that the trees be kept at all stages of their growth from interfering much with one another in their side branches; for if they are ever allowed to confine one another so far as to grow up weakly, they cannot be easily redeemed again: this I have had frequent occasion to observe. The roots of the pineaster are few compared with those of the other pines we are in the habit of cultivating. These, if the trees are confined, become weak and slender; and if thinning be attempted after the roots have been once weakened by confinement, they will, so far as I have seen, never recover their healthy state; so that the blowing down of the greater part may be expected. Therefore, in all cases, pineaster plantations should be kept thin, and the winds allowed to have play upon each tree, which is the very life of them. Where the Norway maple and sycamore are cultivated among the pineasters, these should be pruned at a very early stage, and caused to take a pretty upright habit, in order to keep as many of the pineasters upon the ground as possible for the first twenty years. In doing this, I do not mean that the hardwood trees should be drawn up weakly. On the other hand, they too should have free air about them; but by keeping their side branches pretty closely pruned in, their branches will not interfere much with the pines, which will, of course, admit of a free circulation through the wood, and keep the whole in a more healthy state. Further, in all cases where the maples and sycamores appear to be any way in a state of bad health, let them be at once cut down in the course of thinning, and the pineaster left in preference. In planting the pineaster at four feet separate, it must not be understood that at that distance the trees can stand unthinned till they are of a useful size. Some practical foresters have, indeed, recommended to plant the pineaster at eight feet apart, stating that if so managed, the young trees will come in for use at the first thinning. I have seen them planted at that distance, but found the trees so managed a few years longer in producing the desired effect than when planted at from four to five feet; and being aware of this, and that proprietors in general are more interested in having the desired end quickly produced, than in the mere saving of the expense of a few extra plants upon the acre of land, I would advise the planting to be done at about four feet apart; by which means shelter will be quickly produced, and additional value be given either to other plantations inside, or to grain crops or live stock in the fields. When planted at the distance mentioned, as soon as the trees begin to interfere a little with one another, thin out a part; and if no useful purpose can be found for them, let them be destroyed as best may be. Indeed, although the young trees cut down at the first thinning can be turned to no use, a decided advantage is gained by having the plantation more quickly brought forward than could be the result were they planted at a wider distance.

The pineaster is propagated from the seed, which is generally procured from the continent of Europe, where this tree is indigenous. The seeds are pretty large, and when in the bed ought to be covered by about three-quarters of an inch of fine earth. They should be sown about the middle of April; or, when the season was late and inclined to frost, I have sown them on the 1st of May. The young plants rise up quickly, and become comparatively stout the year that they are sown. Having few fibrous roots, it is often a matter of some difficulty to get the young plants to transplant with safety when of any size. The manner of going to work in the rearing of this plant, so as to secure a supply of fibrous roots at it, is as follows:—

When the seedlings are one year old—that is to say, if the seed was sown in the end of April 1847, in the end of April 1848 I lift the plants from the seed bed, and transplant them all into nursery rows. In doing this I proceed thus:—I have a piece of ground proportioned to the number of plants to be put out, previously prepared by frequently digging it during the winter, and exposing it as much as possible to the influence of the frost. This piece of ground should be of an open, free, sandy nature, with no dung upon it: such as has been under a crop of pease the previous summer answers well. The ground being thus prepared, I take out the opening from one side of the plot and wheel it to the opposite, in order to close with when finishing. I next dig over the earth all along the opening, (not too deeply if there be any bad subsoil,) until I have fully six inches in width dug and levelled. Having this done, I place the garden line about six inches from the edge of the plot, and give a slight beat with the back of the spade all along the length of the line, with the view of making the earth all smooth and level. The line being tightly placed, and the run of the ground under it level to satisfaction, I next proceed to cut out an opening for the plants all along the line, merely so deep as to hold easily their roots and to cover them about half an inch deeper than they stood in the bed. This being done, I allow the line to lie, and take a few plants in the left hand, and place them, resting on the side of the opening, about two inches separate from each other; and upon the roots of each plant put into the cut by the left hand, I put a little fine soil with the right, which keeps them in their place until the whole length of the row be finished. In this manner I proceed with the whole length of a row. When I have arrived at the end of the line, I take the spade, beginning at the one end, and put a little more soil upon the roots and upon the necks of the plants all along. This being finished, I tramp with my foot, slightly, the newly put on earth, with the view of making the soil a little firm about the roots of the plants, and keeping out the drought. I again take a little more earth and put it to the plants, and that as much as will again make up a level of six inches of ground from the first row made. Next I lift the line; measure six inches from the row of plants put in at each end, or from the line before it is lifted; place the line to that measurement for a new row; and in the same manner I proceed until the whole of the plants are put in. Above all things, observe to do this work upon a damp day, and never when the sun shines, nor when any dry basking wind blows; because if so, the plants will suffer much, and very likely very many of them will die. Therefore I particularly recommend the removing of the pineaster seedlings in dull, cloudy, or damp weather. Another point to be particularly attended to here is, to see that the plants be carefully lifted from the bed; and in order to this, let them be carefully loosened with the spade, endeavouring not to strip one fibre from their roots; but, on the contrary, try to take a little of the soil with the roots rather than strip them bare of it. If this be not attended to, many of the plants will, without doubt, die; but if attention be paid to these points, the plants will succeed well.

When the plants have remained one year in this state, they ought to be lifted again in the beginning of May following; and by this second transplanting they will make excellent fibrous roots. In lifting them this second time, attend to the same rules already laid down for the first transplanting; only, in transplanting the second time, let the distance between the plants be about three and a half inches, and that between the rows twelve inches. When they have remained in these rows for one year, they will be ready for transplanting out into the forest ground.

In lifting the plants from the nursery ground, in order to place them in their ultimate stance, have the work done in a very careful manner, or, if not, it will most assuredly be a failure. Have the plants lifted with a part of the earth attached at their roots, and by no means admit of one fibre being broken. In planting upon the ground, have a few men employed taking off turfs, about two inches thick and twelve inches square, from the exact spots where it is intended the plants are to be put in; which turfs, as they are taken off, should be divided into two equal halves, and one half put to each side of the space bared. This being done, before the man leave the spot where the turf is taken off, he should loosen the earth with his spade, but not make a pit; and in this manner any number of men may proceed in preparing for the plants.

Immediately behind the men employed making spaces for the plants, have twice that number of men, each with a boy and plants, coming on planting; that is, one person preparing should keep two planting behind him. In planting, the man with his spade makes a sufficiently large opening in the centre of the bare ground, to admit of the roots of the plant being properly put in. This being done by a boy, and the plant held by him in an upright position, the man with his spade returns the soil all carefully about the roots of the plant, and tramps it firm. Finally, the turf should be put on the opening from which it was taken, but with the earth or under side uppermost, making it meet close upon the plant upon each side; and when it is thus placed on, the seam or opening in the middle of the turf must be neatly and closely fitted together, by using a little of the earth from each of the edges of the turf. It should receive a good tramping with the feet over all; all this being intended to keep out the drought in the early part of the summer until the plants take root; and in this manner the work should be carried on till the whole be finished. The planting of the pineaster should never be done sooner in the season than the middle of April, and even then let it be, if possible, in dull or damp weather.

SECTION XXV.—THE WEYMOUTH PINE.

The Weymouth Pine *(Pinus strobus)* is another member of the same Natural and Linnæan orders as those already described. This tree is a native of North America, has been introduced into Britain for more than one hundred years, and is said to derive its name from having been pretty extensively planted by Lord Weymouth at Longleat in Wiltshire. It is not a tree adapted to stand our climate in very high or exposed situations; but it is certainly an extremely ornamental variety, and in the fertile tracts of England many fine specimens are to be seen. Even in Scotland, where the soil is of a sandy loam, and in a moderately sheltered situation, there are many good specimens of this tree. In the woods about Arniston it grows very well: we have in particular one very good specimen, which shows that the tree is well adapted for our climate when not too much exposed. This tree is above seventy feet high, and about six feet in circumference. In the home plantations a considerable number have been planted at one time: I should say, from the appearance of the trees, about forty years ago. They generally look well, and are tall healthy trees, about forty feet high. In thinning the plantations, I have had occasion to cut down many of them, and find the wood, when at or under forty years, to be extremely soft and short-grained. When used for paling or any out-door purpose, it lasts but a very short time, being not nearly equal in this respect to our Scots pine when young. Not long since I cut down two pretty large trees of this species upon the estate of Arniston. From their appearance, I should say they were about eighty years old. I sold them to a carpenter in the neighbourhood, who cut them up for some house work, and he informs me that the wood is very short-grained and worthless, and not nearly equal to our Scots pine or spruce fir. Seeing, therefore, it is not a pine likely to be useful for general country purposes, I never, for my own part, plant any of it in the plantations upon Arniston; and I merely advert to it here in order to give my opinion of the quality of the timber of the tree. But as an ornamental tree it stands very prominent when in a situation adapted to its nature, which seems to be upon a light dry loam, and in a sheltered situation, with, at the same time, free air to allow of the tree expanding its branches. The leaves of this tree are easily distinguished from most of the other pines, by being five in a bundle, or in fives, from three to four inches long, of a light bluish green, with longitudinal silver lines, *scabrous*, and finely *serrated* on the margin. In summer the leaves hang free and loose, but in winter, and particularly during frost, they contract and lie close to the branches.

SECTION XXVI.—GENERAL REMARKS.

Having now briefly stated the peculiarities of each sort of forest tree which is generally cultivated in our plantations for the sake of timber, &c., I may add further, that all deciduous hardwood trees, to grow them properly, require more shelter than firs or pines do; consequently, in all cases of planting a piece of ground upon a gentleman's estate, the hardwood ought to be planted upon the most sheltered parts, always keeping the firs and pines upon the high and exposed districts. This is only imitating the proceedings of nature in the same operation; for, in the natural disposition of trees over the surface of the earth, the firs and pines inhabit those cold, high-lying districts where the soil is thin; and the oak, ash, elm, &c., the more temperate regions nearer the equator. The hardwood trees, to grow them well, require a heavier and a richer soil than the firs do; which suggests to us, that in laying out a new plantation the hardwood should be planted in the heaviest and richest parts of the soil contained in it.

The planter being possessed of a knowledge of the soil and situation adapted to the healthy growth of each species of forest tree, his duty is, in the planting a piece of ground with forest trees, to use those sorts which, from his knowledge, he has reason to expect will succeed upon it. With this view he may proceed thus:—Let him examine the nature of the soil throughout the whole extent of the ground designed for planting, and, having done so, consider what sort of tree will succeed best, for a permanent crop, upon each different soil and situation that may be contained within the bounds of the intended plantation; and, having determined this point, let him proceed to have pits made for all hardwood trees intended to be put in—say at ten feet distance from each other. Wherever the soil is found of a loamy nature, and the situation is not too high, plant oak, ash, elm, or plane-tree, at the distances specified; but in all cases giving the preference, in number and extent, to that species which is most likely to succeed best upon the soil; and observing, in all cases where it is intended that one sort of hardwood alone shall be the ultimate crop, to plant no other hardwood among them. Thus, if you wish to have any particular part of a plantation to be entirely an oak forest ultimately, plant these in pits at ten feet distance, and make up to the requisite thickness with firs, generally Scots and larch, which are only intended to act as nurses to the hardwood, and to be cut down by degrees in order to give the latter room as they rise up and fill the ground. Where it is intended to have a mixed hardwood plantation, distribute the different sorts in accordance with taste, and make up to the desired distance, which in this case will be forty-two inches, with firs.

Having planted all the better parts of a plantation with hardwood, as above mentioned, if there be any thin heathy parts, which would not raise such wood to advantage, occupy such parts entirely with firs. In doing so, observe that, if it be considered that larch trees would grow to any useful size, but not so as to be relied upon for a permanent crop upon the ground, then plant Scots firs, say at seven feet apart, for a permanent standing crop, and make up to the desired thickness of about three and one half feet with larches, which can be thinned out as the Scots firs require to have room. In this manner the larch thinnings will come to pay well; for, if the entire crop had been Scots firs, little or no value could have been got from them by the first thinning—the larch being always valuable when young, while the Scots fir is not.

If, in planting a new plantation, there are found spots of ground lying very high, with an extremely thin, poor, sandy soil, upon which it is doubtful if even Scots firs would attain useful size, or live long as a permanent standing crop, plant upon such spots one half Scots firs, and the other half birches and beech, of each an equal number per acre. By so doing, if the Scots firs happen not to succeed, as is very likely upon a high-lying sandy soil, then the birches and beeches are sure to keep the ground; and, although they may probably never come to be a valuable crop of timber, still it is desirable to have a cover, though but for the sake of shelter, upon such portions of the land.

If, on the other hand, there are any low-lying, damp, swampy parts in it, make up such parts with alders, birches, and spruce fir,—giving the preference in number to that sort which may be considered most likely to succeed best as a permanent crop; and, when they come the length of thinning, it can then be judged which sort will stand, and which should be taken away.

If there be any rugged precipices or steep glens within the bounds of a new plantation, plant larches and oaks in equal proportions; if it be considered necessary for the sake of shelter, plant a few Scots firs upon prominent points; and in any hollow parts of such grounds, put in poplars or willow-trees, or, if not too damp, spruce firs.

If the situation to be planted be near the sea, no plant, in the form of a forest tree, will succeed so well, as a nurse for others, as the PINEASTER or cluster pine. Upon situations near the sea-coast, it is often difficult to get trees of any description to succeed to any considerable extent, even so as to make a moderate shelter; and it is in such situations that the pineaster is found useful. We have already described the operations of this kind on the estate of Dunskey, the seat of Colonel Hunter Blair, in Wigtonshire, where it was found impossible to grow almost anything like trees, until the pineaster was planted upon the heights along the sea-shore; and now, since those have risen up—and they grew very rapidly—the different sorts of common hardwood trees are thriving well behind them. In such a situation they do not, of course, rise up so as to make valuable timber themselves; yet, as they grow very bushy, they form an excellent shelter for trees inland; and by the shelter attained from them, the more valuable trees behind succeed, which is the end in view in planting them.

CHAPTER III.

Different methods of planting young Forest Trees — Distances at which they should be planted one from another — How to choose Young Trees when buying them from public Nurseries — Manner of proceeding with planting operations—Kinds of Forest Trees which may be most profitably planted in any given district of country, so as to be of the greatest ultimate value to the proprietor as a crop upon his land—Kinds of Forest Trees best adapted for hedgerow timber, and management of the same — Expenses of laying down land under new Plantations—The keeping of Young Trees in a plantation clear from Grass and Weeds.

SECTION I.—DIFFERENT METHODS OF PLANTING YOUNG FOREST TREES.

In the planting of forest trees, two different methods are in practice among foresters: the first is the method of planting in *pits;* and the second, that of planting in *notches*, either with the common spade or the planting mattock. The method of planting in *pits* should be employed for all hardwood trees, for two years' transplanted larches and Scots firs, and for three years' transplanted spruce firs. These pits are made with the common spade, at various distances of from three and one half to ten feet, as the case may be; that is, if the whole of the plantation intended to be done is to be planted with hardwood and two years' transplanted firs, then the whole ground will require to be pitted to the distance required, but observing to make the pits for the hardwood larger than those intended for the firs. In order to do the work properly, make all the pits for the hardwood first, say sixteen inches on the side of the square, and fourteen inches deep; then, having these pits made at the distances, say of ten feet from pit to pit, make those for the firs nine inches on the side of the square, and ten inches deep, and just as close one to another as may be considered sufficient for the nature of the ground, say three and a half feet over all. If, after having the pits made for hardwood upon a piece of ground, it is found advisable to plant up with one year's transplanted firs, then no more pits will require to be made there, for it is not necessary to be at the expense of making pits for any firs which are under two years transplanted.

In the making of such pits as are above described, I generally let the work by contract. I cause the contractor to cut off the upper turf as thinly as possible, and lay it on one side of the intended pit; and in taking out the soil in the act of making the pit, he lays it upon the opposite side, which comes to be of great advantage in the act of planting. Where the soil is hard in the pit, the pick must be used to open it up to the desired depth. I have generally got pits made for hardwood, to the dimensions already named, for 1s. 6d. per hundred, and those for firs for 1s. per hundred; but if the pits have to be made among old roots, where large trees have formerly been, 6d. more per hundred in each case may be considered a fair price.

In the case of planting a piece of ground among old roots, the remains of former trees, the pits should be made at least three months previous to their being used. By having the soil in the pits a few weeks exposed to the influence of the atmosphere, it becomes much more healthy and congenial to the roots of the young plants.

The manner of planting the young trees in those pits must be regulated according to the situation of the ground to be planted; that is, if the situation be a low sheltered one, I plant a tree in the centre of each pit, and, cutting the turf which comes off the surface of the pit exactly into two halves with the spade, I make them fit closely upon the young tree, with the grass side uppermost. But if the situation be an exposed one, then I plant a tree in one of the corners of each pit; and by so doing it is kept firm in its place by finding support against the firm sides of the pit; which method should always be practised when the trees are apt to be blown about by winds and storms. In planting trees in such pits, great care is necessary to see that they be made perfectly firm in the new soil of the pit. But in making the trees firm in the pits, no tramping or beating with the feet should be allowed until the whole of the earth is put in; for if the planter begin to beat the earth upon the roots of the young tree while they are only half covered with soil, he is sure to do them injury. Knowing the evil of this from experience, I never allow a man to beat the earth about the roots of a young tree until he has it all into the pit, when a good firm tramping with the feet is necessary in order to keep the plant properly in its place until its roots take hold of the soil. After the earth has been all put into the pit and made firm, the turf should be put over the whole as closely as possible, and made firm in order to keep out the drought.

A few weeks ago I had a conversation with an extensive proprietor of land in the north of Scotland, who, while speaking to me relative to the different methods of planting trees, said that he was of opinion that the plan of making pits for young trees was altogether superfluous, and ought not to be practised; because upon his estate he had hitherto planted by this method, and found that the pits when made were only receptacles for holding water. Now, as it is possible that many other proprietors may hold the same opinion, I here beg to make a few observations relative to the good arising to young trees when planted in pits.

If the roots of a young hardwood tree, or a two years' transplanted fir, are put into the ground merely by a simple opening with the spade, they are so soft and tender, that they are unable to push their way through the solid earth in search of food: the natural consequence is, that if the tree does not altogether die, it grows weakly, and is long in attaining the character of a healthy tree. If the soil be of a damp open nature, the tree may succeed well after the roots become strong enough to push their way; but if the soil be naturally poor, and of a binding quality, the probability is that the trees planted in it without pits will die altogether.

As to the pits made for the reception of young trees becoming a receptacle for water, that can only be the case under bad management; for where the ground has been drained for young trees, the water will not stand in the pits; and where it has not been drained in the manner already inculcated, it is not in a fit state for planting trees in. Where trees are planted in pits made upon land in a dry state, their young and tender roots have at once free access into the open soil, and, consequently, the trees soon establish themselves in their new site. Generally speaking, I have found that trees planted in pits after the manner I have recommended, are ten years in advance of those planted otherwise.

It is, however, only necessary to plant in pits those trees which are of pretty large size, such as two years' transplanted and upwards: trees under that age and size, having smaller roots, only require to be planted in the natural surface soil, which is generally free and open to the roots of all small plants.

The method of planting termed *notching*, or slitting, is done with the common spade or planting mattock, and is so well understood by all planters, that it would be superfluous to enlarge upon it here. It is the practice most commonly in use for the planting of all small trees, such as two-years' seedlings, or one year's transplanted firs. The great point to attend to in this system of planting, is to see that the cut or notch be properly closed about the young plant after it is inserted, which should be done by the planter using the heel of his shoe in beating the cut all quite close again. The system of notching in trees by the planting mattock, is done upon the same principle as that by the spade, and is generally practised upon a thin hard surface, where the spade could not be used conveniently.

SECTION II.—DISTANCES AT WHICH YOUNG TREES SHOULD BE PLANTED ONE FROM ANOTHER.

Every proprietor of land, in planting a portion of it with trees, has in view, first, the cheapest possible way of doing the work, consistent with future profit; second, the raising of the greatest possible rental from the land under a crop of wood; and third, the quickest possible way of producing both shelter and timber from the land planted.

At the present day, there are a few speculative individuals who maintain that in planting land with young trees, they should not be put in the ground closer than from six to eight feet, making about nine hundred young trees to the imperial acre. On the other hand, all practical foresters who, from much experience, have tested the results arising both from wide and close planting, recommend putting in the trees at from three to four feet, making about three thousand five hundred plants to the imperial acre. This is an important point in arboriculture, and ought to be subjected to the test of sound reasoning combined with experience. Therefore, in order to make it appear clear to each planter how far he is to be guided by any particular rule of distance, let us consider briefly the proper and reasonable way of judging in this matter.

We may suppose forest lands to be divided naturally into three distinct localities—namely, sheltered, moderately sheltered, and exposed. Each of these demands our particular attention, in order to come to a right conclusion as to the proper distance for planting trees. First, then, with regard to the distance at which young trees should be planted in a sheltered situation. Every one is aware that trees will, in a naturally sheltered situation, grow more freely without any artificial means being used to protect them, than the same trees would were they to be planted in an exposed part. The artificial means used by experienced planters for the protection of young trees growing upon an exposed part are, to plant them pretty closely together, so that they may soon come to shelter one another; therefore, in a sheltered part of the country, where trees do not require any artificial rearing, they may be planted at any distance consistent with future good management and profit; and this must be regulated according to the demand for the various sizes of wood required in the neighbourhood. Let us take an example here of two estates, both alike situated in a sheltered part of the country, but the one in a neighbourhood where small wood is much in demand, and the other where no such wood could be sold to advantage. In the case of the former proprietor, whose estate was situated in a neighbourhood where small trees or thinnings were much in demand, I would ask, would it be wisdom in him to plant at such wide distances that he could not thin out any for sale till his trees become of timber size? This would certainly not be a wise step; yet it would be strictly according to the theory of those who advocate thin planting. They say, in all cases plant at about seven feet apart, it being for the benefit of the trees: practical experience points out the contrary. Again, in the case of the proprietor whose estate was situated in a neighbourhood where no small wood could be sold to advantage, would it be wisdom in him to plant his trees so closely as the other proprietor, seeing he required no artificial shelter for their health, and that he could not get any of the small thinnings sold as they were taken out in order to give the others room. Undoubtedly, in such a case, his wisdom would be to plant his trees at such distances as that they could come to a size fit for useful purposes in the neighbourhood before he would have occasion to thin. In these two comparisons the whole secret as to distance in planting in sheltered localities lies. In such situations they might be planted from three to five feet, according to the local demand for wood: not closer than three feet, because, at any distance much closer, the trees would come to no useful size before they would require to be thinned for the health of the plantation; and not wider than five feet, because I consider, at distances beyond that, there would be a great loss of land, by its not being occupied; while at five feet apart, trees will be able to stand together till such a time as they will be, when cut down, fit for the most useful country purposes, without doing injury to one another.

Again, trees growing upon what may be termed moderately sheltered parts of the country, or in a situation between sheltered and exposed, ought to be, laying aside every local consideration as to the sale of the thinnings, planted more closely than those in a sheltered part, and that on account of the health of the trees individually, as well as of the plantation as a whole. This is evident; for in order to make up for the shelter possessed by trees in a naturally sheltered site, those in a less sheltered part, in order to give them equal advantage, require to be planted so closely as to produce shelter to one another artificially, and that to as great an extent as the nature of the site may demand. In such situations, again, where no very small wood could sell to advantage, I would advise to plant at from three and a half to four feet apart. At distances much wider than four feet, the young trees would not prosper well, but would be much checked by exposure and want of due shelter: on the other hand, in such situations where small thinnings could meet with a ready market, I would advise to plant at from three to three and a half feet.

In all situations which may be termed exposed, or very exposed, no young trees, if wished to prosper at all, should be planted more widely than three feet, whether the first thinnings may meet with a ready market or not. The great point to be aimed at in the growing of timber in such situations, is to produce shelter as quickly as possible among the trees themselves; and this can only be done by planting rather closely in the outset. Even although a few hundred trees should be cut out as they become too close, and allowed to lie as useless and unsold, no objection should be made: they will have answered their purpose, namely, that of producing artificial shelter for a time, and of rearing up the whole as a plantation much more healthily and quickly than could have been done without them.

These considerations comprise, I think, the whole art of judging as to the distance at which trees should be planted in any given locality of country. This distance will, in all cases, be regulated by the demand for timber in the neighbourhood, whether that may be for small or large, or both together, and at the same time by the site of the ground to be planted. If the site be a sheltered one, the trees may be planted more thinly, as local circumstances may demand; and if an exposed one, for the sake of the general and future health of the plantation, the trees must be planted closely in order to produce artificial shelter. Having premised the above, it may here be profitable to say a little as to the consequences which would be most likely to arise were forest operations to be conducted upon the principle of thin planting, as has been recommended by theorists.

They say, plant hardwood as a permanent crop upon the ground at twenty-eight feet apart, and make up with firs between to seven feet over all. In this case the proprietor's views as to the cheapest way of doing the work are realised; but I maintain, not in a manner consistent with future profit: for at seven feet apart the young trees will not come away quickly; they will remain for several years in a stunted state, growing widely to side branches, and not to proportionable height till they come the length of sheltering one another; while in an exposed site they might never come this length at all, and in all probability they would not require to be thinned before they were twenty-five or thirty years old; much depending upon the nature of the soil and site. And, moreover, a very few deaths per acre—say only forty plants—would occasion forty large gaps, each not less than fourteen feet in diameter, which would be a most ridiculous system of forest management if carried to any extent. Further, in most cases, proprietors who would plant trees at seven feet over all, as has been recommended by some theorists, would not receive one penny of income from such plantations until they were above twenty-five years of age; and even then the trees in such plantation would not be in nearly so vigorous and healthy a state as those planted at from three to four feet, as I have recommended. In short, relative to this system of thin planting, instead of being a gain to a proprietor, it would, in every sense of the word, be a decided loss both for the present and future generation.

Suppose that all the plantations upon a gentleman's estate were to be planted with hardwood at twenty-eight feet apart, and made up with firs to the distance of seven feet, how could he ever produce small firs for stobs or rails for general estate purposes? If he did, he would spoil the general health of the plantation by taking out even a few trees per acre. Again, at what age could a plantation so managed be expected to produce a hardwood tree, even for a pair of trams? If any wood-merchant were to come and offer a high price for young hardwood trees of any description, how could the proprietor of such woods take advantage of it, seeing that his hardwood trees all stood at distances so wide, that he could not, without great loss, cut down even one tree till of age? Again, were the whole of the plantations in Britain to be conducted in this manner, what would we do for small wood of any description in the country generally? These questions seem to me quite sufficient to point out the extreme folly of parties who would recommend any proprietor of land to plant at wide distances.

Those who have advocated the system of thin planting as above stated, argue that plantations, when planted at from three to four feet, soon become too close, and that such closeness produces unhealthiness in the trees; and further, they maintain that this is the very reason why we now see so many of our home plantations in a too crowded state. That many of our home woods are shamefully over-crowded at the present day, is too plain; and I myself am one who set my face as much as in my power against such a state of things; but what is the fundamental cause of this? It by no means is attributable to planting it from three to four feet. The cause is *bad management*, or rather, I may say, the want of timely thinning. Wherever plantations have been managed in the way that I here advise, and timelily and judiciously thinned, the work has been attended with the most happy and profitable results.

The whole secret of training up healthy plantations lies in the after-management. If plantations are left entirely to nature, as is too often the case, without any art being used, the trees must of course kill one another.

SECTION III.—HOW TO CHOOSE YOUNG FOREST TREES WHEN BUYING THEM FROM PUBLIC NURSERIES.

Every proprietor who has occasion to plant forest trees to any considerable extent, will find it necessary to supply himself from some respectable nurseryman. In doing so, it is absolutely necessary that healthy trees should be selected; and also those of such a nature as may be suited to the situation where they are intended to be planted for good and all.

The proprietor who intends to plant should either himself visit, or cause his forester to visit, during the summer previous to the planting season, any nursery from which he intends to purchase his supply of young forest trees, and see that the stock of young trees in it is in a clean healthy state, free from all *scale*, *bug*, or any other vermin generally infesting young trees.

Such a visit in the summer season may by many be considered unnecessary, but every experienced planter can bear witness to the propriety of it. I have known an instance of diseased trees from a nursery being the cause of propagating the same disease through several plantations in the neighbourhood. In asserting this, however, I do not mean to say that any respectable nurseryman would be guilty of sending diseased trees to any of his customers; but I do mean to say, that every planter or forester should, previous to making a purchase, go and visit the nursery grounds, and judge for himself as to whether he shall buy or not. The proper time for such a visit is during the month of July, when the trees are in full leaf, and in a vigorous state of growth.

In that month, all young trees should have the bark upon the main stem and branches clean and free from any appearance of *scale* or *bug;* and when a little of the surface skin is removed by the nail of the thumb, the bark underneath should be of a pure healthy transparent green colour, not pierced by any small holes. The surface bark of a young tree in perfect health should be easily removed from the inner bark. There should be no appearance of small holes in the leaves at this season of the year; neither should they seem to have been bitten short by any insect.

Having visited the public nursery grounds in the month of July, and found the general health of the young trees quite satisfactory, it will be necessary for the intending planter again to visit the same grounds about the first week of November, in order to make purchase of such trees as he may require for the season. In making purchase, it is absolutely necessary to bear in mind the nature of the ground and situation to be planted. If the ground is a thin soil upon a high situation, then choose trees from the nursery that have stood rather wide in the rows, and have had free air and room, and are rather of a low set, bushy character, and altogether presenting a hardy appearance: plants of such a character will suffer very little indeed from being removed to a high climate. For a high situation, always choose one year's transplanted firs, and hardwood not exceeding two feet in height. If plants of an opposite character be chosen for such a situation—that is, tall slender plants, which have made long shoots of young wood the previous summer — they will be sure to suffer, and it is more than probable that one half of them will die.

If the situation to be planted is a low sheltered one, with a good soil, then choose tall well-grown plants for it; for in such situations there is generally a luxuriant growth of the natural grasses; and unless the young trees be pretty tall, they would be altogether choked by such a mass of herbage surrounding them. Above all, it is necessary to be most particular in seeing that the young trees chosen be well rooted; that is, having plenty of small fibrous roots, which are the mouths by which the plant derives its nourishment from the earth. In a rather light soil, not too highly manured, the roots of young trees are generally good; but if the young trees have grown in a stiff heavy soil, there is a risk of their being badly rooted; that is to say, they will most likely have few small fibres; and young trees with few fibres never succeed well when replanted—more especially those of the *pine tribe.* Much of the success in the growing of trees in the forest depends upon a good healthy choice from the nursery; therefore this point should always be carefully attended to by every intelligent planter.

No proprietor should grudge to give a fair price to a respectable nurseryman, in order to have his orders punctually attended to. The gentleman who offers a fair price is always sure to have a good article sent him; while, when a proprietor offers a low price to any nurseryman for his trees, the nurseryman is not enabled to bestow that labour upon the lifting of the young trees which is necessary to secure the safety of the roots. Trees of the pine tribe, if they are lifted out of the earth carelessly, generally lose one half of their roots; and in such a case the trees cannot grow. Therefore, every planter ought to see that the trees he uses are carefully lifted from the nursery ground.

SECTION IV.—UTILITY OF PROPRIETORS HAVING THEIR OWN HOME NURSERIES.

That every proprietor of land who has occasion to plant young forest trees to any considerable extent, should have a piece of ground adapted for the raising of young trees, is quite consistent with good management in forest operations. I do not here mean to advise that every gentleman should be his own nurseryman; for the raising of forest trees to such an extent would be altogether out of the question, and such a state of forest operations would come to be found bad management. No gentleman's forester, however well qualified he might be, can possibly have sufficient time and opportunity to attend to the minute operations of raising young trees from the seed, from cuttings, layers, &c.: but I do assert, that a piece of ground kept as a reserve nursery is absolutely necessary in order to good management.

In order to point out the utility of gentlemen having their own home nurseries, and to show to what extent it is advisable for them to cultivate their own young trees previous to planting them out into the forest, I shall here detail my manner of proceeding at Arniston with regard to this operation.

At Arniston we have about two acres occupied as nursery ground. In it I raise all our own oaks from the acorn; and as I am in the habit of getting a regular supply of acorns, I have ready for transplanting out into the forest grounds about twenty thousand every year successively. Having this piece of ground occupied as a nursery, I am enabled to raise the oaks in it to a pretty large size previous to planting them out, which is of great advantage to us, as we have very many hares and rabbits to contend with; and besides, being tall, they are not apt to be choked by long grass and weeds overtopping them. To get such large plants as I am in the habit of using for our home woods from the common nurseries, would be quite impracticable to any considerable extent. I do not raise all our oaks to a large size previous to planting them out, but only a part, so far as is required. This spring (1847) I have planted out in the home plantations six thousand oaks from three to five feet high, with strong fibrous roots; and, in order to have them strong bushy plants, I give them abundance of room, plant from plant, in the rows, which is never the case with plants got from the common nurseries. In our nursery ground, I also raise yearly three or four thousand larches to a pretty large size, as also a number of all the common sorts of trees generally planted in the forest, which, when I have them grown to the desired strength, I plant out into the forest ground to fill up any vacancies which may have occurred among the young plantations; and even in some instances, where a small plantation may be required to have immediate effect, I have planted up with such large trees entirely.

Now, from what I have said above, my meaning will appear evident in advising proprietors to have their own home nurseries; namely, that they may have a command of good specimens of all the general varieties of trees, to plant out at any time into any parts of their plantations where they may be required. No proprietor's establishment can be said to be complete, as relates to forests, without such accommodation. Without a reserve nursery, no forester can have young trees at command in order to meet the demands of his employer as occasion may sometimes require. Without a reserve nursery, no gentleman can reasonably expect to have forest operations conducted properly. It would be folly to send forty or fifty miles to a nurseryman for a few good trees to answer some particular purpose, when the same could be got more conveniently and more safely from the home nursery; and even after sending for such trees, they might not be such as were expected. Difficulties of this kind I have myself experienced in certain situations; but where I have had the accommodation of a home nursery, I have been able at all times fully to meet the demands of my employer, and that also at a very moderate expense. Therefore it is that, having experienced the disappointments attendant upon the want of a reserve nursery, I would here urge every proprietor to adopt the system of having a small one, merely with the view of raising a few particularly good trees for particular purposes. The extent of ground to be occupied as such must be regulated according to the probable demand; that is, if the forest grounds be extensive, two, or perhaps three, acres may not be too much; and if the forest grounds be not extensive, half an acre may be quite enough. In making such a nursery, never let it be in a sheltered or low-lying part, for there the young trees would be drawn up and weakly; neither make it upon a stiff clay soil, for in such a soil young trees never make good roots: but let the situation be rather an exposed one, with a light friable soil. There the young trees will become bushy and hardy, and also throw out numerous fibrous roots, which is always favourable to the healthy growth of young forest trees which have to be transplanted.

SECTION V.—MANNER OF PROCEEDING WITH PLANTING OPERATIONS.

In all planting of young forest trees, the superintendent of such operations should be a man who has had considerable practical experience in that line of work. No man should undertake, or be allowed to undertake, the management of planting operations, who has not had at least ten years'experience in his profession. Unless he has had such experience, and that rather upon an extensive scale, he will not be able to judge for himself in any extraordinary contingency. A man who is allowed to undertake planting operations without proper practical experience, is generally put off his way by every change of the weather, and then knows not how to proceed. In such extremities he seeks the advice of others, who, very likely, are as ignorant in the matter as he is himself; consequently, the mind of an inexperienced man is liable to give in to wrong advice, and then the whole work goes wrong; time is lost, the work is badly done, and, in the end, failure is the sure result. This state of things, I am aware, often happens in planting operations; therefore, for the guidance of those who may not have experience enough, I shall here lay down, in a particular manner, the way of proceeding with planting operations as they ought to be done.

All land intended for the growing of young forest trees should be drained at least two months before commencing to plant upon it; and, indeed, if the land to be planted is of a very damp nature, and has been under a crop of trees formerly, I would advise to have it drained six months before planting. By using such a precaution, the ground will be considerably cleansed from any bad quality it may contain, and consequently the chance of success will be much greater. If the land to be planted has been under a crop of trees formerly, and the roots of those are still in the ground, and if hardwood is to be planted upon it, have the pits for them made at least three months before planting. Indeed, for my own part, I am always anxious to allow the pits made for hardwood plants in such land to lie all the previous winter, in order to have the soil cleansed by the action of the frosts; that is to say, when I plant hardwood trees upon land formerly under wood, I have the pits all made by the month of November, and allow them to remain open till the month of March, when I plant the young trees in them. If, however, the land to be planted be what is generally termed *clean* and *new*, the pits for the hardwood plants may be made at any time as the work goes on. In all cases where the surface soil is thin, say not more than six inches deep, and where the subsoil is of a hard tilly nature, and drains upon it are found not to act in so decided a manner as to draw off the water that may fall into the pits after they have been made, do not make the pits for the hardwood deeper than the top of the subsoil; for if they are made into the subsoil, the water will be retained there in the bottom of the pits, and will most assuredly tend to keep the roots damp, and retard the future progress of the trees. In such a case, make the pits only as deep as the bottom of the upper stratum of soil; and in the act of planting the trees, if the pit be found not deep enough, the earth can be raised sufficiently round the roots upon the surface: by using these means, the trees will be preserved in much better health than they would otherwise have enjoyed.

The above observations should all be had in view by every intelligent planter previous to commencing planting operations. The not attending to these very plain and necessary precautions, is the cause of very many failures among planters of the present time. Therefore I most earnestly recommend to every planter who wishes to excel, to go over his ground at least one year before commencing planting operations upon it, and lay down rules for the work, and proceed with them accordingly, and not to let the work stand till the very week when operations should commence, as is too often done. However, the forester is not always to blame in such cases of neglect. I have myself known active and intelligent foresters, who were not allowed time and money to go on with their plans. This is to be regretted, because it is in the end a decided loss to the proprietor himself. In all cases where a forester is known to be really an intelligent man, and aware of his business, the proprietor should give him proper opportunity for doing his work in the best possible manner. By so doing, the proprietor will be amply rewarded himself, and the forester have credit from his operations.

Then, allowing that all the precautions above stated have been strictly observed, and that the drains have been allowed to act for a proper time upon the land, the person who is to take the management of the work will first consider the nature of the situation he is about to plant upon, which we shall suppose to be an extensive piece of moor-ground containing several varieties of soil. This being the case, he will next begin upon one side of the ground, and take observations as to the kinds and quantities of trees he will require for each particular part, supposing it naturally divided into thin heathy ground, with high exposure—good loamy soil, upon a slope—moss two feet deep, resting upon clay—deep swampy moss, but well dried—strong clay soil, upon a level—light sandy soil, resting upon gravel — bare rocky parts, with here and there good dry loam. Supposing that the ground to be planted contains all the varieties of soil above mentioned, the manager of the work will consider as to the quantity of ground contained in each of the divisions; and having ascertained this either by measurement or by the eye, according as he may find himself qualified, he will put up a *pin*, with a number upon it, in the centre of each district, and enter a corresponding number in his notebook, thus—

No. 1.—Twenty-seven imperial acres of thin heathy ground, to be planted with Scots and larch firs, one year's transplanted, of each an equal number, and at three and a half feet apart.

No. 2.—Ten acres of good loamy soil upon a sheltered slope, to be planted with one hundred and eight oak, and three hundred and twenty-seven ash, to the acre, and made up to three and a half feet with one year's transplanted larch, and two years' transplanted Scots pines, of each an equal number.

No. 3.—Twelve acres of moss, two feet deep, resting upon clay, to be planted same as No. 2.

No. 4.—Twenty-four acres of deep swampy moss, but well dried, to be all planted with two years' transplanted Scots and spruce firs, at three and a half feet apart, of each an equal number, excepting three acres in the centre, which cannot be well got dried, and which must be planted entirely with alders at four feet apart.

No. 5.— Thirty acres of strong clay loam upon a level, to be planted with three hundred oaks to the acre, and made up with equal numbers of two years' transplanted larch and Scots pines, to four feet apart over all.

No. 6.—Seventeen acres of light sandy soil, resting upon gravel, to be planted with two hundred and twenty beech, and two hundred and twenty birch eighteen inches high, to the acre, and made up to three and a half feet over all with one year's transplanted larch and Scots pines, of each an equal number.

No. 7.—Forty-three acres of bare rocky ground, with here and there spots of good loamy soil to the extent of six acres in all—bare rocky ground to be planted with eight-inch birch, two years' seedling larch, and Scots pines, of each an equal number to the acre, making them stand three feet plant from plant; good loamy soil to be planted with ash, at ten feet apart, and made up with Scots and larch firs to three and a half feet over all.

Now, supposing that the person who is to take charge of the planting of such a piece of ground has gone over it, and marked very particularly in his note-book the different natures of the soil in it, and stated the kinds of plants that he considers will be most likely to do good upon it, as I have above stated, and which is my own manner of going to work, he will, when he goes home in the evening, sit down and draw up a statement as to the number of each kind of tree he will require to have brought forward for the planting of each of the districts as numbered. In order to assist him in this calculation, the following table will be found most useful. Indeed, such a table is not only useful to a young and inexperienced forester; it is as useful to the man of fifty years' experience as to one of five, because no forester can keep in his memory the number of plants he may require at a given distance per acre, nor can he at all times find it a convenient matter to calculate these numbers. In order, therefore, to save time, and to form a sort of ready-reckoner for the forester, I insert the following table:—

TABLE showing the Number of Trees that can be Planted on an Acre, whether the Scotch or the Imperial Acre, from 1 foot to 25 feet distance Plant from Plant.

Distance.	The Scotch Acre.		The Imperial Acre.	
	Plants of the Short 100 of 5 Score.	Plants of the Long 100 of 6 Score.	Plants of the Short 100 of 5 Score.	Plants of the Long 100 of 6 Score.
Feet.				
1	54,760	45,633	43,560	36,300
1½	24,382	20,318	19,360	16,133
2	13,690	11,408	10,890	9,075
2½	8,761	7,301	6,969	5,808
3	6,084	5,070	4,840	4,033
3½	4,470	3,725	3,556	2,963
4	3,422	2,852	2,722	2,268
4½	2,709	2,257	2,151	1,792
5	2,190	1,825	1,742	1,452
5½	1,810	1,508	1,440	1,200
6	1,521	1,257	1,210	1,008
6½	1,296	1,081	1,031	852
7	1,117	931	889	740
7½	973	811	774	620
8	855	713	680	567
8½	758	631	602	502
9	675	562	537	448
9½	606	505	482	402
10	547	456	435	363
11	452	375	360	300
12	380	317	302	252
13	324	270	257	214
14	279	232	222	185
15	243	202	193	161
16	214	178	170	141
17	189	158	150	125
18	169	141	134	112
19	151	126	120	100
20	137	114	108	
21	124	103	98	
22	113		90	
23	103		82	
24	95		75	
25	87		69	

Before proceeding further, it may be proper to give a slight explanation of the above table. If, for example, the forester wish to ascertain how many trees will be required to plant one imperial acre at three feet apart, he will first cast his eye to 3 in the left-hand line of figures, headed *distance*, from which figure he will next cast his eye to the right, and in the fourth line of figures exactly opposite, and under imperial acres, headed *plants of the short* 100 *of* 5 *score*, he will find 4840, which is the number of plants required to plant an imperial acre at three feet plant from plant. If he wish to ascertain the number required for any other distance, he has only to go upon the same principle, always looking first for the distance required in the left-hand line of figures. If it is desired to know the number needed for a Scots acre, let him look for the number under Scots measure instead of under Imperial. Having given the table, I shall now point out the manner of drawing up the statement mentioned above.

STATEMENT OF THE NUMBERS AND KINDS OF YOUNG TREES REQUIRED TO PLANT THE DIFFERENT DISTRICTS IN ——— PLANTATION, UPON THE ESTATE OF ———, 1850.

DISTRICTS.	Imperial acres in each.	NUMBER AND KINDS OF TREES REQUIRED.								Total Number of Trees.
		Larch.	Scots Pines.	Spruce Fir.	Oak.	Ash.	Birch.	Beech.	Alder.	
1	27	48,006	48,006	..	..	..	..	..	..	96,012
2	10	15,605	15,605	..	1,080	3,270	..	..	..	35,560
3	12	18,726	18,726	..	1,296	3,924	..	..	..	42,672
4	24	..	37,338	37,338	..	..	..	..	8,166	82,842
5	30	36,330	36,330	..	9,000	..	..	..	..	81,660
6	17	26,486	26,486	..	..	..	3,740	3,740	..	60,452
7	43	69,056	69,056	..	..	2.610	59,693	..	..	200,415
	163	214,209	251,547	37,338	11,376	9,804	63,433	3,740	8,166	599,613

It may be necessary for me to give a little explanation of the above statement. In order to this, we will look over District 2. Upon looking back to particulars on the second district, as they were supposed to be taken upon the ground, it will be seen that it contains ten acres, which number is stated in the second column from the left hand in the above table. Next, it was to be planted with 108 oaks and 327 ash to the acre. Now, if we multiply these numbers by ten, for the number of acres, we will have 1080 oaks and 3270 ash for the whole district, which is stated, accordingly, under oak and ash upon the same line as formerly stated. Again, the particulars state that the ground was to be made up to three and a half feet with one year's transplanted larches and two years' transplanted Scots pines—of each an equal number. Now, if we look at the table of distances formerly given, we shall find that, in order to plant one imperial acre with trees at three and a half feet apart 3556 are required; but as we have already allowed 435 hardwood to the acre, this quantity must be deducted from the 3556; consequently, leaving 3121 firs for the acre to be planted among the hardwood; and as the firs are to be larch and Scots pines, of each an equal number per acre, we must take the half of the last number given for each sort of fir; that is, 1560½ of each for the acre. Now, there being ten acres of ground to plant in this instance, we must multiply the last number by 10, and the gross amount of each sort of fir required will be 15,605, which will be found to correspond with the numbers stated under larch and Scots pines upon the line No. 2. In the same manner all the other districts are described; and in the summing up of the whole it will be at once seen, that in order to plant the whole 163 acres, the forester will require to bring forward to the ground 599,613 young trees, of the various kinds stated in their respective places.

Presuming now that the person in charge of the work of planting has looked over the ground, and has put up a pin in the centre of each district to correspond with the number entered in his statement, and that he has drawn out such a statement as I have shown above for his future guidance in the work, he will next order the plants to be brought forward and *sheughed*, each district having the quantity of trees adapted for it put by themselves; that is, in order to plant No. 2 in the manner proposed, there will require to be sheughed in it 15,605 one year's transplanted larches, and the same number of two years' transplanted Scots pines, with 1080 oaks, and 3270 ash; and so with each of the others. Great care is requisite, in bringing forward the young trees, to see that it is done in a fresh day, and when there is a little moisture, if possible; and if the plants have to be carted far from the nurseries, all their roots should be covered with matting during the journey, to prevent the air from having any bad effect upon them. As soon as the cart arrives, a deep dry part of the ground must be chosen for sheughing or laying them in. This requires to be done in a very careful manner, avoiding too many hands being employed on the work at once. If those points are not strictly attended to, there will be a great chance of failure in the results of the work. I have frequently, when assistant-forester, seen shameful carelessness practised in regard to what I am now recommending; and this is the very reason that makes me so urgent in recommending carefulness where it is wished to have success in the work of planting.

In sheughing the young trees, take out a trench deep enough to hold the roots easily, and put the turf and earth which is taken out of it all along upon that side of it which is meant to be the outside when the work is done. On having this earth levelled along the back or outside of the opening, if it is the hardwood trees you intend to put in first, you may do so without loosening the bundles, (as I presume the plants will be tied up in bundles), as they are not apt to spoil although they lie a time in the ground in a crowded state. But if the plants you sheugh be firs, have the bundles opened out, and the plants spread out upon the side of the trench not more than two inches thick. When the whole length of the trench is filled with the plants, whether hardwood or firs, put the finest of the earth from the next trench next to the roots of the plants laid in, and make up above that with a sufficient quantity of soil to cover the roots of the plants laid in, as well as to make another sufficient opening for another row. When the roots are thus sufficiently covered, give the whole a firm tramping, in order to keep out frosty winds the more securely. Then, immediately after this tramping, gather up in your spade any fine earth in the bottom of the trench which is to receive the next row, and fill up with it any open parts about the necks of the plants in the line put in, in order that no open spaces may be left for the air to get down to the roots. After re-levelling the surface of fresh earth which is tramped above the roots, the front of the new trench may be lined off, and filled up as before. Many planters are very careless about this part of the work, and sheugh in the plants in a mere temporary manner; but I would caution every forester, who wishes to excel in the work of planting, against such a manner of procedure, and urge him in all cases to put his plants into the earth in a manner as permanent as if he knew they were to remain for months. I have myself seen young trees sheughed in a temporary manner, the planter supposing that they would be all planted out in the ground in their places in the course of a day or two; but instead of this expectation of his being realised, frost set in, and snow followed. The trees lay in the sheugh in the same temporary state they had been put in for at least two months. When the weather broke up, the forester who had the management of the work persisted in planting them, and, as I myself anticipated, there were not more than a hundred trees to the acre which were found alive in the summer. I mention this here, in order that others, being aware of the fact, may in future guard against such a manner of going to work, which is not only discreditable to any forester, but, what is worse, ruinous to the proprietor. In the same manner as I have described for the securing of the trees in No. 2, let the trees belonging to the other districts be done also, care being in all cases taken to have them sheughed in a piece of dry soil, and where water is not apt to lie in the bottom of the trench.

The young trees being all brought forward and sheughed in their respective places, the superintendent of operations will next consider as to the number of men he may require for executing the work. In this case he had better select a few good hands, and have the work done properly, than gather together a number of bad workmen, who perhaps never had planted a tree before, and who may very likely be regardless how the work may be done, provided they receive their daily wages. As to the number of men that will be required to do the work in a given time, we shall suppose that the work of planting is to be commenced about the 1st of February, and that the forester, on account of having other plantations to make the same season, is anxious to have the plantation in question—that is, the 163 acres referred to above—finished in the course of four weeks. There are thus 163 acres to be planted in four weeks; and as at that season of the year it is more than likely that a portion of the time will be broken upon by bad weather, therefore, in order to have the work finished, if possible, by the time specified, instead of calculating that it is to be done in twenty-four days, we must deduct a portion, and say that the work is to be done in twenty-two days. We have thus 599,613 plants to put in the ground in twenty-two days. By the system of notching, I generally calculate that a man in a short winter day, working from eight in the morning to four in the afternoon, and allowing one hour for rest, should plant one thousand young trees with ease, and at the same time do his work well. Let it be understood, that if a man is much hurried at his work, he cannot do it well: the superintendent should, therefore, keep in view not to hurry his men unreasonably, but to make them give a fair conscientious day's work—as, by so doing, he will have his work much better done than if he acted otherwise. As this work is to be done in the month of February, when the men, instead of working from eight to four, can work from seven to five, they will be able, with the assistance of a boy each, to plant 1300 plants each. Now, if we divide 599,613, the number of trees to be planted, by 1300, the number that a man can plant in a day, we will find that, in order to plant the whole with one man, he would require 461 days; but if we employ twenty men, they will, at the rate of 1300 a day each, plant altogether, in one day 26,000 trees; and, if we divide 599,613, the number of trees to be planted in all, we will find the answer to be twenty-two and a half days nearly; therefore, in order to finish the work in about twenty-two days, twenty men will be required to plant at once. As, however, there will be pits to make for the oak, ash, and beech, and the planting of these will take more time than the others, it is necessary to calculate upon them as extra, even allowing that we have already included the number of hardwood among the other trees. By looking at the statement containing the number of trees to be planted, it will be seen that there are 24,920 oak, ash, and beech; and these require to be planted in pits. Now, in order to plant these in twenty-two days, we must calculate thus:—one man will in a moderate soil, where no picking is required, make 1000 pits and plant them with hardwood in one week, being about 167 to a man in the day, and at this rate seven men will make pits and plant the hardwood trees in the same time that the twenty men will plant the others, which have to be notched; consequently, in order to have the whole work done in twenty-two days, twenty-seven men will require to be employed. The superintendent, after making a calculation of this nature, should, when the men begin work, keep a note of the number of the trees planted upon the first day, and compare the work actually done with his calculation. By doing so, he will be aware of how far he is likely to be correct in his plans in the future management of the work.

We shall now suppose that the superintendent has twenty-seven men looked out in order to commence work, and has given them orders to meet him on the ground at a certain time; and that he intends to commence by planting No. 1, being twenty-seven acres of thin heathy soil, not adapted for the growing of hardwood, to be planted with Scots and larch firs, three and one half feet apart, one year transplanted, of each sort an equal number. We shall further suppose that the superintendent is forward on the ground on the morning appointed before any of his men are collected, which ought always to be the case with him; for if he be a man of an indolent habit in the morning, the men will very likely prove the same, and consequently the work will not go on in a prosperous manner, and there will be small hopes of getting through it in due time.

Being then thus forward, he will arrange in his own mind quietly as to the work to be done for the day. If it have the appearance of being a fine one, he will put the men to plant upon the most exposed parts of the grounds; and if otherwise, upon the most sheltered parts. The superintendent should provide himself with three or four poles, such as farmers generally use for straightening and measuring off their furrows; and while the men are collecting, and before it is light enough for them to plant with propriety, he will begin upon one side of the ground to be planted for the day, and pace off, from the side at which it is intended to begin, about three yards in breadth for each man to be employed upon, making in all, for the twenty-seven men, about eighty-one paces or yards. At the end of that distance, from the outside, he will put up one of his poles as a guide for the innermost man to keep by in the act of planting; and in the same manner he will pace off the whole length of the ground by one or two more poles before the men commence.

The poles being set to the breadth required, he will next see that each of his men has provided himself with a stout boy for handling the young trees, and that each boy has brought a stout apron for holding them, in order to protect their roots from the wind, as well as to keep them together while he takes out one at a time with his right hand. Being satisfied of this, he will next examine the sort of spades the men have brought to work with. So far as my experience has enabled me to judge, there is, for the purpose of notching, no implement so useful as a half-worn common garden-spade;* and for this purpose I always prefer one with the blade from eight to nine inches in length. In all notching of trees, therefore, I make every man bring along with him such a spade as I have described, never allowing any man to plant with a new one, as I have found from experience that the man who uses a new one cannot plant the trees nearly so well, nor can he plant nearly so many in a day, as he would do with a half-worn, sharp-edged spade. However, those who may not be satisfied with using old spades as I am in the habit of doing, will find an excellent article, made for the purpose of planting young forest trees, in any nurseryman's warehouse. These are termed *planting spades*. They are of the same form as a common garden-spade, but smaller in the blade, and having the *shears*, or that iron part which clasps the wooden handle, made stronger than in the common garden-spade, in order to resist the more certainly the strong pressure which is sometimes put upon the handle in the act of notching upon the tough turf.

In cases of necessity I sometimes use these planting spades; that is, when I cannot procure enough of half-worn ones for the number of men that I may have occasion to employ; but in all cases I have observed that those of the men who have half-worn common spades, do far more work in a given time than those who use the planting spades; the reason being, that those tools are

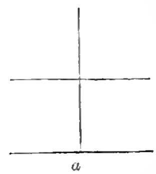
* Mr William M'Corquodale, forester at Scoon, Perthshire, has recently invented a spade constructed exclusively for the planting of young fir trees by the notching system; but as I have not yet myself practised with it, I would simply at present call the attention of foresters in general to examine and test its adaptation for that purpose.

made too heavy in the iron, and, when new, are not so pliable in a man's hand as a sharp old spade.

The superintendent being perfectly satisfied as to the good state of all the things above mentioned, he will cause some old trust-worthy man to take charge of the plants that have been sheughed, whose duty it will be to give out to the boys the different sorts of young trees as they require them. This must not be trusted to the boys themselves, as they would most likely leave the earth from the roots of the plants when they came to take away a quantity; and, besides, they could not judge themselves as to the quantity required to be taken at one time. Having appointed an old man for this purpose, the superintendent will send the boys to him to where the plants are, and cause them to bring with them in their aprons, each, as nearly as possible, fifty larch and fifty Scots firs, with their roots laid inwards; that is, the old man will take fifty plants of larch and place them in the boy's apron, say upon the left side, with their tops out and their roots inwards, and he will also take fifty Scots firs and place them in the same apron upon the right side in the same position. This precaution is necessary, in order to protect the roots from the winds and drought. It is not necessary that the man should count every plant he puts out; but if he count a few times, he will very soon, from practice, be able to give the boys the desired number, always observing in the present case to give larch and Scots firs of each an equal number. This he will do every time the boys come to him for a supply as their former quantity is done: fifty plants of each at once makes a very good quantity.

The men, with each a boy and plants, being all arranged in a line upon the edge of the ground to be planted, having their backs towards the plantation ground, and their faces looking upon the fence or boundary from which they are to start, and each having a space of three yards in breadth to plant, the superintendent will, with his own hands, take a spade and show them how he wishes the trees to be planted, and also the manner of keeping the distances of one tree from another; at the same time he will show the boys how to put the tree into the notch as it is opened by the man. I may here explain the manner of planting by the system of notching, and how the boys ought to put in the plants. The operator, with his spade, makes two deep cuts upon the turf, crossing at right angles exactly where the plant is to be put in. (See Fig. 81.) He next inserts his spade across one of the ends of the four rays, as at *a*, which may be about five or six inches from the centre, this insertion of the spade being made on the side next himself. When the spade is inserted at *a*, he bends the handle or head of the spade towards himself, and nearly to the ground. At this stage of the operation the turf will open in the centre of the cross in four equal parts, but most from the point *a*; and at this instant the boy inserts his plant at the point *a*, where the spade intersects the ray from the centre. Immediately on inserting the plant he will draw it to the centre, while the planter will retain his spade for a moment until the boy has the roots slightly adjusted after passing them through the cut. As soon as this is done, the operator raises up the handle of his spade, letting the earth and turf down upon the roots of the plant, and makes all the cuts close and compact about it by tramping with the fore-foot first, and then with the heel. If the cuts do not close tightly, as is sometimes the case when the turf is of a hard benty nature, a little piece of thin turf may be taken from the open space and placed over the cut, which will keep out the drought, this also getting a tramp with the foot. When the situation to be planted by notching is upon a sloping brae, the operator should stand with his back up the hill and his face looking down. By doing so, he inserts his spade for the opening of the turf at right angles with the rise of the ground upon the upper side; and in this case the water coming along the surface is intercepted by the cuts, and retained for the advantage of the young trees. Another point to attend to in the planting of young trees by notching, is to see that they are not inserted too deeply, for this is an error in planting which very often takes place. In order to avoid this, which is against the health of the plants, the boy should be instructed to hold the young tree between his fore-finger and thumb, just about one inch above where the earth has been formerly. When he puts it into the

Fig. 81.



cut, he should hold it firmly by that part until the turf falls down in its place; and if he finds that the turf, when down, is much above the points of his finger and thumb, he must pull it up a little so as to have these resting upon the surface of the turf. By attending to this precaution, the young trees will have a better chance to succeed well. I have frequently seen the boys left to make the plants firm in their place; but this should never be allowed by any man who wishes to do anything like his duty to his employer. I have also known foresters who were so stupid and foolish as to make the men and boys hurry on and get the plants put into the ground at all events, not paying the least attention as to the manner in which the work was done; boasting then to their employers as to how many plants they had put in in one day, and of the low price at which they could plant an acre of ground; and all this with the view of deceiving their employer and gaining his favour in the mean time. But, as was the natural result, the crop was a failure. Every forester who wishes to do well to himself, and to his employer at the same time, should have his planting work executed well, without paying respect to a few extra shillings of outlay on the acre. The work when well done will prove satisfactory to the proprietor afterwards, as well as to himself; and I again urge the making every man employed in the work of planting accountable for the planting of the trees in a proper manner, and not the boys.

The superintendent will now see that his men go on according to the instructions given them, which are in the mean time supposed to be as above; while he also takes care that they cause the boys to mix the larch and Scots firs equally upon the ground; that is to say, that the boys put in one larch and one Scots fir alternately, mixing them in equal numbers as nearly as possible, and as near to the given distance as can be guessed—that is, in the present instance, *three and one half feet*. With regard to this point, I have generally found that men are more apt to plant a few more trees per acre than otherwise. After the men had done planting a piece of ground, I have measured off an acre and counted the plants upon it, and have found two hundred more than the stated allowance. Upon exposed situations, however, this is the surer way of going to work; for a few trees extra per acre are always easily thinned out in due time, but a blank is always an eyesore in any plantation ground, and this can scarcely fail to be the case if a plantation is left thin at first.

The men being now, as we will suppose, going on briskly with their work, the superintendent will keep a sharp look out behind them, to see that they do the work according to his directions given to them when they commenced. If there be any hands among them who are more *green* than others, he will look most sharply after them, and leave more to themselves those whom he knows to be well acquainted with the work. He must go backwards and forwards among the planters, minutely examining their work; in short, he must examine almost each tree as it is put into the ground, and see that it is properly planted and made firm in the ground. When the least fault is observable, it ought to be checked at once, and the fault laid to the person who did it; and if he persist in doing the same thing over again, the better way is to pay him off at once rather than run the risk of having the work badly done. An example will thus be made among the men, showing them that the orders of the superintendent must not be trifled with. Every cut made with the spade in the act of planting a tree should be firmly closed, in order to prevent the drought from taking effect upon the roots.

When any boy has his supply of plants nearly finished, say all but ten of each sort, he will give these to the man whose assistant he is, and run for a fresh supply while the man is planting them. By this method no time is lost; and as the supply of plants is generally not far off, and the old man ready to give them out, any boy may be back with a fresh supply before the man has twenty planted. Some planters have one boy serving the others with plants; but this method I have found objectionable, seeing the plants are more exposed by it.

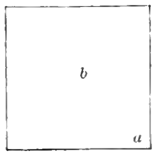
When the planters have arrived at the other end of the ground laid off for them by the poles, the superintendent will, from the pole at which they ended, measure off another space of the same description as the first, and cause the men to fall in upon it, and plant backwards another breadth of land, ending at where they commenced. In order that the men may not be hindered, the superintendent should have the land measured off previous to their finishing the first piece, and make the pole at which the men end the last to be removed, and the first to begin at again. By going to work in this manner, the superintendent is on the spot to see his men fall into their proper places again upon the new land; and thus the planters will cross and re-cross the ground until they have the district finished. When there may be any odd corners to finish, upon which the whole number of men could not be profitably employed at once, the superintendent should cause a few of his most trustworthy hands to finish them, and carry off the others himself to commence upon another district.

At any time when the day may turn out wet, if the men have all collected, and are willing to work, let them do so, but only as long as the ground is not saturated with rain, which can at once be known by the young trees not firming in the ground. As soon as the superintendent sees that the men cannot, with the usual beating, firm the trees, let him give orders to drop work at once: to persevere in such a state of things is the worst management. However, upon dry ground this will seldom occur. If the day should prove frosty, let the men be set to make pits in any district of the ground where it is required to have them—an operation which, in new land, should always be left for days of this nature; but the superintendent should be most careful never to allow a tree to be planted in such pits till the frost has been properly thawed out of the earth. To plant a young tree among frozen earth will kill it as certainly as if it had been put into boiling water; therefore the planter should always be extremely careful to avoid this.

It sometimes happens that a morning will be frosty, and yet the day prove good for planting operations after the sun has reached a certain height. In a case of this kind, the superintendent ought to set his men to the working of pits for hardwood in the mornings, till the sun gets well up, and the frost has abated. This he will at once know by the fresh earth which has been turned out of the pits in the morning. If the particles of it are crumbly on the top, and rather dry, the frost is too keen to admit of planting with safety; but if they are, when handled, of a soft and pliable texture, he may proceed with planting immediately. In the afternoon, when the sun begins to get low, he must observe the same precautions: as soon as the earth, from its crumbling dryness, begins to indicate the presence of frost, he must leave off the planting, and resume the work of making pits; but if the earth continue soft and pliable to the feel, he may go on with planting, whether that is in pits or by notching upon the turf.

We shall now suppose that the planting of district No. 1 has been finished, and that the superintendent wishes to go on with the next district in succession, No. 2. This consists of ten acres of good loam upon a sheltered slope, and which is to be planted with 108 oaks and 327 ash to the imperial acre, and to be made up with one year's transplanted larches and two years' transplanted Scots pines, to the distance of three and a half feet over all. By looking at the table of distances given in this section, it will be observed, that in order to plant 435 hardwood upon the imperial acre, the pits will require to be made at distances as nearly ten feet as possible. Now, supposing that this has been partly done during a frosty morning, while planting the first district, the superintendent will, as is the most profitable way, and that by which he can always have the men most immediately under his notice, set all hands to fill up the pits which have been made with trees, and not put one party to the making of pits, and another to the planting of the trees, unless, indeed, he can put on one party to make the pits in whom he can place more than ordinary confidence, and enable him to devote his undivided attention to the planting. This I frequently do myself; but where the superintendent cannot place confidence in a certain party of his men, his better plan is, in order to have the work properly executed, and to have it carried on to advantage, to keep them all at one department of the work. This he must do as he finds himself circumstanced, because either of the ways will answer so far as the work itself is concerned. In planting the hardwood in the pits, the boys will not be able to carry about with them so many plants as they did of the firs, the hardwood plants being larger; twenty-five plants of oak, and the same of ash, will, in the present case, be a fair proportion, and enough of trees at once.* In the act of planting in the pits, if the situation be an exposed one, I put the plant, not in the centre of the pit, as many do, but in one corner of it. (Fig. 82, *a.*) My object for doing so is to obviate the bad effects arising from the wind shaking young trees when first put in their place, as in exposed sites this is greatly prevented by planting the tree in the corner of the pit rather than in the centre. In the former position the young plant has two firm sides to rest upon instead of the open soil all around it, as in the case when planted in the centre, as at *b*. As to this, the superintendent must judge for himself, whether he ought to plant the one way or the other, and be regulated, in doing so, according as the trees are apt to be shaken or not by severe storms. Whatever way, however, may be resolved on, the boy holds the tree in its place until the man with his spade fills in all the loose earth taken out of the pit; the boy all the time moving the plant slightly up and down until he find the earth heavy about its roots. When the whole earth is in, the man should take hold of the plant, and judge if it is too deep: if so, he should pull it up a little, and then with his feet make the soil firm about the roots of the newly-inserted plant. As it is understood that, in the making of the pits, the turf, when taken off, was divided into two equal parts, the man will next take the divided turf and place it, grass undermost, upon the surface of the pit, with the tree in the centre, and make it quite firm and close about the plant. If, however, it is intended to plant the trees in the corners of the pits, it will not be necessary to divide the turf at all, but merely to turn it upside down upon the surface of the pit. The earth upon it should then be pared off, and put with care upon the joining all round, the whole receiving a firm beating from the feet. In the same manner proceed with the planting of all the trees in the pits; and when it happens, at any time, that the men, on account of frost, are set to make pits altogether, the boys may be dispensed with for the time, the super-

Fig. 82.



* In the case of planting the above mixture of oak and ash, the oak should be first put in at twenty feet apart, and the ash between them to ten feet alternately.

intendent letting them know when to come back, provided the weather shall be fresh.

Some planters have recommended to plant the ground first with firs; and where it is intended to plant hardwood among them, to do so when the firs are from four to five feet high. This they say is in order to produce shelter for the hardwood previous to putting them in. I am decidedly against this system of rearing hardwood, being certain that no advantage is gained by such a method, but, on the contrary, there is much lost. For example, if oaks are either sown or planted among firs when these are from four to five feet high, they very soon overtop the oaks, and render them, if not useless, at least tall, slender, and unhealthy; but so far as I have seen the effects of the system, the oak trees so dealt with are more generally found crushed down, unhealthy, and stunted; this being always occasioned by the rapid growth of the firs as compared with that of the oak. In all high-lying situations, any hardwood that may be planted should be plants of a rather small size as compared with others that would answer in a sheltered place. These small plants, I have always found, are much improved by being cut over by the surface of the ground the second year after being planted out: by this method of treatment they make fair good shoots during the third summer of their standing in the forest ground. During the fourth summer, the young shoots are thinned out, and one left for the ultimate tree at each stock, when a fine young tree is formed, fresh and new, and in every respect adapted for the climate in which it has been produced. By this time also the firs are beginning to make rapid progress, and give the hardwood plants the benefit of their shelter, so that at eight years' growth, upon a high situation, the firs will very probably be from six to eight feet high, and the young hardwood, if dealt with in the manner I recommend, will be at least half that height. Thus we have, by the method I recommend, when the firs are from six to eight feet high, good healthy hardwood, whether of oak or any others; whereas, by the method referred to above, the planter would be several years behind, besides running the risk of having his trees choked up and ruined, by the firs being so much in advance of the hardwood.

The hardwood being all planted in the district No. 2, the superintendent will next proceed to have the ground filled up, to the distance formerly specified, with the firs, by the method of notching already described. District No. 3, containing twelve acres of moss resting upon clay, is to be dealt with in the same manner as the district last referred to. I have seen excellent oak timber upon a mossy surface soil resting upon clay, and that was when the moss had been well dried from superfluous moisture. When it is well drained, the moss has a strong and rapid tendency to subside, and the roots soon find their way down into the clay, where they derive their principal nourishment. Indeed, upon a soil of this description, larch and Scots pines thrive well also.

District No. 4, being twenty-four acres of deep swampy moss, but well dried by draining, will not grow hardwood to any advantage; unless, indeed, we may except ash, which will do well in moss as a coppice. In this case, however, I have advised to plant spruce and Scots pines, both thriving pretty well in a mossy soil: the spruce firs more particularly do well upon such a soil. These should all be planted by notching, unless the plants used be large, and the surface rough with strong grass, in which case they should be planted in pits; and particular care should be had to see that they are made firm, as the cuts in the moss are very apt to open when the drought sets in during the spring, which would be against the health of the plants. In a mossy soil, plants of any description never come away quickly. I have observed mossy tracts that had been planted in new plantations, make scarcely any progress whatever for the space of eight or ten years from the time of planting. This was occasioned by the want of stimulus in the soil to set them off in their growth, the moss being always what foresters term *dull;* but as soon as shelter is produced by other trees growing around the moss ground, the plants in it come away rapidly. In the centre of No. 4 there is a spot of three acres, which, from the difficulty of getting conveniently a sufficient fall for the water, is not well drained. In such a place the alder is the only crop which will succeed upon it, and these may be planted by notching.

District No. 5, being thirty acres of strong clay loam upon a level, is excellently adapted for the growing of hardwood, and more particularly for the growing of oak; therefore I have recommended to plant three hundred of them to the acre, and make up to four feet over all with two years' transplanted larch and Scots pines, of each an equal number. In this case, the oaks being upon a level part of the ground, and sheltered by rising ground in the neighbourhood, the plants may be inserted in the centres of the pits, and the larches, which here, on account of the strong herbage upon the ground, are to be two years transplanted, will, in order to have justice done them, require to be planted in small pits, merely the breadth of the spade upon the side of the square, which can be very quickly made. I have found that a man will make five hundred of such pits in a day upon a good pliable soil such as that at present supposed: they need not be more than from seven to nine inches deep. The Scots pines, although two years transplanted, may, in a good clay soil, where there are no roots of old trees, be planted by the notching system, taking care to make them firm in the ground, and not to put them in too deep, an evil with regard to pines of all kinds which should be particularly guarded against. The roots of pine trees, if buried out of the influence of the air, are sure to be thrown into bad health, or perhaps die, according to the degree of depth.

District No. 6, being seventeen acres of light sandy soil, with thin surface turf, and resting upon gravel, is to be planted with two hundred beech and two hundred birch to the acre, each sort eighteen inches high. These must be put into pits; but the soil being of an open free nature, these need not be large. Pits of the same size as has already been recommended for the larch firs in the last district, will answer perfectly well; and allowing four hundred hardwood to the acre, the pits for them will require to be made about ten and a half feet apart. These being put in, the ground is to be made up to three and a half feet over all, with one year's transplanted larch, and one year's transplanted Scots firs, of each an equal number. They may all be notched; and in putting them in, care should be taken to see that they are properly mixed, and larch planted next the hardwood.

District No. 7 consists of forty-three acres of bare rocky ground, with here and there spots of good loamy soil, to the extent of about six acres in all: bare rocky ground to be planted with eight-inch birch, two years' seedling larch, and two years' seedling Scots firs, of each an equal number to the acre, making them stand three feet, plant from plant: good loamy soil to be planted with ash, ten feet apart, and made up with larch and Scots pine to three and a half feet over all.

In this case, have first the six acres of good loamy soil made up with the desired number of trees to the acre; planting the hard-wood first in pits, and then filling up the ground with firs, as already specified, by the notching system.

In planting the bare rocky parts with the two years' seedling larch and Scots pines, and also the birches, a system of planting, different from what we have yet mentioned, must be resorted to—namely, that of planting by means of the planting-mattock. (See Fig. 83.) The handle of this implement is generally made about forty inches long, and of a piece of good ash-wood: the mouth or cutting end, *a*, is about four and a half inches broad, and pretty sharp; and the length of the one side, from the face to the eye, is about fifteen inches. The other side, instead of being broad and sharp, is made to taper to a point, as in the common pick, (see *b*.)

Fig. 83.

In using this implement for the purpose of planting, which is only done upon thin, stony, or rocky ground, where the spade could not be used to advantage, the operator takes it into his hand in the same manner as he would do a common pick, and first pares off a thin part of the turf, with the broad end, *a*, exactly on the spot where he intends to plant a tree. Having this turf taken off, say about six inches square, he next with the pick-end loosens the soil in the spot pared, to the depth of about eight inches, bringing up at the same time to the surface any considerable-sized stone or stones that might interfere with the planting of the tree. In this manner any number of men may be employed, always observing to keep to the specified distance as nearly as circumstances will permit. In general, every two men employed with the planting mattock are followed by one person having the trees in an apron, which he plants in the spots prepared. In planting with small seedlings, he uses an implement called the *planting hoe*, represented by Fig. 84. The iron part of this implement, from *a* to *b*, is generally about twelve inches long; the mouth or sharp end at *a*, is made about four inches broad, and is not kept so sharp as the mouth of the mattock, it having to be used in the earth; the handle may be about fifteen inches long. The person who is entrusted with the planting of the seedlings in the spots previously prepared by the men with the mattocks, carries his plants in an apron before him. In using the planting hoe, he keeps it in his right hand, and digs it into each spot; and by pulling it, when in, a little towards himself, he makes a sufficient opening at the back of it to hold the roots of the young tree, which he puts in with his left hand, inserting the roots very carefully. As soon as the roots are properly put in, he withdraws the instrument, taking care at the same time not to disturb the plant in its position. When the implement is out, he gives the earth, upon the side of the hole next to him, a push with its mouth, in order to hurl the loose earth into the hole about the roots of the newly inserted plant; and finishes by tramping and making the plant firm in its place. In this manner three men will plant nearly two thousand plants a day.

FIG. 84.

On very bare or rocky surfaces, it is not always even possible to get as much earth in a certain spot as will properly cover the roots of small seedling plants. Where this is the case, it is a better plan to sow the seed of the trees wished to grow in the ground at once; which is the only way of getting young trees to rise in certain districts. This plan has been adopted in some parts of the West Highlands of Scotland, and has been attended with good success.

We often see seedling trees, of almost every common variety, growing upon old walls, or any chink of a stone where the seed has only got a small portion of lime rubbish or other decomposed matter to vegetate in; and in this position we have seen them attain considerable dimensions, so much so as to rend the wall, in which they had got a footing, into pieces. Even in the crevices of rocks we often see trees of very large dimensions growing, which points out that, where a young tree can only obtain a very slight footing for fixing its roots, it will prosper ultimately, and make room for itself. I am strongly of opinion that many bare rocky parts of a country might, under proper management, in growing the seeds of forest trees upon them, be made very productive and valuable, not only as a shelter to the surrounding country, but as yielding a profitable crop of timber. The oak and birch, in particular, are well adapted for this purpose. I have myself cut oak and birch coppice of valuable quality growing upon bare rock; and I am convinced from what I have seen upon this point, that both these trees are well adapted for covering bare rocky ground;—the oak in moderately exposed, and birch in high and exposed, parts of the country. In sowing the seeds of either of these trees upon a bare rocky surface, it is necessary to have little patches prepared for the sowing of the seeds; and this can very easily be done by carting several loads of earth to where that does not previously exist in sufficient quantity. The acorns may be laid two or three in a shallow fissure of the stony ground, and merely covered by one spadeful of earth; and the birch seed may be sown upon the surface of a spadeful of earth laid down for the purpose, and merely get a slight beat with the back of the spade, in order to prevent the seeds being blown away. Even Scots and larch fir seed may be sown in the same manner, but the oak and birch being trees adapted for coppice-wood, are decidedly preferable for ground of the nature in question. Another reason for sowing the seeds of trees in poor, thin, rocky soil is, that there the seed is not very apt to be destroyed by mice, birds, and other vermin, they being more in the habit of frequenting more favoured spots for the sake of cover and shelter.

In growing trees from the seed in such situations as that referred to, it is necessary to keep the patches clear from weeds for the first two years, and to thin out all the patches to one individual after the second year of their growth, at which stage the plants will be established in their place, and require no further attention.

Having now stated pretty fully the method of proceeding with planting operations, I shall now conclude with a few general observations.

In the planting of firs among hardwood, it is of importance that the larch plants should as much as possible be kept next the hardwood. By this method of procedure, when the first course of thinning takes place, we shall have larch trees to sell instead of Scots pines, which would not be the case were the Scots pines planted next the hardwood; for in the first course of thinning it is always necessary to relieve the hardwood first by taking a few trees off them.

In making up with young trees old plantation ground, upon which a number of large trees may be still growing for the purpose of producing a clothed appearance until the young wood rise up, the spreading branches of such of them as may be covering a large piece of ground, should be lopped off; for the young trees will not thrive under their branches. In planting young trees near old ones, it is always advisable to keep the young beyond the drip or outer points of the extended branches of the old; and as the young trees rise up, the old ones should be either cut away altogether, or their side branches so much shortened as to give the young ones free room and space to rise up healthily.

In preparing old plantation ground for planting young trees upon it, the pits for the hardwood should be made three or four months previous to planting the trees in them. By using this precaution, the soil is made more healthy for the roots of the young trees, and they will consequently come away much better. Young trees planted in ground from which a crop of wood has been lately taken, seldom come away so freely and quickly as trees planted upon a fresh soil, and this more particularly if the crop be not changed. On this point it may be necessary to give a few more practical hints, for many foresters are liable to error in this point, and I have seen many failures take place in consequence.

It is now a well-ascertained fact among the more observing and intelligent foresters, that in the culture of trees, as well as in the culture of any agricultural or horticultural plant, a change of crop, or a rotation of cropping, is necessary upon the land; and in many instances where this has not been attended to, a failure has been the result. However, there are modifications as to the extent of the failure in cases of this nature; this depending upon the adaptation of the land to the nature of the trees cultivated. For example, if a piece of land upon which firs have been grown to full size, be of a rather deep sandy loam, another crop of the same species may be taken, and the trees of the second crop may very likely prove nearly as good as those of the first. But if a piece of land, upon which firs have been grown to full size, be thin in the upper stratum, with a hard tilly subsoil, the second crop will not succeed so well; while, on the other hand, from the upper stratum having been greatly enriched by the fall of the foliage of the firs, hardwood trees would succeed well; and after they had got themselves established in the upper soil, and had gained strength, they would send down their roots deep into the subsoil, and improve it to a great extent. After the hardwood crop had been perfected and cut down, and the soil in the upper surface had been much improved by the foliage of the hardwood rotting upon it, a crop of firs would thrive well upon it again, and in all probability would be much better than the first crop; because, the soil being now much deeper than at first, and improved by the penetration of the roots of the hardwood, the roots of the firs would have a renewed soil to grow in: the one crop thus preparing the soil for the reception of another, as is well known to be the case in all agricultural rotations of cropping.

But although firs will not grow to the same state of perfection when planted successively upon the same piece of land, they will, notwithstanding, grow to a considerable size, and even to the extent of becoming useful timber ultimately. Of this we take advantage in the planting of nurses among hardwood trees planted after firs. In many soils, however, where Scots pines have been cut down as a matured crop, the soil is what foresters generally term *foul;* that is, it is infested by an insect which preys upon the young trees of the same species when planted as a second crop; and there are very few Scots pine plantations of any considerable extent in which this insect is not found. Even after the old trees have all been carried off, they will live and prey upon the bark about the roots of the trees that remain in the ground; and on this account it is often found a matter of great difficulty to get young Scots pine trees to come away after a crop of old ones, the insects preying continually upon the bark, and consequently killing the young trees. This insect is termed the *Hylurgus piniperda*. It has the appearance of a small beetle, of a bright gray colour, and beautifully spotted, and from half to three quarters of an inch long. These insects, in their attack upon the young Scots pine trees, generally commence at the part next to the ground, and eat the bark all round. They proceed gradually upwards, leaving the young trees peeled in to the wood, and the tree, of course, dies in a very short time. When there are larch planted among the Scots pines, it attacks them in the same manner, generally commencing its ravages pretty early in the season, when the young trees are in sap and beginning to grow.

Many plans have been tried by foresters to avoid the ravages of this destructive creature; but the most effectual plan, and one which answers perfectly well, was first pointed out to me by Mr William M'Corquodale, forester to the Earl of Mansfield, upon his estate of Scone in Perthshire. Having myself been much annoyed by the ravages of the insect mentioned above, in most of the older fir lands upon which I had planted other of the same species (both larch and Scots) as nurses to hardwood, I learned that Mr M'Corquodale was very successful in raising a second crop of firs upon the same land, and avoiding the ravages of the insect. I therefore visited him at Scone, and had a convincing proof of the entire efficacy of the plan he adopted, which I shall here describe, for the guidance of others who may find it necessary to plant young firs as a second crop upon the same land, and which I can recommend to all foresters as being a system well worthy of their adopting.

In planting young Scots pines on land which has been recently under a crop of the same kind, Mr M'Corquodale uses two years' transplanted trees. In planting them, he first takes off a turf with the spade about twelve inches on the side of the square, rather thinly, and lays it to one side of the opening. He next loosens the earth upon the spot from which the turf was taken, to about nine inches deep, giving it a sort of dig, and making the soil open, and in a good state for the reception of the roots of the plant; and next he inserts the plant rather shallowly with the spade in the usual manner, giving the earth about it a firm tramping with the feet. He then takes the turf which came off the spot in which the plant is now put, and with the spade divides it into two equal halves, and lays it, grass side undermost, back upon the spot from which it was taken, making the two halves meet upon the tree, joining the seam in the middle pretty close, and giving the whole a firm beat with the back of the spade. Then, in order to finish the whole, he raises a piece of turf from the surface, anywhere near to him at the time, with his spade; then takes out two or three spadefuls of clean earth, and puts it upon the top of the inverted turf, and round about the plant; and then, taking a hold of the plant, he with his foot makes very firm the soil laid over the turf; which being done, he next with the spade gathers up the loose earth as it lies flat round the tree, and puts it neatly up all round upon the tree, giving it the shape of a little cone or mound, with the tree in the centre. This being neatly done, he claps it all round, firmly and smoothly, with the back of the spade—when the work of planting is finished. In the same manner he proceeds with every one of the trees he may plant under such circumstances. Fig. 85 will show the appearance of the tree, with its mound of earth about it, when planted.

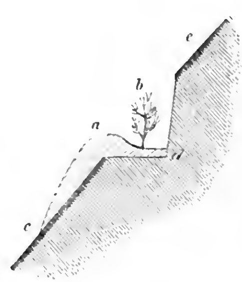
Fig. 85.

Now, with regard to his reason for planting the trees in the manner described, he says, "The insects, when they make an attempt to climb the little mound of earth, cannot keep their footing, and invariably fall down before getting half way up." He says, "I have frequently sat down to observe the movements of the creatures, and find that when the surface of the mound of earth is made perfectly smooth, they can, on account of the steepness of the mound, scarcely make any advance at all, and very soon give up the attempt; and even when the glaze does wear off the surface, the earth, as they endeavour to mount upwards, on account of the steepness of the mound, always gives way with them, and hurls them to the bottom before they can advance an inch or two. This points out the whole secret of the matter."

To those who may be incredulous as to the effects of such a simple contrivance, I have only to say, try, and the effects will be evident. The woods under Mr M'Corquodale's charge point out the effect of this system of planting; and having examined for myself in this matter, I can confidently recommend it to others.

In planting trees in pits, the planters should always be very careful to see that the best portion of the soil be put next the roots of the plants; for, if this be not attended to, the success will not be equal to expectation. They should also bear particularly in mind, to chop down and pulverise with the spade all soil which is put next the roots; for if put in about them in lumps, vacuities will be left about the roots, which will probably cause water to lodge there; whereas, when the soil is made firm and small, it gets in about the tender roots, nursing them kindly, and preventing superfluous moisture from lodging near them. Where pitting is performed upon a sloping piece of ground, such as the side of a hill, the earth, as it is taken out of the pit, should be put to the under side, and close upon the edge; and when the trees are planted in these pits, the good soil upon the upper edge of the pit should be broken well down with the spade, and put in about the roots of the young trees, leaving all the soil which was taken out of the pit still lying upon the under side, in order the better to protect the roots from drought and retain moisture about them; forming, when the tree is planted, a bowl in which a little moisture can be retained in its descent down the hill. Fig. 86 will explain the nature of this sort of pitting: *a* represents the earth taken out of the pit; *b* the tree standing in the pit, which has been filled up with earth by reducing the bank behind as at *d*, the original slope of the ground being indicated by the line from *c* to *e*.

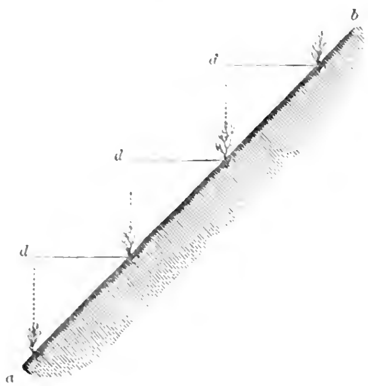
Fig. 86.



Although the spruce fir does not naturally grow in this country when planted in a high exposed situation, it will do well, and even grow to useful size, in a plantation upon an exposed part, if it be but sheltered by other trees of a more hardy constitution, such as the Scots pine and larch. Every planter, therefore, who wishes to produce a variety of trees in any high part of the country, if he will plant spruce firs in the interior, where they will ultimately be well sheltered, may depend upon raising spruce fir timber of good and useful size; that is to say, if the soil be not too light, and of a dry gravelly nature.

In planting trees in glens and steep hollow parts, the operator should not measure his distance between the trees with the slope of the ground, but in the manner as represented in Fig. 87, which is drawn to the scale of an eighth of an inch to a foot. The line *a b* represents a sloping bank, to be planted with forest trees, at four feet apart; the places of which are shown in the Figure at *c*, *c*, *c*, *c*. By measuring upon the line *a b* with an eighth of an inch scale, it will be at once seen that the distance between each tree from *c* to *c* is six feet; and had the planter planted his trees, measuring his distance of four feet along the slope, he would, when the trees grew up, have had them growing at about two and a half feet instead of four. In taking distances for planting trees in a case of this nature, the operator must always keep his *measure stick*, if he use one, in the position as pointed out in the Figure by the line from *c* to *d*; or, in other words, the operator must, when taking a measurement for planting another tree, set the one end of his measure-stick at the bottom of the last tree he planted, and, keeping it level, let fall a perpendicular from the other end for the place where the next tree is to be planted, as shown by the dotted line from *d* to *c*.

FIG. 87.



SECTION VI.—KINDS OF FOREST TREES WHICH MAY BE MOST PROFITABLY PLANTED IN ANY GIVEN DISTRICT OF THE COUNTRY.

In raising timber as a profitable crop upon any proprietor's estate, two things require to be kept in view—namely, 1st, to plant those sorts of trees which will come to be of the greatest value in the nearest market; and, 2d, to plant those sorts, which are most likely to grow to useful size upon the soil to be planted. In illustration of this, we may suppose a proprietor desirous of planting hardwood, such as oak, ash, elm, and sycamore. If his ground was not naturally adapted for the healthy growth of these sorts, he would ultimately be a loser by planting them, even admitting that he could get a ready market for the timber in the neighbourhood. On the other hand, were the same proprietor to plant pines upon his land instead of hardwood, even although he could not get a ready market for such wood in his neighbourhood, he would (the land being adapted for pines) ultimately, from the healthy state of his trees, and the greater bulk of timber produced, be a great gainer by such culture. From this it will at once appear evident, that, in order to receive the greatest possible value from timber in any given district, it is of greater importance to grow that sort of tree for which the soil and situation are adapted, than to grow that sort for which the greatest price may be given in the market.

On an estate thirty miles from a good market for oak timber, and in a district difficult of access, if the proprietor were to plant oak in a soil perfectly adapted to it, and at the same time to plant pines in another situation as well adapted for them, supposing that both grew equally well and arrived at good size, and that he had the same number of feet of wood in each per acre, yet, on account of the great distance there would be to carry the oak to market, there being no demand for it in the neighbourhood, the oak very likely, after deducting all necessary expenses, would not bring so much clear cash to the proprietor as the fir would do, there being, as we shall suppose, a great demand for it in the immediate neighbourhood. This I have frequently had occasion to observe, and I am aware that proprietors are often misled in this matter, calculating much upon any wood, such as the oak, which is famed for its value, but not calculating the expense necessary to be incurred in getting that wood brought to market. Before proceeding to point out the different kinds of wood which may most profitably be planted in any certain district, I shall give a statement showing how the value of timber is affected by distance from market. The following are the prices, varying according to distance from market, at which I have seen wood sold on the ground in 1846:—

Oak	at 5 miles from Leith,	at 2s.	6d.	per foot	
Do.	at 10 miles,	at 2	3	do.	
Do.	at 20 do.	at 1	8	do.	
Larch do.	at 5 do.	at 1	6	do.	
Do.	at 10 do.	at 1	3	do.	
Do.	at 20 do.	at 0	10	do.	
Ash do.	at 5 do.	at 2	0	do.	
Do.	at 10 do.	at 1	8	do.	
Do.	at 20 do.	at 1	3	do.	
Scots pine,	at 5 do.	at 1	3	do.	
Do.	at 10 do.	at 0	10	do.	
Do.	at 20 do.	at 0	6	do.	
Pit props,	at 5 do.	at 3	6	per 100 lineal feet	
Do.	at 10 do.	at 3	2	do.	
Do.	at 20 do.	at 2	6	do.	
Fire-wood,	at 5 do.	at 10	0	per ton.	
Do.	at 10 do.	at 5	0	do.	
Do.	at 20 do.	at 2	0	do.	

The statement given is from sales, the superintendence of which I had myself, and can therefore vouch for the correctness of the different prices given. Any proprietor, therefore, twenty miles from the market, must not expect to realise much more than half the value for his wood that his neighbour who is situated five miles from the market does; and so on in proportion to distance.

In all districts near to any ship-building port, or to the sides of rivers, &c., where access is easy, no wood can pay better than oak and larch, both of which are used in the construction of first-class vessels, and, indeed, in vessels of every size. I have myself seen oak timber, brought from a distance, draw a higher price per foot than oak grown near the market, in consequence of superiority in the quality of the wood; and I have heard a proprietor, whose plantations were within four miles of a thriving sea-port, say that his plantations of pine paid him much better than his oak ones, his land not being so well adapted for the raising of oak as for pine. I mention these facts, to avoid misleading any, because the value of wood as a crop upon any piece of land, let the locality in which it is grown be what it may, does not so much depend upon the kind of wood planted, as on whether the soil and situation are adapted to the growth of the kinds of timber planted upon it. Hence I always advise the proprietor of land to plant those trees which his soil and situation are best fitted to bring to perfection. In this case, although he may not have wood to answer the demand in the neighbourhood, yet when he takes into consideration the greater health of his plantations, and the consequent greater bulk of timber, he will find himself far better paid than if he had adopted a contrary plan. In the neighbourhood of all large towns there is a continual demand for Scots pine, larch, and spruce fir, for deals; and wherever the soil is adapted for the growth of these kinds of trees, they in general pay as well, if not better, than any other sort of wood, seeing their growth is quick. Ash is a wood much in demand about all considerable towns for handle-wood and coach-building, &c., and pays any proprietor well, when his land is adapted to the healthy growth of it; such as in dells, and other local hollows having a good strong loamy soil. The Scots elm is also much used in large towns, frequently for the same purpose as the ash; but unless it be grown in a heavy loamy soil, or in a light loamy one, with a supply of water from a running stream, it will not prosper well, nor turn out a profitable tree to the planter.

In the neighbourhood of all large towns, a great quantity of wood is generally consumed in the form of fuel; and for this purpose many sorts of wood are used. In Scotland, where coals are plentiful, wood is never grown for the purpose of being consumed as firewood, only the tops and larger branches of full-grown trees being sold for this purpose, along with the heavier timber when cut down; therefore, in Scotland, the raising of trees for firewood does not constitute any part of forestry; but in England, and particularly in the central counties, where fuel of every description is scarce, the raising of wood as a substitute for other fuel is necessarily resorted to, and constitutes a part of forestry. In order to meet the demand for firewood in such districts, hedgerow trees are kept down in the form of *pollards;* that is, the trees are headed down to ten or twenty feet in height, according to the kinds cultivated, and are allowed to produce lateral shoots, which are cut down again, in the same manner as coppice-wood, at stated intervals. These lateral shoots, from being so frequently cut over, become very numerous all over the trees, giving them the appearance of enormous coppice stools, and from them a great supply of young shoots is taken for firewood. Besides this supply, there are large tracts of mixed coppice grown in the usual way for firewood; that is, this sort of coppice is planted in the usual form of a plantation, and enclosed with a proper fence. The trees which are intended to form the future coppice are generally planted at four feet apart, using none but such kinds of hardwood as are known to produce a great quantity of stoles from the bottom or collar when cut over; such as the oak, ash, sycamore, hazel, willow, poplar, &c. These trees, when first planted, are treated in the same manner as in the raising of hardwood for a timber plantation; but instead of thinning any out when they come to such a size as to stand close together—and that will be when the plants are from fifteen to twenty feet high, and from three to five inches diameter in the bole—they are cut over to the surface, and allowed to push up another supply of shoots for another crop. In this manner these stools may be cut over for a supply of firewood for an indefinite number of years, and at intervals, as may be found necessary in order to supply the demand. In cutting down these coppice plantations, the whole is not used for firewood, all the straight rods being used and sold for bobbinwood for manufacturers, hoops, basket-willows, poles for various purposes, besom-sprey, implement handles, &c.; and when the best of the wood has been picked out for these purposes, all the sprey, and what may properly be termed refuse, is bundled up and sold in the form of faggots. Now, in districts where this sort of wood-produce is much in demand, it is certainly right and proper for the proprietors of land to grow it in order to supply the inhabitants with fuel; and in many instances large returns of profit have been made from such a mode of cultivating wood; but I do not see that it can be profitable for proprietors generally to plant their lands for the exclusive purpose of raising firewood. In thin tracts, where it would not be possible to raise large timber, this sort of crop answers well, and indeed pays well, as also in low swampy grounds. But wherever land is of a fair quality, the more profitable system is to plant, at a given distance, hardwood trees, to be raised as timber of full size, and allow the thinnings to be used for firewood as they are cut out. By this mode of going to work, a greater weight of wood will be taken from an acre of land at the end of a specified time, than if kept entirely under coppice, and consequently a greater return of profit would be received. In the districts in England where hops are grown, nothing pays better than the cultivation of small larches. These may be planted very closely together—say at from eighteen to twenty-four inches apart—and drawn up quickly for hop poles, and as the same land will produce several crops of the same sort, when planted in succession, very profitable returns are made, and at very little expense; while, at the same time, in raising such a crop, little or no professional skill is necessary in the person who grows it.

In districts where coal mines abound, great quantities of wood of various kinds are in demand; and it is in a neighbourhood of this description that I am at present situated, having no fewer than ten extensive coal mines within as many miles of the place. The demand for wood of all sorts to supply their various purposes is very great, —more particularly for *propwood*, which is generally small thinnings of various kinds of wood not less than two and a half inches diameter at the small end. In the neighbourhood of coal mines, the most profitable wood to plant is, first, larch, which, in a young state, when taken out as thinnings—say from three to five inches in diameter—is in great demand as propwood. When of a larger size—say about eight inches diameter—it is much sought after for sleepers to lay under the rails upon underground railways; and when of full-grown size, the larch is used extensively as boards for various purposes. Second, Scots pine and spruce fir, which, when of small size, are also used for propwood, but seldom for sleepers, the larch being preferred for this purpose; but when they have arrived at full age, the wood of the Scots pine and spruce is much sought after for boards and planks. Third, Poplar and willow is much sought after about coalworks, particularly when of good large scantling, and is used in the form of plank for clothing their waggons. Fourth, Ash is also much used about coalworks for handles to their picks. Fifth, Elm is also a good deal used for trams to the underground waggons. Sixth, Oak is also in considerable demand about coalworks, and is used for framing for their large waggons, and for various other purposes connected with such establishments. The above are the principal sorts of wood used for coalworks; but the most important in such districts is small thinnings of wood of every kind, provided it be of a size averaging from two and a half to five inches in diameter, which is now generally sold at three shillings per hundred lineal feet.

In the neighbourhood of flax manufactories, there is always a great demand for plane-tree bobbins about six inches in diameter, as also of a smaller size, which are sometimes made of birch. In the neighbourhood of all considerable manufacturing towns, and more especially where there are bleaching-works, there is an extensive demand for plane-tree of a large scantling, where it sells sometimes at a very high price. For railway purposes a great deal of wood is now used in the form of sleepers, for which larch is used; in the form of stobs and rails for the purpose of fencing the fields along the line, for which larch is also mostly used; and in the form of waggons of various kinds, for which purpose ash, elm, oak, and fir are used. In the making of a line of railway, the contractors require a great quantity of wood from the different proprietors through whose grounds they pass in the act of working, and in cases of this nature a good price is generally given for the wood; but the sales of this description are only of a temporary nature, in so far as the contractor's work is to be calculated upon. When, however, a line of railway is opened up through any gentleman's property, although he should be twenty miles off, he is, in respect of a market for his wood, or indeed of any other produce upon his estate, nearly on a level with his neighbours who may be within five miles of the same market. In such circumstances, the proprietor may plant any crop that will best succeed upon his land, and calculate upon having it brought to market in a cheap, sure, and expeditious manner. In such a case, if the proprietor find his land adapted for the growing of the more valuable kinds of timber trees, he need not be in any hesitation as to planting and rearing them, although he may not have a market near for its sale; because, when his wood is ready for cutting down, he can avoid the expensive process of horse-cartage, and put his trees at once upon trucks adapted for the purpose; and at a very trifling expense he may have them conveyed fifty miles to market, and sold and delivered much quicker than his neighbour who may have to cart his wood only five miles to the same place, although the trees may have been all cut at the same time. This I have now seen frequently done.

In conclusion, upon this head I have to state, that every proprietor of land who intends to plant a portion of it with forest trees, should not reason with himself merely as to what kinds of trees will sell best in his neighbourhood when grown. He should, on the contrary, also study the nature of his soil and situation, and plant those sorts of trees upon it which will thrive best and arrive at the greatest state of perfection, let the kinds be what they will. If he do this, he will have the greatest possible bulk of timber from a given number of acres in a given number of years; and will realise the greatest sum of money as their value. But if he act in an opposite way, and plant trees not adapted to his soil and situation, he will without doubt spend his money in the first place uselessly, and the after result will be vexation and disappointment.

SECTION VII.—KINDS OF TREES BEST FITTED FOR HEDGE-ROW TIMBER, AND MANAGEMENT OF THE SAME.

At the present time, when agriculture is improving so rapidly, many of its advocates are crying out vehemently against hedge-row timber, declaring to an enlightened public that all hedge-row timber trees are injurious to the raising of plentiful and healthy crops in the fields upon the edges of which they are planted. That this is true to a certain extent, cannot be denied; but the cause of hedge-row trees being in some cases injurious to the crops in the adjoining fields, cannot so much be attributed to the presence of the trees themselves, as to the bad management in growing them; for let it be kept in view, that anything, however useful in itself when properly managed, if it be allowed to overstep due order and balance, at once becomes an evil instead of a good. This is the very state of a great many hedge-row trees, particularly in England, at the present day. In many cases the kinds of trees have not been adapted to the nature of the soil, thereby causing them to spread too much; and in most the trees have been entirely left to nature, never having been trained up with the view of doing good as shelter to the adjoining fields. They have thus often become a pest; have been allowed to spread out their branches widely upon all sides; have been irregularly and most injudiciously planted; have been topped and mutilated, and made to answer any purpose but that of doing good to the farmer: in short, hedge-row timber at the present day is a part of forestry the least understood, and yet its proper management is of the greatest importance both to the proprietor and the farmer. Hedge-row trees, when trained up and managed upon right principles, instead of being a nuisance to farmers, become of first-rate importance in all well-cultivated districts; and instead of impoverishing the land, they become a source of fertility to it.

But although this may properly be said to be the state of things generally relative to hedge-row trees, there are nevertheless many fine examples of their being well managed; and in such cases I have myself heard farmers say that they were very much benefited by the shelter produced by them, and would not upon any account have parted with them. Having myself seen both the evil arising from badly managed hedge-row trees, and the good which is derived from them to all parties when grown in such a manner as to answer the desired end, I am prepared to speak from experience upon the matter, and to give my advice as a practical forester, as to the best method of growing hedge-row trees, so as to produce the greatest amount of shelter, and, at the same time, to cause as little shade upon the land as possible.

The planting of hedge-row trees is generally done with a threefold view—namely, that of raising useful timber in the country, without occupying much breadth of land exclusively for that purpose; the producing a degree of shelter for stock and crops in the adjoining fields; and the giving the country a clothed and ornamental appearance.

Now, all these three objects can be most amply attained without any injury whatever being done to the agricultural produce of the country. Before, however, proceeding to detail how this can be done, it will be necessary first to make a few observations as to how far these objects have been attained by the past or present system of managing hedge-row trees, and at the same time to point out the injurious effects of the system now practised. Generally speaking, hedge-row trees, as they have been managed, and as we now find them, are not of great value to the proprietors, or of much advantage to the country. The reason is, that no attention has been paid to their culture. In some districts, both in England and Scotland, where, of late, attention has been paid to the pruning of hedge-row trees, much good has arisen from their influence. In all cases, trees planted in hedge-rows are freely exposed to the air; consequently, the natural habit of trees under such circumstances is to become branchy; but if the forester apply his knowledge and practical skill to trees under these circumstances, he can, by the timely use of his knife, check this rambling habit, and give them a contrary tendency; and it is in a great measure from the want of this application of timely pruning, that hedge-row trees are now of so little value as timber, and so ruinous to the fields. That shelter has been produced to the fields from the existence of trees about them, is evident; but then the amount of good which has been done in this respect has been overbalanced by the shade they have cast upon both sides from the spread of their branches, causing a deficiency in the actual crop upon the shaded parts. Thus it cannot be said that much real good has arisen from the presence of hedge-row trees.

That they are an ornament to the country, and give it a clothed appearance, is admitted by most travellers passing through it. But the farmer, who has his rent to raise off the land, when he looks upon the trees in his hedge-rows, and is aware of their doing him much damage, feels no pleasure in them, but becomes desirous to have them removed, in order that he may have the land occupied by them brought into more profitable use.

Farmers are, generally speaking, averse to the growing of hedge-row trees upon their land, and declare that they are ruinous to their crops, both from the great shade they produce, and from their harbouring vermin in their vicinity. I have frequently tried to convince them of the bad consequences that would follow the entire extermination of hedge-row trees from any particular district, pointing out to them the beneficial effects of shelter when that can be secured without doing injury to the land. In this respect I have found the most intelligent of them to agree with me, they being most anxious to have their land sheltered, provided that can be done without occupying much land, and without causing much shade upon the crops in the adjoining fields. This is the very thing required; and in order to attain it, these three rules should in all cases be strictly adhered to: 1st, To plant all hedge-row trees upon the surface of the land, and in straight lines; 2d, To plant no trees but those of an upright habit; and 3d, To keep the trees regularly pruned and within given bounds. I shall now give a few hints showing how all this can be done.

1st, In travelling through England, one is particularly struck with the manner in which hedge-row trees have been planted, that being for the greater part upon raised banks of earth, with sometimes a deep ditch on each side, sometimes with a ditch upon the one side and a dyke upon the other. Frequently too, we find this bank of earth over-grown with thorns, brambles, and other rubbish; making altogether, with the broad-spreading trees, a formidable mass of very considerable extent. This is the state of things that farmers complain of. Now, in order to grow hedge-row trees upon right principles, the trees in this state should be taken out, tiles put into the ditches on each side in order to convert them into proper drains, the bank levelled down over them, the ground trenched, and a requisite quantity of lime put into it in order to decompose all the old roots the more quickly. This being done in the spring months, the ground so dealt with should be subjected to a summer fallow; when, in the autumn, a hedge of thorns with beech should be planted in one continuous straight line upon the surface, putting in a young tree among the thorn plants at every thirty feet for hedge-row timber. In the act of renewing the fences in this manner, any alteration could be made that might be considered an improvement upon the old style, such as, in some cases, omitting the renewing of some of the fences altogether, and consequently enlarging the fields so far as might be considered necessary. In some cases a new fence might be made along the middle of a field, thereby making such a new fence upon new land, and converting one field and a half of the old into one of the new; and in the act of making such improvements, the direction of the line of many of the present fences could be altered so as to suit the views of the improver.

2d, A great error has occurred in the rearing of hedge-row timber, in planting those sorts of trees which are of a spreading habit, and not easily kept within due bounds. The following trees are the only ones which should be planted in the neighbourhood of fields:—The oak, the English elm, the sycamore, Norway maple, the birch, the sweet chesnut, the poplar, the willow. These are all trees more or less of an upright habit, and such as, by the timely use of the pruning-knife, can be easily kept within due bounds. We often find the ash growing as a hedge-row tree, but it ought very sparingly to be planted under such circumstances. When standing alone and exposed to free air, its top is extremely liable to diverge off into large limbs; and, what is even worse, the roots of the ash are of all other trees the most searching upon land, and impoverish it very much.

The beech is another tree we frequently find growing in hedge-rows; but I object to its being used under such circumstances, for these reasons:—I have always observed, that under the drip of beech trees a thorn hedge will not prosper; and, as far as my experience goes regarding agriculture, grass and grain do not thrive under it either. Besides, the tree is of a diverging habit when standing alone, and does not do with much pruning when of large size. Another peculiarity of the beech is, that, when growing in a free open situation, it is always found leaning to the sheltered side; that is to say, if the prevailing winds of the district be from the west, the tree will be extremely bare of branches upon that side, and over-heavy upon the opposite side, giving it an oblique attitude, which, of course, does not answer in every situation, and more particularly when growing as a hedge-row tree.

The fir and pine tribes are all trees of an upright habit; but they are not adapted for standing alone: they always thrive best when congregated together. Besides, the roots of these trees run too shallow for growing upon the borders of fields where the plough must have free access to their very boles. No fir or pine tree, therefore, should be planted as a hedge-row tree.

3d, The training up of the young trees planted in hedge-rows is a matter of the greatest importance, and should be most perseveringly attended to. We shall suppose that trees of the kinds above recommended for hedge-rows have been raised in the nursery for the purpose; and for this purpose every proprietor should raise his own trees. These should be pruned one year before they are lifted from the nursery ground, so that they may not be injured in any way when transplanted; and the size of the tree should be from three to five feet. They should be lifted from the nursery with great care, not taking away any of the earth from their fibrous roots, but letting it remain about them in the form of a little ball to each; and by attending to this, the success will be the more certain, and prove more satisfactory afterwards.

The hedge-row being planted with thorns to form the fence, and spaces being left in them at intervals of thirty feet for the trees, have them planted, each kind to answer the nature of the soil as nearly as possible; and upon both hedge and trees being planted, put a fence of paling upon each side, if there are to be cattle in the fields, attending to the cutting of the hedge as has been advised in its own place. These hedges, when at their full size, should never be more than three feet in diameter at bottom. As the trees advance, let them be regularly pruned, causing each of them to have ultimately a clean bole of from fifteen to twenty feet high, in order to allow the hedge under them to have free air; and as the tops of the trees advance in breadth, their branches should be shortened well in, so as, when they have arrived at thirty years old, their side branches may not extend more than four feet over the fence upon each side. In order to keep them in this state, they should have their branches shortened in every two or three years; and even when they have attained full size, they should not extend more than seven or eight feet over the hedge upon each side. In these things being properly attended to, the whole art of growing hedge-row trees consists. In districts where fuel is a scarce commodity, the prunings, as they are taken from the trees, should be gathered up and used for that purpose. To those who may never have seen trees kept in the way that I recommend above, it may appear at first sight that a line of hedge-row trees kept in this manner will have a stiff and formal appearance. In this they are quite mistaken; for having myself seen trees kept thus, I maintain that they by no means present a formal or stiff outline, but, on the contrary, have a very ornamental effect, and form, when well kept, an agreeable object.

No doubt, were the trees to be clipped with the shears, they would certainly have a very formal appearance; but as they must in all cases be pruned with the pruning chisel, their forms can be varied very much, and that with very little trouble, when the work is progressively well done, and no neglect takes place.

The advantages of this system over the old one are many, and of vast importance to both landlord and tenant.

By the old, or I may rather say the present system, of growing hedge fences and hedge-row trees in England and in many parts of Scotland, there is generally from eight to fifteen feet in breadth of land wasted, and taken up for that purpose, upon the boundary of every field where they exist; whereas by the method I recommend, and which is being practised in some districts of Scotland, only three feet in breadth, at most, is occupied by the fence or hedge; and as the trees are not allowed to grow beyond a certain breadth, their shade does not materially injure the crop even when sown close into the side of the hedge; while, at the same time, from the shelter afforded, the crop is very much improved; and, moreover, the hedges never being allowed to grow above four and a half feet high, and the trees being kept bare of branches in their boles for at least fifteen feet up, a free current of air is allowed to pass everywhere, keeping both the hedge and crop upon the land in a healthy state.

The trees, when treated in the manner above recommended, in consequence of being so much kept in upon the side branches, soon become tall, and form fine trunks of timber. In order to gain this end quickly, the top of each tree should have the lead from the very first, and no side branch be allowed to gain strength upon it.

SECTION VIII.—EXPENSES OF LAYING DOWN GROUND UNDER PLANTATIONS.

In calculating the expenses likely to be incurred in the laying down of a piece of land under a crop of young forest trees, the proprietor has to consider, first, the nature of the figure in which he may intend to lay out his plantation. On the form or figure of a plantation much of the expense of fencing it depends; and as this item forms a very considerable proportion of the entire cost, it will be proper here to show the circumstances which, when attended to, lessen this expense.

When a proprietor intends to plant a piece of land upon his estate, say to the extent of fifty acres, he cannot exactly calculate the sum that would be required for the fencing of it until he has laid out, and actually measured, the line of plantation; unless, indeed, he shall fix upon a regular-sided figure. In order to illustrate the truth of this, I shall here give an example:—To lay out a plantation of fifty acres in extent in the form of strips, of four chains or eighty-eight yards broad, the proprietor would require to erect 5676 lineal yards of fence to inclose it; and supposing the fence used in the inclosing of this plantation in the form of strips to be stone dyke, costing 1s. 6d. per yard, then the whole expenses of fencing, in this instance, would amount to £425, 14s.,—equal to £8, 10s. 3d. per imperial acre upon the land inclosed.

Again, supposing that, instead of laying out the fifty acres in the form of strips, the proprietor wished to lay out the same quantity of land in the form of a regular square, then the side of a square that would contain fifty acres will be 490 yards; consequently the four sides added together will amount to 1960 lineal yards, which would be the extent of fencing required, instead of 5676 in the last instance, although the same quantity of ground is inclosed in both cases. Supposing, as before, the 1960 yards to be stone dyke, at 1s. 6d. per yard, the whole expense of fencing the square of fifty acres would be only £147,—equal to £2, 17s. 9d. upon each acre of the land inclosed. Now, this at once points out to proprietors of land the great utility of planting all plantations in a solid compact form, in order to prevent a large original outlay. By the cheaper method, a much more valuable plantation is raised, apart from any other consideration.

The above examples point out the impossibility of giving anything like a just rule whereby the expenses of fencing ground for a new plantation can be ascertained, as these in all cases must be influenced by the form in which the ground is laid out. I shall give two examples, as under:—

For home ground with hardwood, inclosed by stone wall five feet high, with mortared cope:

To medium expenses of fencing, per acre, with stone wall, 76 yards at 1s. 6d.,	£5	14	0
To 100 roods of open drains, at 1½d. per rood,	0	12	6
To 435 pits for hardwood, at 1s. 6d. per 100,	0	6	6
To 435 hardwood trees, at 20s. per 1000,	0	8	8
To 3000 firs, at 6s. per 1000,	0	18	0
To five days of a man planting an acre, at 2s.,	0	10	0
	£8	9	8

For moor ground with firs only, inclosed by turf dyke, and paling on top:

To medium expenses of fencing per acre with turf dyke and paling, 76 yards at 4d.,	£1	5	4
To 100 roods of drains, at 1½d.,	0	12	6
To 3500 firs, at 5s. per 1000,	0	17	6
To three days of a man planting, at 2s.,	0	6	0
	£3	1	4

The first example contains the highest cost per acre that I ever found necessary for making of hardwood plantations,—and the second contains the lowest that I ever could get the work done properly for. I am aware that many planters say that they can do the work more cheaply; but this of course must depend upon the average amount of wages as given to labourers in the district. What I have stated above is taken from notes of expense actually incurred by myself; and, of course, I can speak with certainty upon the subject only so far as my own experience goes. From these two statements, it will be observed that fully one-half of the expenses consists in the fencing of the ground.

SECTION IX.—THE KEEPING OF TREES IN A YOUNG PLANTATION CLEAR FROM GRASS AND WEEDS.

Any piece of ground having been planted with young forest trees, in order to preserve them in a healthy growing state, it is necessary to have them kept clear of all long grass, as well as any other weeds that might have a tendency to injure them, by over-topping and crushing them down. The forester, then, should keep a sharp look out during the summer season, particularly the first one after the young trees have been planted; and wherever it is observed that the grass or any other weeds are likely to become strong, and to keep down the young trees, a careful man, with a few women and boys under his superintendence, should be sent over the different young plantations, who, with common shearing sickles, should be made to switch away all grass, &c., from every young tree that may require this to be done.

This work must be carefully done, particularly where boys or other young people are employed, as they are very apt to cut off the tops of many of the young trees if they are not strictly looked after; therefore the man who is put over them should not work alongside with them, but go immediately behind them, and closely inspect all that they have done as the work proceeds, observing that they do not pass over any young trees requiring to be cleared, as well as seeing that those cleared be done in a proper manner. This operation ought to be performed twice during the summer season, viz.—between the middle and end of the month of June, and a second time in the month of August; and where the trees are growing among vegetation of a rank description, the same process may require to be repeated for three or four years successively, or at least until the young trees have risen above the rank growth of the weeds in the summer season.

Young trees, besides being apt to be injured by grass and other common weeds, are often still more seriously hurt by whins and broom growing among them. It very often happens that young trees are planted where whins and broom have been cut down and not grubbed out by the roots, in which case the whins in particular are sure to push out a stronger and more vigorous growth than ever the following year. Whenever this may have been the case, the planter ought to have particular attention paid to such parts, and see that the young growths of the whins, as they rise up, do not hurt the young trees. For clearing away the young shoots of the whins, a strong sickle will be found to answer the purpose well; and in the doing of the work, they ought to be shorn clean by the surface of the ground wherever they are found among the young trees, whether they may be injuring them in the mean time or not; for though the whins may not hurt the young trees in many places in a young plantation for the first year of their growth, they will decidedly do so the second year, when it will be much more difficult to get the better of them. Therefore it is always necessary to cut such rubbish during the first year of their growth, when in a soft state; besides, if they are allowed to stand undisturbed upon the ground for a whole year, they give shelter to rabbits, hares, and other vermin, which are always a most dangerous stock in young plantations.

Where whins have been, even although they may have been grubbed up, it is, I am aware, a most difficult matter to take them out so clean as to prevent any roots that may be left in the ground sending up shoots of considerable strength the first summer after; consequently, it is necessary to attend in a particular manner to those young plantations where whins have existed previous to the young trees being planted. I have frequently seen large tracts of young plantations entirely ruined from not having been cleared from rubbish in due time; and in such a case, where this necessary clearing of the young trees has been neglected, a replanting of the ground must take place before anything good can be expected. This of course is the cause of a great outlay of money, all which might have been saved had due attention been paid at first.

The necessary expense of doing this sort of work is but trifling. Upon the estate of Arniston we employ a man, with six young people, from the beginning of June to the end of August, constantly clearing among the young plantations; and I find that where no whins are, the expense of keeping clear a young plantation, for the first four years, is about sixteen shillings per acre; and where there are whins to contend with, the operation costs about twenty-five shillings per acre, until the trees rise above them.

In asserting the above, as to the expense of keeping young trees in a plantation clear of weeds, &c., I do not mean to say that the whole of the trees growing in a plantation will require to be so dealt with: that will depend entirely upon the nature of the original grasses, &c., growing on the surface. It is quite possible that not one-half the extent of a plantation may require to have the young trees thus cleared; but wherever they are likely to suffer from weeds, &c., they should be attended to in the manner advised.

CHAPTER IV.

The nature and necessity of Thinning Plantations—The nature and practice of Pruning Plantations—System of Thinning and Rearing up of Fir Plantations—System of Thinning and Rearing up of mixed Hardwood Plantations —Rearing up and Thinning of Oak Plantations.

SECTION I.—THE NATURE AND NECESSITY OF THINNING PLANTATIONS.

THINNING is one of the most indispensable operations in arboriculture. The right understanding of the nature and design of thinning plantations forms one of the most important points to be aimed at by every practical forester.

The object which ought to be aimed at by the forester in the act of thinning, is the regulating of the trees in a plantation to such a distance one from another, and that in such a manner as is, from well observed facts, known to be favourable to the health of each tree individually, as well as to the general welfare of the whole as a plantation.

In order to grow any plant to that size which the species to which it belongs is known to attain under favourable circumstances, it is necessary that it have space of ground and air for the spread of its roots and branches, proportionate to its size at any given stage of its growth. Upon this the whole nature and intention of thinning plantations rest.

It is much to be regretted that there does not exist, both among proprietors and foresters, a sounder knowledge relative to the nature and intention of thinning plantations than there is. I have frequently seen plantations upon a high situation going back, from having been injudiciously thinned; and in a low one, I have as often seen them going back from not having been thinned at all. Where the blame rested I know not, neither is it my business to inquire into that, but in all such cases there is evidently bad management.

There are, indeed, few proprietors' estates in Scotland upon which there is not considerable room for improvement, as regards the thinning of their plantations. There is a decided loss of timber, as well as shelter, whenever plantations are made too thin; and there is also equally a loss where they are not sufficiently thinned. Wherever plantations have remained long in a close state, and are thinned suddenly and severely, which I term injudicious thinning, they are at once cooled. This I reckon equal to being removed a few degrees of latitude farther north, or to a situation a few hundred feet higher than the original; and the natural consequence is, that the greater part of the trees which have undergone such treatment, become what is generally termed *hide-bound*—the bark contracts, and prevents the free flow of the sap, consequently it stagnates and breaks out into sores; the trees fail to make wood; and, in fact, the whole plantation falls into a state of consumption, and declines gradually. I have frequently been called upon to examine and give my advice relative to what ought to be done with plantations in such a state as that described above; and wherever I have found plantations above thirty years old to be in the state described, and to have stood in the same state for four or five years without showing much signs of any improvement, I have always in such cases recommended to cut down at once, drain, and replant the ground. However, if the situation be a rather sheltered one, and the soil dry, a recovery of an over-thinned plantation will often take place; although the trees, after having been checked, will never attain that size they would have done had they been otherwise treated; but where the situation is exposed, and the natural soil cold and damp, recovery is hardly possible.

On the other hand, where plantations are not sufficiently thinned, the trees become drawn up weakly, and seldom attain the size of useful timber before maturity comes upon them. Where any plantation has stood long without being thinned, particularly a fir one, it is, I may say, impossible to recover it; for if even a very few trees be thinned out, a number of others, from the want of their shelter, are sure to die, which ultimately causes blanks to occur here and there; and the wind getting play in such blanks, great havoc is often made among the trees during a storm. As an instance of this, I may here mention the case of a fir plantation upon the estate of Arniston, of above thirty years' standing, and to the extent of nearly forty acres. This had been allowed to grow on in its natural state from the time that it was planted, when an attempt was made to take a few trees out of it, by way of thinning it gradually; this having been done, many more were blown down the very first storm that occurred; and an opening having thus been made by the wind, the whole plantation in a short time became a complete wreck; so much so, that when I came to the place, I had the whole cleared off and replanted.

From what has here been stated, it will appear evident that there is a great loss sustained by every proprietor who allows his plantations to be mismanaged, either from not thinning, or from over-thinning; and the result may be reckoned the same in both cases.

Upon many estates, I have often regretted to see plantations of considerable extent, and of perhaps forty years' standing, with the firs all overtopping and crushing down the hardwood trees. From the appearance of such plantations, it was evident that they never had been thinned: the hardwood trees were miserable-looking things, and not more than ten or twelve feet high, striving for existence; while the firs, which, of course, grew more rapidly, were more than thirty feet high, and of a broad spreading habit, from having been widely planted among the hardwood. In this state many plantations have been allowed to grow up, under the false impression that the firs were of more value than the hardwood for the sake of shelter.

Now, could any circumstance be a more convincing proof of the want of sound knowledge relative to thinning? If the hardwood trees had been relieved in due time, would they not at forty years' standing have been valuable, both as timber and as affording shelter? Could not the firs have been all taken out for estate purposes, and been of value to the proprietor, while at the same time they left a more valuable crop of hardwood on the ground? But, as the case was, the hardwood plants were useless and past recovery; and upon the ground where a valuable crop of hardwood might have been, there existed only a few firs of little permanent value, either for shelter or as timber.

The distance at which trees in a plantation ought to stand one from another, must, in all cases, be determined by the nature of the soil and situation upon which the trees grow, and also by the ultimate object the proprietor may have in view as regards any particular plantation. As a sort of guiding rule for thinning, I may here state, that if in any particular plantation it should be intended to rear up trees for park or lawn scenery, then, in such a case, the distance between each individual tree ought to be at least equal to the height of the same; and this rule ought to be kept in view at all stages of the growth of the trees after the first thinning has taken place, in order that they may have free room and air to form spreading tops as well as massive trunks, which is the true and natural form of every tree, and which constitutes the great beauty of lawn trees.

If it should be intended to rear up a plantation of hardwood trees principally for the sake of value of timber, and for giving shelter at the same time, in such a case the distance between each individual tree ought to be equal to about one half its height. This ought to be kept in view at all stages of the growth of the trees, after the first thinning, in order that they may not have so much free air and room as to allow of the spread of their branches horizontally, while they are not so much confined as to be drawn up weakly from the want of air. If it is intended to rear up a plantation of firs or pines, for the sake of shelter and timber, the distance between each tree ought to be a little more than the third of the height, which is the distance found most favourable to the useful development of the fir and pine tribes as timber trees.

In order to give a clear and practical description of the manner of proceeding with thinning operations in the forest, it will be necessary to treat of them under three distinct heads; and this I shall do in the proper place. (See under the heads, *System of* *thinning mixed hardwood, fir, and oak plantations.*) It may, however, be useful here to observe, that all plantations, ere they require to be thinned, must have grown for at least eight years; and even this period may in most instances be far too early. In fact, no particular period can be specified as to the length of time that a plantation should stand previous to commencing to thin it; for much depends on the nature of the soil and situation—on whether or not a plantation may have been well laid out—and on the state of the ground, as being dry or damp. These things considered, it will appear evident that no particular time can be stated as to when a plantation should be thinned for the first time, but that this must be judged entirely from the state of the trees, whether they may have grown rapidly or not. I have myself found it necessary to thin a young plantation of seven years' standing, at which age the trees were twelve feet high; while, on the other hand, I have much oftener seen plantations of fifteen years' standing, scarcely the length of requiring to be thinned: therefore, observation upon the spot is the only sure way of determining this point.

SECTION II.—THE NATURE AND PRACTICE OF PRUNING TREES.

For three or four years past, many conflicting opinions relative to the pruning of forest trees have been issued in some of the periodicals of the day; which opinions, I believe, have had more a tendency to darken the point referred to, than to throw light on it. Many have recommended pruning as an operation eminently favourable to the health of forest trees; many more doubt this; and as many more affirm that pruning ought not to be practised at all: and each, as he advocates his own peculiar system of management, gives an instance of some plantation he has had under his care, as undeniably illustrating the advantages of the system he recommends. Now, all the diversity of opinion arises from the want of a properly extended knowledge on the subject in question. A man of extensive experience comes to find that no particular rule can be laid down to answer the pruning of trees in all cases. He finds out that pruning in some cases is proper, and in others improper; but the inexperienced man, who wishes to be instructed in the art of pruning, when he sees one man strongly recommend it in all cases, and another as strongly urge its not being practised in any, is brought to a stand. He becomes bewildered, and knows not how to proceed; he is not able, from deficiency of experience, to determine whether in his own case he should prune or not. Now, the only way reasonably to confirm the mind upon this important point is, not to lay any particular stress upon any particular example that may be given, but to examine the true nature of the art of pruning, and the tendency it has to improve or retard the healthy development of trees in various situations. In short, in order to a right understanding of the nature of pruning as applied to forest trees, attention must be paid to its effects upon trees under every variety of circumstances. I consider it proper that every proprietor of plantations should be able to judge for himself in the matter of pruning, and to detect proper from improper pruning. And to this end I shall enter minutely into detail under this head, and give a distinct statement of my reasons for doing it in one case and not in another. But before entering into detail regarding the practical operation, it will, I think, be proper first to examine the effects that the amputation of a branch from a tree has upon its constitution: such previous knowledge will prepare the mind for a better understanding of the true nature of pruning as it is generally practised among intelligent foresters.

A tree, through the agency of its roots, draws nourishment from the earth into which these enter, chiefly in a state of solution in water; which liquid nourishment, or, as it is generally termed, the sap, ascends the trunk through the longitudinal vessels or pores; from which, again, each branch or limb of the tree is supplied in succession. The body or trunk of a tree forms one bundle of longitudinal tubes, through which the sap ascends from the roots to the branches. From this bundle each separate branch is supplied by its own separate line of tubes; or, which is the same thing, each particular root of a tree has to draw nourishment from the soil to supply its own particular branch; and the communication between these two points is maintained by a particular set of vessels in the trunk of the tree. The watery part of the sap, when it ascends into the leaves, is for the most part given off by them in the form of perspiration; that which remains at this point undergoes a change previous to its descent in the form of proper woody matter, which change is effected by the leaves inhaling *carbonic acid* and other gases, which enter into the composition of the returning sap; and in this manner there is a continual circulation of the sap in the tree—the roots drawing in and supplying the whole with moisture, which, when it is raised to the leaves, undergoes a chemical change, and is returned in the form of proper woody matter. The practical deduction to be drawn from this is, that every branch growing out of the main body of a tree is by nature meant to act as a laboratory, in which woody matter is prepared and returned for the joint supply of itself and the body of the tree. From this we are bound to conclude, that when we cut a branch from a tree, we take away from it the means of supplying it with a certain proportion of woody matter for its enlargement; and this is, indeed, the case with pruning in all cases of the operation. But under good management in pruning, this depriving of a tree of its due means of nourishment is only temporary; and in one or two years after the operation has been done, and when the tree operated upon has had its growth properly directed, the increase of timber is at once remarkable, as compared with others of the like nature and age which had not been pruned, or with others which had been unscientifically managed.

When a large branch is cut off immediately from the body or trunk of a large tree, the usual sap which supplied it in its ascent from the roots, will be stopped short, and for a time will ooze out at the cut part. In a short time however, the sap, as it rises in those vessels of the trunk which formerly supplied the branch taken off, becomes stagnated, and causes rot in that part, which can never be the case while the branch remains to draw up and prepare the sap in its leaves; and this is the case in all instances of large branches as they are cut from large trees. But in the case of a branch being thus cut from a young sapling in a rapidly growing state, the tree is not injured, but improved; the sap of the plant being in such a vigorous state, that rot cannot take place. Now, the practical deduction to be drawn from this is, that the amputation of a large branch immediately from the body of a large tree, instead of being favourable to its health and value as timber, has quite the contrary effect. I say, immediately from the body of the tree, because the cutting off of a part of a branch is by no means injurious to the health of a tree; but, on the contrary, when part of a large branch is cut off, the flow of sap to that part is checked, and the body or trunk of the tree is in proportion enlarged.

During my practice as a forester, I have had extensive opportunity of observing the nature and quality of full-grown timber as it has been affected by different kinds of management in the way of pruning. Having seen much timber of all ages cut up for different purposes at saw-mills, I have had occasion invariably to observe a practical truth, that wherever branches of above four inches in diameter at their base had been cut from the trunk of the tree, the wood for a considerable way under that part which had been so pruned was worthless, and of a black colour. Where much cutting of large branches had taken place in one individual tree, I have always found such a tree to be scarcely fit for any valuable purpose whatever when it came to be cut up; and where the pruning had been done a considerable number of years before the tree was cut down for use, the wounds upon the surface were not easily observable; in fact, such trees often appear sound to outward appearance; but when the bark is removed, the pruned part is at once observable, and the vessels leading from it, down to the roots, are generally found soft and of a black colour.

On the other hand, I have always had occasion to observe, that in the cutting up of trees which had not had their large branches cut off close by the trunk, the timber was of good quality, and sound throughout, excepting where extreme old age had caused natural decay; and of the truth of this I am perfectly convinced. Therefore, I urge every proprietor of plantations, never, as he values their health as timber, to cut clean from the boll of a tree a branch which is more than four inches in diameter at its base.

Having now pointed out the effects the amputation of a branch from the trunk of a tree has upon its constitution, I next proceed to detail the method which ought to be practised with pruning operations in all cases. And in order to a right understanding of this most important point in arboriculture, I shall bring under consideration the pruning of trees, from the time they are planted out from the nursery, to that of their full growth in the forest, under every variety of circumstances, as I have had occasion to observe them.

Many foresters are in the habit of closely pruning all young hardwood trees, particularly elms and oaks, when they are newly taken from the nursery grounds, and preparatory to planting them out into the forest; which close pruning is most injurious to the health of all young trees when newly lifted from the ground. The system generally practised by foresters in this case is, to cut off clean to the main stem all strong branches, and only leave a few small twigs near the top of the plant, with the view of drawing up the sap. The natural consequences of such a cutting off of all the stronger branches from a young tree are, that, when the sap ascends in the plant in the spring, it is arrested at the wound where the first or lowest branch was taken off, and escapes from the cut part by evaporation. It being thus arrested, there is a natural effort made by the plant to produce young shoots and leaves at this point, in order to convert the sap into proper woody matter; consequently, we almost always find a few young shoots made the first season immediately under the part where the lower strong branch was taken from the plant, while all the rest of the young tree above this growth of young shoots dies—the sap not rising to carry on life above the part where the new shoots spring out. Even if the sap should not be all arrested at the point referred to, the part above it remains in a sickly and unhealthy state; while the young shoots produced lower down draw all the nourishment to themselves, and ultimately form a distorted unshapely plant, unless it be carefully attended to, by giving some one of the shoots the preference, and, cutting away all the rest, allowing it to become the top.

The proper manner of proceeding with the pruning of forest trees, as they are newly lifted from the nursery, and preparatory to planting them out into the forest grounds, is to *shorten* all the *larger branches* that have the appearance of gaining strength upon the top or leading shoot of the young tree. This shortening of the larger branches ought to be done in such a manner, as to leave only about one-third of their whole length remaining, with, if possible, a few small twigs upon it, in order the more readily to elaborate the sap as it rises in the spring; and in this state the young trees may be planted with the greatest assurance of success. The great advantage of this method of pruning young trees is, that when the sap rises in them, the first summer after planting, there being a regular supply of small proportionable branches along the main stem, leaves are formed, and sap is drawn up regularly to every part of the tree; consequently, the tree maintains an equal vigour throughout. Were all the branches left upon the young trees, the roots, from the effects of removal, would not be able to supply the whole with due nourishment; and the consequence would very likely be, that the plants would die down to the ground-level, from which part of the trees numerous young shoots would issue, much in the same manner as they do from the cut part of those trees which have been over-pruned.

It is now a well-ascertained truth among all practical foresters, that when a young tree is in a vigorous state of growth, and the wood full of sap, previous to its having made any heartwood, any branch may be taken off without doing the least injury to it. It is, therefore, just at this stage of the existence of a tree that it can with certainty be made to do well or otherwise according as it is attended to—to give the top the lead in the growth—to check the stronger branches—and to give the tree that shape it may be desired it should have when it attains full age.

When young hardwood trees have been pruned in the manner above recommended, and after they have been planted and grown in their permanent situation for the space of five or six years, they will by that time have established themselves properly in the ground; which circumstance is known by their putting forth considerable shoots of young wood. At this stage of their growth it will be necessary to go over them all with the pruning-knife, and cut close to the main stem or trunk all the parts of the branches that were formerly shortened, and, at the same time, to take off clean all other branches that may have gained strength, or may have the appearance of gaining strength, upon the top or main shoot. But it should be particularly observed, that this pruning ought never to be allowed to be done until the young trees have decidedly established themselves in the ground, and are in a vigorous healthy state of growth. At the same time, any unhealthy plant which may not have succeeded well, should be cut over, when it will soon rise up with renewed vigour.

I have now given a statement of the manner of proceeding with pruning operations, in the case of young trees about to be planted out into the forest; and also the treatment they ought to receive after being five or six years established in the ground. There may, however, be—and, indeed, too often are—cases where hardwood trees, while young, have been entirely neglected. It will now be proper to consider the treatment that such ought to receive. I shall first suppose that we have to do with a plantation of young hardwood trees, which had received no pruning at all previous to being planted; and we shall further suppose, that the trees are oaks, and of five or six years' standing in the forest grounds. On examining the state of young hardwood trees of the description above mentioned, it will be observed, if the situation be an exposed one, that the greater part of them have died down to the part resting upon the surface of the ground, and that from this part a number of branches have issued, each contending for the lead in the growth. In such a case as this, no time should be lost in giving the strongest and most healthy shoot the preference, and cutting away all the rest, as well as the dead part of the tree nearly by the ground, or at least down to the part where the young shoots issue. Prune up the shoot intended to be left for the future tree, by taking off all the stronger branches clean to the boll or stem; and in this manner go over every young tree in the plantation, always choosing the most healthy shoot for the future tree, and one which appears to have naturally a good balance of branches, with the leader or top shoot strong in proportion to the rest.

We shall again suppose a plantation of oaks, of the same age as the one above alluded to, but the trees in which, instead of having been planted without pruning, have been pruned too severely when lifted from the nursery ground, and previous to being planted. The treatment in this case must in every respect be the same as in the former; that is, all the dead wood should be cut away immediately above the point from which the young shoots issue; and the strongest and most healthy shoot being fixed upon for the future tree, it must be properly pruned up, by taking off all the stronger branches, and cutting cleanly away the rest of the inferior shoots which formerly contended with it. But in a case of this nature, where the trees had been over-pruned previous to their being planted, there is often more difficulty in making choice of a good young shoot, than where no pruning at all had taken place. This arises from the young shoots springing from the main stem in a horizontal manner, and that, too, very often a considerable way up the stem. In a case of this nature, where a proper leading shoot, rising perpendicularly, cannot be got, the only way, and the method I always follow myself, is to cut the main stem by the surface of the ground, and allow a set of new shoots to rise up. The chance generally is, that, when the tree is thus cut down, all the new shoots will rise in an upright position, and a choice can be afterwards made; but wherever a proper leading shoot can be had, let it be chosen, although it come away rather far up upon the stem. If it rise perpendicularly, and the plant be in a vigorous healthy state of growth, it will succeed well. This sort of work should be done in the spring months, so that the growth may set in immediately after the operation is performed.

It very often happens that a forester, upon entering a new situation, finds that the several plantations which are put under his management have been hitherto much neglected: he finds that, in many cases, pruning is absolutely necessary, but he is at a stand to know how to proceed. If he be a man who has not had much experience, he is very apt to go wrong in a case of importance. He looks upon the trees before him, and is, no doubt, aware that pruning is necessary to their health; but, in consequence of some particular circumstance connected with the trees with which he has to deal, he finds much difficulty in making up his mind as to the manner in which he ought to proceed. If he should be a man who has had extensive practice, he will look back upon his former experience, and consider where and when he had to deal with a case resembling the one that may be before him. If he has, he will review the manner in which he went to work in it; and, at the same time, he will consider the consequences that attend such operations, whether these were beneficial or not; and, in all cases, he will endeavour to govern his conduct in pruning operations by the result of his past experience. Whatever method of operations he has known to succeed well, he will put again in practice, according as the nature of the case may require; and whatever method he has found to have been followed by injurious effects, he will avoid, except in particular cases, where he is aware it would answer the end desired.

With regard to the pruning of forest trees generally, all would be simple and well, provided a distinct practical rule were attended to, both by proprietors and foresters, for the rearing up of plantations at every stage of their growth; but in practice, the case is almost always the contrary. No distinct practical rules being adhered to among foresters as a body, one goes to work in one way, and another in a contrary way, in the same piece of work; and in the manner of doing the work all depends upon the practical experience of the man. A man of sound practical experience finds out for himself what ought to be done, and guides himself in the execution of his work accordingly; but the man of small experience, unless he has some definite rule laid down to guide him, will go to work merely under the direction of his own judgment, whether that may be right or wrong; and if his master, the proprietor, has not himself a knowledge of how the work ought to be done, matters will often go very far wrong indeed; even so much so, that the greater part of the plantations upon an estate, if not ruined, are made of very little value. We very frequently see plantations upon an estate over-pruned, while those upon a neighbouring one are not pruned at all; which at once points out the bad management that exists relative to forest operations in general.

In one place where I acted as assistant-forester, I had a most convincing proof of the want of a practical rule among foresters as a body relative to pruning, and which told me at once that they have hitherto acted in such matters more according to their own private judgment than upon any well-founded scientific rules. When I went to B—— as under forester, I found the head forester an old man, who had reared up most of the plantations upon the estate; and the situation being in a high exposed part of the country, he had never either pruned or thinned much; in fact, in most cases pruning had never been practised at all, from the idea that the baring of the trees of their branches would diminish the shelter which they were meant to produce. Many of the plantations consisted principally of a mixture of ash, elm, and plane trees; and from the circumstance of the firs having been cut out pretty early, the trees were low-set, and spreading in the habit of their branches, never having been much drawn up: they were about thirty years old. Shortly after I went to this place, the old forester died, and a young man was appointed in his place. The proprietor wishing to have his plantations improved, and having no knowledge of how the work ought to be done himself, he, of course, left the whole management of them to his forester. The new forester set about the pruning and thinning of some of the plantations at once, and a number of men were set to accomplish this. I was appointed one of the pruners, and my orders from the forester were to prune all the trees left standing upon the ground, and to give every tree a clear stem to one half its entire height. The trees being generally from twenty-five to thirty feet high, we gave each tree a clear stem of from twelve to fifteen feet from the ground. In doing this, we had often to cut off large branches from the bole as thick as itself, which gave the trees completely the appearance of having been manufactured artificially; and, having been very thickly set with branches all along the trunks, when they were pruned the entire trunk was a surface of wounds. With regard to the tops of the trees, our orders were not to do anything excepting where two or more tops appeared to strive for the preference, in which case we left only one, cutting away the others. Having left that place shortly after this operation of pruning had taken place, in five years after I went to visit it, in order to draw for my own private instruction a lesson of experience, by observing the effect of the former severe pruning upon the trees: the consequence was exactly that which I anticipated in doing the work. On looking over those plantations, the ruin of which I had myself assisted in bringing about, I felt sorry to think that gentlemen should be imposed upon by inexperienced men. All along the boles of the trees, and about the wounds which had been made in the cutting off of the large branches, young shoots had sprung out. The trees were generally now hide-bound, from having been suddenly exposed and the atmosphere cooled about them. The trunks had scarcely increased anything in girth since they were pruned, and the top branches had made little or no wood. The trees, generally speaking, were ruined in their health, and all hope of their recovery was gone. From this example I had indeed a lesson of experience for my future guidance, and I have detailed it here in order that it may be a lesson to others also. The question now comes to be, whose mismanagement had been the cause of ruin in the case alluded to? Whether was the blame attributable to the old forester, who neglected to prune and train up the trees as he ought to have done, or to the young man who succeeded him, and pruned them without due consideration and experience? In my opinion they were both to blame; for, had the old forester pruned and thinned in due time, all would have been well in the end; and had the young forester been more cautious, and pruned and thinned gradually, all might have been well also. The practical truth that I wish to enforce from this instance of mismanagement is, that in every forester great caution, combined with practical experience and reflection, are necessary before he commences to thin or prune any plantation. From the temporary nature of the crops which they raise, although the gardener or farmer mismanage any of their crops, all can be redeemed in the course of another year; but in the case of mismanagement in a forester, the work of past years is lost, and thirty or forty years, with a considerable outlay of extra money, may possibly not be sufficient to redeem what is put wrong.

Having given the above example of mismanagement, in order to point out the necessity of using caution in entering upon pruning operations, I shall now proceed to give a few examples of the manner in which I have gone to work in similar cases of neglected plantations; and I am convinced that, wherever plantations have been neglected as to pruning, if they are under thirty years old, they may, if dealt with as I shall here point out, be recovered, so far as to make profitable timber trees, although probably not to that extent of value that might have been expected had the same trees been properly pruned and trained up in their young state.

When I came to act as forester upon the estate of Arniston, I found that many of the hardwood plantations under thirty years old had never been pruned at all, and that there was great need for means being used as quickly as possible to put such into proper state. In setting about this part of our forest operations, I determined to begin with the younger part of the woods, as being most likely to recover quickly, and to be of the most value ultimately if taken in due time, and to go on with the pruning of the older districts of plantations as I could find convenient opportunity. Having laid down this principle as a rule of procedure, I commenced first upon a plantation of oaks, about twelve years of age—which plantation, I saw, had never, up to the period I commenced upon it, been either thinned or pruned. The first thing I did, was to go carefully over the whole, and examine most minutely its state, observing, in a particular manner, whether or not the situation was exposed. Being convinced, from the general bearing of other plantations in the neighbourhood, that the situation was rather sheltered than otherwise, I determined upon thinning out the firs pretty freely from among the young oaks. Having done so, and had the firs all cleared off which were cut, I found that the young oaks had been a good deal crushed down by the firs, which had grown very freely as compared with the oaks; and in consequence of having been thus crushed down, many of the latter had grown strongly to side branches, and not to height; but wherever the oaks had had free top room, with firs rather close upon their sides, they were tall plants, and generally well shaped. The average height of the oaks was from five to eight feet; the bark of the trees was clean and fleshy; and, generally speaking, they were in good health. In the pruning of those trees, I first had all the small branches, not exceeding two-thirds of an inch in diameter at their base, cut from the trunks, and close to the bark, to the height of about one-third of the tree in each case. Next, all branches which grew upon the same part, with a diameter at base exceeding the last mentioned, I cut off to within about four inches of the stem or trunk from which they proceeded, leaving the stems in the mean time; and all large top branches, which appeared to be gaining strength upon the leading shoot, I shortened down to nearly one-half of their whole length; but in all cases where two top shoots appeared, I cut one of them closely away, always leaving the one which appeared to be the most healthy and strong, and which at the same time appeared to come most directly from the centre of the system of the tree.

But I must observe here, that in the pruning of a young hardwood plantation, all the trees do not require to be pruned to the same extent: in many instances it will be found that pruning is not necessary at all; and so it was in the case of the plantation I am referring to. Wherever a hardwood tree is drawn up rather closely among firs, with sufficient head-room, it seldom produces many side branches, but will grow upwards to the light; therefore, in all cases of pruning, where the side branches upon a young tree are few, let such remain, and merely shorten them down where they are long and slender. Pruning is an unnatural operation, and ought always to be avoided unless absolutely necessary; that is, it ought to be avoided wherever the tree does not produce unnaturally strong side branches, excepting so far as to clear from branches one-third of the height of the tree from the ground, in order to form a trunk; and even upon this part, where the branches are large, they ought to be taken off gradually, as already noticed. Having gone through this plantation, in the manner above described, I allowed it to remain so for the space of two years; when I again went through it a second time, and pruned in the following manner all the oaks that stood in need of it.

Having taken out a few more of the firs, which I observed were rather encroaching upon the young hardwood, and having examined the general state of the same, I found that they had thriven remarkably well during the two years since I pruned them. From being relieved of a superfluous and unnatural weight of side branches, they were growing tall, and in a generally healthy and rapid-growing state; therefore, seeing this, I cut close to the main stem or part which formed the trunk, all those stumps which I formerly shortened to four inches; and in regulating the tops of the young trees, I merely shortened such shoots as had the appearance of ultimately gaining strength upon the main top shoot. With regard to my reason for not having cut away the strong shoots or branches from the main stem when I first pruned those trees, I have to observe, that had I cut them away at the first course of pruning clean to the bark of the trunk, the consequence would have been that the sap of the young trees in its ascent would have been arrested at the cut parts, young sapling shoots would have been formed upon the stem immediately under the cuts, and the general health of the trees would have been injured from the sap not rising unchecked to the top shoots. These evils were avoided simply by cutting off a large portion of each large branch, and leaving a small portion of each upon the stem, in order to continue the regular flow of the sap to that part, and which, from being partially weakened in the branches, was proportionately forced to flow upwards to the supply of the top parts of the trees. After this had taken place, the stumps were cut away, without doing any injury to the trees. By this method of pruning off parts of large branches from a tree, I have often brought unhealthy trees to a state of sound health; and as soon as I observed that such trees had regained their health, which is at once observable by their making vigorous shoots of young wood in the top branches, I immediately cut away the parts of the branches that were left, when the wounds were soon made up by the extra supply of proper woody matter, which increased with the health of the trees. This cure, however, is only applicable to trees in a young state: I have succeeded in effecting it upon trees under twenty years old.

After pruning the oak plantation in the way just detailed, I next set to the pruning of another of about twenty years' standing. This other, also of oaks, was situated in a rather sheltered part of the estate; and from having been nursed by Scots firs, many of which were growing when I commenced pruning operations there, the oak trees were very much drawn up. I observed that the oaks had never been either thinned or pruned, and consequently they were growing within four feet of one another; that being the distance at which they had been originally planted. As the situation was a sheltered one, I thinned out a few of the Scots firs, and also a few of the oaks, previous to commencing to prune. When I had those removed, and the trees standing more upon their own weight, I saw that they were, from the effects of having been drawn up, very slender, and not able to stand much exposure or much cutting in the way of pruning, although they were from eight to fifteen feet in height; I therefore only shortened a few of the stronger side branches below, and at the same time shortened a few top branches upon each tree as I found it necessary, in order that they might be properly balanced, and that the wind might not have much power upon them. In this state I left them for two years, when I again examined the trees, and finding that they had improved in a remarkable manner, I again set to work and gave them a final pruning. I have seldom found any plantation make such an improvement as this one did during these two years. This was owing to the gradual manner in which I thinned out a few trees, and cut off a part of the branches as a preparation for pruning. This is what every forester ought particularly to attend to; for, had I foolishly and thoughtlessly commenced to prune severely at first, it was quite possible that every tree in the plantation might have been thrown into an unhealthy state,—which, indeed, I have more than once seen done; but by having gone cautiously to work, I had the satisfaction, at the end of two years from the time that I first examined those trees, to find them not only stiff, healthy, tall trees, but in a most vigorous state of growth also. I now pruned them upon the same principle as stated in the former case; that is, I removed off all the branches to one-third the height of the tree in each case, in order to form a clean trunk; and above this, among the top branches, I merely shortened such as had the appearance of gaining strength upon the top. And wherever two distinct tops occurred in one individual tree, I cut off one, always leaving the one which appeared the most strong and healthy, and which issued most directly from the centre of the system of the tree, although in many cases it did not take an upright direction; for, let it be observed, an oak tree is the more valuable for having a bend in its form, such trees being useful in ship-building.

In the pruning of all young trees, any branch of which may be got at by a man standing upon the ground, which branches, generally speaking, will not be more than one inch in diameter, the work ought to be done by the common forest pruning-knife. (See Fig. 88.) This is not made with a hinge between the blade and the handle, as is the case in common pocket-knives, but the blade is fixed into the handle. The blade is also made straight in the face, that is, without any hook at the point, as is the case with garden-knives. The forester, in working with this knife, when he has no occasion to use it, puts it into a sheath of leather hanging by his side. In cutting off any branch of a tree from its bole with the forest pruning-knife, the operator takes hold of the branch with his left hand a little forward from its base, and eases it upwards, and at the same moment he applies the pruning-knife with his right hand to the base of the branch to be cut off, cutting it upwards in the same line as the bole of the tree—taking care not to enter the knife upon the plane of the bole of the tree, but a little upon the base of the branch to be cut off, say about a quarter of an inch upon the rise of the wood forming the base of the branch. By this means the bole of the tree is not injured, and, at the same time, the damp is thrown off the wounded part.

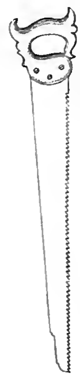
Fig. 88.

In all cutting off whole branches immediately from the bole of a tree, the wounded part should be made perfectly smooth, paring it neatly all round with the knife, which should be kept very sharp. When the work of lopping off a branch is finished, the part will have the appearance as represented in Fig. 89 at *a*; and in the course of two years after being done, the wounded part will be entirely covered over with young wood.

Fig. 89.

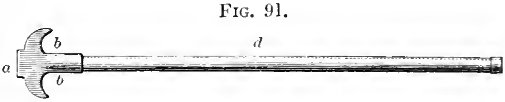
When pruning operations are done upon a tree, the branches of which are within the reach of a man standing upon the ground, but which are too large for being easily cut off by the pruning-knife, the pruning-saw must be applied. (See Fig. 90.) In all cases of cutting off a branch with the saw, care must be taken, first, to make a slight cut with it upon the under part of the base of the branch to be taken off; say about half an inch deep if the branch be three inches in diameter, and so on with any other size of a branch in proportion. This is in order to prevent the branch, when nearly cut through, from falling away suddenly and tearing away the bark below its base upon the bole, which circumstance sometimes happens with careless hands. Care should be also taken to pare with a sharp knife all the wounded surface made by the saw, which is always rough. By attending to this, the damp will not be so apt to lodge upon the wound.

Fig. 90.



Where the operator cannot reach to the branch to be taken off, and where of course he could neither use the pruning-knife nor the saw, the *pruning-chisel* is used. (See Fig. 91.) In this instrument, the handle *d* may be of any convenient length to suit the height of the tree to be pruned; and it should always be made of a piece of good tough well-seasoned ash-wood. In using the instrument, the operator takes hold of the handle with his left hand, and puts the sharp face of the instrument *a* to the under part of the base of the branch. He then, with a mell in his right hand, with one or more strokes upon the lower end of the handle *c*, which has an iron *virl* or ring upon it, forces the instrument through the branch and separates it from the bole of the tree. In the act of doing this, care should be taken to repeat the strokes lightly when the branch is nearly through; because, were a heavy stoke of the mell given at this time, the instrument might be forced upwards and injure the bole of the tree, making a deep cut. When it is necessary to take any part of a branch off, which may be considered too long, and not in balance with the tree, the

Fig. 91.



hooked parts of this instrument, *b b*, are used. They are kept very sharp in the inside; and in taking off any part of a branch with them, the operator pulls the instrument suddenly towards him, by which means a pretty large branch may be cut very quickly through. In using the pruning-chisel, a considerable deal of practical skill is required; and in the hands of a practised man, it is a most effective instrument. I have had workmen who, with a single stroke of the face *a*, upon any branch three inches in diameter, could force it through in a clean and neat manner; and of course this was in favour of the health of the tree so pruned; for the less haggling there is in taking off any branch of a tree, the less is it injured, and the more healthy is the result.

All pruning operations should be done in the spring or summer months, observing to leave all maples till the summer season. I would not advise to prune any after the 1st of August, for after that time the motion of the sap becomes slower, and the wounds are consequently longer in healing up. I have this season (1848) pruned extensively from the end of April to the end of July, and have found the results most satisfactory. I observe, that those trees which were pruned in May and June, heal up in their wounds much faster than those done in July or a week in August. My impression, therefore, is, that the month of June is to be preferred to any other month in the year for this operation. In pruning oak trees in the month of June, the bark can be taken from such branches as are of any size; and I have found this to be a source of profit in forest management.

SECTION III.—SYSTEM OF THINNING AND REARING UP OF FIR PLANTATIONS.

In order to point out properly the manner of proceeding with the thinning of fir plantations, it will be necessary to give a detailed account of how the work should be done at the different stages of the age of any plantation; and, as I have already stated that no particular age of a young plantation can be given as that at which thinning operations ought to commence upon it, the observation of the operator must always be his guide in such a case. Every man who has given his attention to the rearing of forests must have observed, that on some particular soils and situations a young plantation may be in a fit state for thinning at eight years of age, while another, composed of the same sorts of trees, and planted at the same time, may not be ready for this operation at twice that age—all depending upon the elevation of the situation, and the nature of the subsoil, as that is open or retentive, dry or damp. Therefore it is that observation upon the spot is the only decisive way of ascertaining when a plantation is in want of being thinned.

I may state, that at the present time, (1848,) upon the estate of Arniston, we are thinning a fir plantation for the first time, which is fifteen years planted. The situation is nearly one thousand three hundred feet above the level of the sea, and notwithstanding that altitude, the trees are healthy, and promise to do well, although of a slow growth. Another fir plantation, in the same neighbourhood, was made in the autumn of 1842, being at the present time (autumn 1848) of six years' growth. The trees in it are not more than thirty inches high upon an average, and yet they are in most perfect health, and promise to do well. This young fir plantation will not, I conceive, be ready for the first course of thinning much under fifteen years of age. These remarks are made to show that the time for the thinning of any plantation for the first time depends much upon the altitude of the situation, and a great deal upon the nature of the soil, upon which they are planted.

For the guidance of those who may not have had much experience in the thinning of plantations, I shall here lay down a few hints of practical utility, from which, I am certain, a cautious intelligent man may be enabled to lay the foundation of future experience in this art. In examining the state of a young fir plantation with the view of ascertaining if it be in a condition so far advanced as to admit of being thinned, it will be necessary first to walk very carefully through its whole extent, and mark well the bearing which the young trees have one upon another. If the points of the branches of the young trees be merely touching, or slightly interfering with one another, thinning would be premature, and ought to be put off for a year or two longer; but if, upon examination, the lower side branches of the trees have the appearance of having been considerably checked in their growth, and are actually becoming deadened in the extremities from the want of freedom and air, and if the higher side branches of one tree are spreading widely, and actually encroaching about half their length upon those of another, it is high time that thinning should be commenced. If the lower branches of the young trees have a brown and deadened appearance, and the upper are spreading so widely that in many instances the points of the strongest of them touch the boles of others, thinning has been delayed too long; and from the trees being heavy topped, and light in the lower parts, many of them would be apt to be blown down if thinned suddenly: therefore, thinning should never be delayed so long as to allow the last-mentioned feature to manifest itself upon the trees.

Having in the manner stated gone through the young plantation, and determined as to whether it ought to be thinned or not, supposing that it has been found necessary to thin, it will be necessary, previous to commencing operations, to examine which sort of tree has thriven best upon the ground, and has the appearance of becoming the most valuable for a permanent crop of timber. Thus, if the ground has been originally planted with a mixture of Scots, larch, and spruce firs, examine each district of the plantation as it may naturally divide itself into height or hollow, sloping banks or level ground, and ascertain which variety appears most healthy, and is most likely to come to perfect maturity as a timber tree in each separate district. In each district spare that species which, from general appearance, is most likely to succeed well; and when thinning, remove those sorts which have not the appearance of becoming good timber upon the soil.

In commencing to thin any plantation, it is also necessary to have in view its situation. The operator should observe that, if the situation be a high one, he must thin sparingly at first, for fear of checking the growth of the trees. At the same time, regard should be had as to what winds prove most violent and destructive in the neighbourhood of the plantation; and having ascertained the quarter from which the most injurious winds come, it is wisdom to thin most cautiously upon that side, and more severely in the interior of the plantation. But if shelter is given, either naturally, or artificially by older plantations upon other heights, then less caution is necessary, and the trees may at once be allowed more freedom, in order to develop themselves quickly and perfectly. The operator having fully informed himself upon each of these points, he will next proceed to have those trees marked which it is considered should be taken out.

In the act of thinning, particular attention should be paid to leaving, in all cases, the healthiest trees upon the ground, and to cutting out those that are most weakly, as the nature of the thinning may require.

In thinning a plantation, many foresters think that the principal object to be aimed at is, that of giving the whole a regular systematic appearance, by leaving the trees as nearly as possible at a given distance one from another, without taking into consideration the ultimate welfare of the plantation. Such a method of conducting thinning operations may, indeed, have the effect of pleasing the eye and taste of the inexperienced for a time; but the effect is certainly ruinous to the proprietor in the end, and is never practised by the forester of extensive experience. If the trees in a young plantation are all equally healthy, then it is but proper to thin them out to a regular distance from one another; but where many of the trees appear of an unhealthy cast—which is frequently the case in a high situation—the healthy trees should be preserved without respect to a nice regularity in appearance. Wherever two trees may be found growing together, the one healthy and the other unhealthy, and, according to regularity in the act of thinning, the unhealthy tree may be found to occupy a proper place, and the healthy one an improper, yet, for the sake of the future welfare of the plantation, there should be no hesitation as to which should be cut down. In all such cases, at once cut out the sickly and leave the healthy.

In the thinning of young fir plantations for the first time, it may be asked at what distance the trees should be left the one from the other? No certain distance can be specified: for this reason, that the young trees do not all grow alike in the same plantation, either as regards height or breadth of branches; consequently, they do not all occupy the same space upon the ground. In the first thinning of any plantation of considerable extent, it will often be found prudent and necessary to pass over some parts altogether, without taking out almost a single tree; and this will happen upon a part of the ground which is of a poor thin nature: while again, wherever the ground is of a stronger nature, with a little shelter from the higher grounds, it may be found necessary to take out nearly one third of the trees in order to give proper air and room. All this must be regulated by observation more than by any rule that could be given. As the general rule, however, my own method of procedure generally is, to leave the trees, as nearly as possible, *free from one another* after the thinning has been performed: that is, when a plantation of young trees has been newly thinned, the extreme points of the branches of one tree should do no more than touch those of its nearest neighbour; and in all cases where fir trees are raised for timber as well as for shelter, they should be kept rather close together than otherwise. By observation, the most advantageous distance will be found, as I have formerly mentioned, to be about one third the height of the trees generally. When firs are kept growing at a distance less than one third of their height, they become tall, slender, and weakly; and if grown at a greater distance from one another, they become branchy, and do not increase proportionately in height, and the timber is generally coarse. No pruning of fir trees should be allowed: pruning invariably deteriorates the quality of the wood of fir trees, and their health also is much injured by it. If the trees are kept as nearly as possible at the distance specified above, they naturally prune themselves as they advance in height; for as soon as the lower branches of the fir and pine tribe become confined, and a want of free air ensues in the body of the plantation, they gradually die and fall off, without in the least injuring the quality of the timber. All the ends or stumps, however, of dead branches should be carefully removed from the boles of fir trees, and that as soon as they become deadened; this tending to make the quality of the wood much finer. In the act of thinning, great care should be taken that no large open space be left among the trees, which in any direction would in length measure more than the height of one of the trees growing by it. This can easily be avoided by proper attention in the disposal of the trees upon the ground, not to have them running in rows, but in such an alternate manner that, which way soever the eye looks from any given point, there may be always a tree to intercept the view within a short distance. This, indeed, is a point of the utmost importance in the art of thinning plantations, and can only be attained by careful observation and experience. If open spaces be left for any considerable distance, the wind gets play among the trees, and has a tendency to cause havoc among them, particularly after being newly thinned, and the more so if the plantation has been formerly neglected. As soon as the young trees which were marked to come out have been cut down, they should be carried out entire to one of the nearest roads in the plantation, and pruned of their branches there. This is not, indeed, always done; but still it ought to be the method of going to work among young trees, the health of which requires free circulation of pure air among them. I have often had occasion to remark that plantations in a young state are much benefited by having a dry wholesome air circulating through them; and being aware of this fact, it must appear evident, that if the prunings of the felled trees be allowed to lie upon the ground when they are cut, the gases arising from their natural decomposition must prove injurious to the health of the standing trees. This is particularly the case when plantations are composed entirely of one tribe or family of trees; that is, if a plantation be composed entirely of the different sorts of firs, the gases arising from the decomposition of their own kind is injurious to their health, whereas those arising from the decomposition of firs are favourable to the health of hardwood trees. On the other hand, the gases arising from the natural decomposition of hardwood trees are injurious to the living plants of the same species in the neighbourhood, but the same gases prove beneficial to fir trees. The reason of this I do not pretend to explain, as a question of chemistry is involved in the answer; still, from my own observation, I am satisfied of the truth of what I here assert, although I do not remember of ever having heard that any other forester had observed this phenomenon: and it is to be regretted that, generally speaking, foresters are not allowed time and expenses to keep young plantations in the clean healthy state which their ultimate value demands. I have observed, in several places of note in Scotland, where men of first-rate abilities acted as foresters, that the plantations under their charge, although generally well conducted in other points, were, notwithstanding, always in a confused state from the prunings of all felled trees lying upon the ground; and on inquiry into the reason of such a state of things, I have always learned that the operation of keeping plantations clean being an expensive one, they were not allowed strength of men sufficient to make all right. Proprietors of plantations often lose much valuable timber by this state of things being allowed to go on in their plantations. It does, no doubt, demand a few more pounds of outlay at the time, but ultimately that would be paid to their successors ten times over, from the effects of a superior system of management.

Supposing that a plantation of young fir trees had been thinned in the manner above recommended, when about twelve years old, the trees would then, probably, be from eight to twelve feet high, according to soil and situation; and supposing that the same plantation was then in a fair state of health, and to have continued so for another period, say of five years from the time that it was first thinned, it would, at the end of this second period, be about seventeen years old, with the trees from twelve to twenty feet high; and they would, in all probability, be ready at this age for another thinning. In the thinning of the same plantation a second time, the same practical points relative to the work must in all cases be attended to as have already been recommended for the first thinning; consequently these need not be repeated here. But there are one or two points which must be observed by the operator in the thinning of plantations at or above twenty years old: the first of these being to see that the standing trees are not injured by the falling of those that are cut down. I have seen much damage done to the trees in a young plantation, where the falling down of the cut trees was carelessly conducted; and it cannot be too strongly recommended to all operators, in the act of cutting down any tree of considerable size and height, to be most careful in the operation. When a fir tree happens to lose its top by a felled neighbour coming in contact with it, such a tree seldom or never increases any more in height, and very frequently dies. The operator, in the act of cutting down any tree of such weight of branches as may be considered dangerous to let fall against any of its neighbours, should, if he has not a sufficient opening for its safe fall, provide himself with a pruning chisel, having a shaft proportioned to the height of the tree, and also a mell; and with these he should lop off all the heavy branches from the tree to be felled, previous to its being cut. When it is thus made bare of all its branches, any tree of seventeen years may be at the command of a man's strength, in so far as he may be enabled to push it down to one side or another as he may see fit to suit an opening among the standing trees. The lopping off the branches from a tree of any considerable size, is, however, an operation requiring considerable time; consequently it need not be adopted excepting in extreme cases, where there is evidently danger to the young and growing trees.

In most cases an expert woodsman can, from observation and practice, make a tree fall very nearly to any given point he may choose as an opening of the safest description. The method practised by expert woodsmen in this sort of work, is to observe, first, toward which side the tree he may be about to cut has naturally its centre of gravity. Having ascertained this point, he proceeds to judge if the tree will or can be made to fall into a proper opening among the growing trees; and being from observation well assured as to the side to which the tree can be made to fall with the most safety, he commences to cut first upon the side to which he wishes it to fall. After cutting rather more than half through upon that side, so as to throw the centre of gravity in the desired direction, he next applies his axe to the opposite side. As he gradually weakens the perpendicular attitude of the tree, he observes now and then if the centre of gravity in the tottering tree is likely to take an unexpected turn upon him; and if so, he checks the same by cutting oppositely. By these means alone I have had men who could lay down trees upon the ground to almost any given point. But, notwithstanding all this, I have frequently had to do with instances in the thinning of plantations where the coming down of a heavy-topped fir tree would have done much damage; and in such cases, when I applied the chisel in the manner as above stated, the work was safely accomplished.

At the age proper for the second thinning of any fir plantation, it should never be too severely thinned; because, at such an age, say at about seventeen years old, the trees are generally in a very healthy and rapid state of growth; and if they should happen to be checked at such a stage, the ultimate value of the whole plantation might be materially impared, and it is even possible that the whole might be ruined. Hence it is requisite, in all cases, to thin with experience and caution.

It is always better to thin frequently, and take out a few trees at a time from any given plantation, than to thin at distant periods, and then to do so severely. Many foresters recommend to thin plantations at regular intervals of ten years. To such uniformity of procedure I cannot agree, because it is evident that no specified time can be given as an interval between thinnings: plantations do not grow with equal vigour every year; in some years trees will make strong healthy shoots of young wood, and in others much less. Trees grow more rapidly in a warm season than in a cold one, and, as has been already stated, they are very much affected by variety of soil and situation; and being aware of these circumstances, it is folly to say that a plantation of trees can be thinned advantageously at any definite period. After any young plantation has been thinned for the first time, it is advantageous to its welfare to go over it and take out a few trees in the way of thinning at intervals of four or five years—in all cases judging upon this point according to the appearance of the trees, whether they have grown rapidly or not since they were last thinned. At such thinnings I would advise every proprietor merely to take out such trees as are really doing injury to others. By this method, which I always practise myself, plantations never experience any sensible check, and, consequently, they are kept in a constant quick-growing state; whereas, by the method of thinning at regular intervals of ten years, the trees in a plantation are by that time generally hurt to a very great extent from the effects of confinement; and as soon as they are thinned in such a manner as to relieve each tree for another period of ten years, the whole plantation must be very much cooled down in temperature and shelter from what it was before the operation was performed; the natural consequence being, that the trees thus receive a severe check, which in too many cases they never recover. A plantation thinned at intervals of about five years, will yield one-third more timber at the end of sixty years than one of the same extent thinned at intervals of ten years.

Every fir plantation, whether composed of larch, Scots, or spruce, ought to be gradually thinned as the trees advance in height and breadth, until they are about forty-five years of age, after which period no fir plantation which has been properly managed should be at all disturbed by the operation of thinning, excepting the taking out injured, unhealthy, or decaying trees. At forty-five years of age, the trees in a fir plantation should stand at such a distance one from another, as may be considered sufficient to bring them to confirmed maturity upon the soil upon which they are growing. This distance of the trees one from another should, as I have formerly stated, be about one-third of their height; and, indeed, this ought to be as nearly as possible the rule for distance among fir plantations at all stages of their growth, commencing our calculation with the time the trees receive their first course of thinning.

In many high-lying districts, the trees in a fir plantation may, at forty-five years of age, be about thirty feet high; therefore, the distance of such trees at that age should be as nearly as possible ten feet: in a more sheltered situation, with a dry and favourable subsoil, they may at that age be about sixty feet high; and in such a case, the distance of the trees one from another may be about twenty feet.

At from sixty to seventy years of age, the wood of the pine and fir tribes is generally considered to be in its most valuable and solid state as timber. It is then heavier, and more full of resinous matter, than at any other stage of its existence; consequently, at that age, if the object be a crop of valuable timber, the tree should be cut down, and disposed of as may seem best. But if the proprietor have in view the giving shelter to his lands, which is generally one end aimed at, the plantation may be allowed to stand for other twenty years, after which period the trees will begin to become lighter in their wood, and many will then be showing marks of natural decay, and the whole plantation will of course be, generally speaking, of less value than it was at sixty years' standing. However, this is not always the case; for very much depends upon the nature of the soil and situation upon which the crop of wood may be growing, as to whether that may be high or low lying, dry or damp. In a high situation, with a good dry bottom, I have seen excellent fir trees one hundred years old; while, on the other hand, I have seen firs beginning to show symptoms of rapid decay at fifty years of age, and in many cases even at a much earlier age, where they were in a low and rather moist situation, and without a free circulation of air.

It very frequently happens that fir plantations have to be dealt with which have been much neglected; and although they may in many instances be past any good hopes of recovery, and might, in so far as regards the value of their timber, be very properly cut down, yet it is very often the wish of the proprietor to have old fir plantations preserved; particularly if such a plantation should happen to be placed upon a part of his estate where, from its evergreen appearance, it proves ornamental from a certain point of view, as well as shelter to the neighbourhood around it. In such a case, profit and ornament should be combined. It would not be profitable for the proprietor of an old neglected fir plantation to leave the ground entirely occupied by a few trees only in a fair state of health, with many others dead and dying; therefore, the profitable way of going to work in such a case would be to plant anew with other trees all vacant parts, and, for the sake of ornament and shelter, all good old trees could be left for a time.

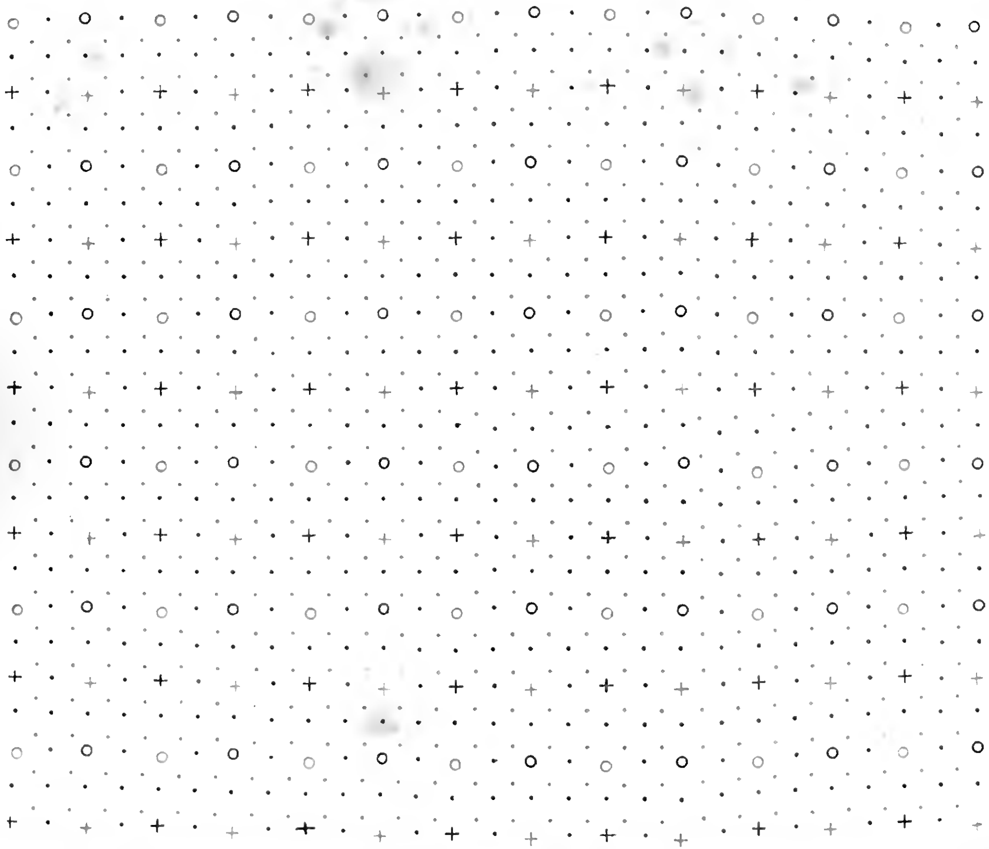
I have frequently been called upon by proprietors to give my opinion relative to the state of fir plantations upon their estates which had grown up under utter neglect, and requested to say whether I thought that such a plantation would recover by any means I could suggest. Where I have found such plantations young—say at or under thirty years of age—and spoiled merely from the want of having been thinned in proper time, I have very often seen them recovered by a very cautious and gradual course of thinning, especially where the trees grew upon a dry bottom; but wherever I have found thinning neglected upon a damp soil, I at once pronounced that there was no hope of recovery for the trees. In many such cases I have seen a gradual course of thinning with draining tried for the purpose of recovery, but all to no purpose. If ever the pine or fir tribe have been much affected by dampness in the soil, the sooner that the trees are cut down the better; after which, draining and replanting can be got done in a proper manner.

Where the trees in a neglected fir plantation may happen to be old—say at or above sixty years—and where, in such a case, it is the wish of the proprietor to extend the existence of his plantation as long as possible for the sake of shelter and general ornament, it is a very good method to cut out gradually all the trees which have the appearance of decay, and to leave the best trees standing at wide distances, and as nearly regular as possible. Say that good trees are left at seventy feet distance one from another, from a distant view the plantation would seem good; and then the open spaces between the old trees could be replanted with a crop of hardwood trees, which, from being sheltered by the old firs, would grow very rapidly. In the course of ten or fifteen years from the time of this replanting, when the hardwood may be expected to be pretty strong, the firs might with propriety be dispensed with altogether, or only a few of the best trees left, according as the taste of the proprietor suggested.

SECTION IV.—SYSTEM OF THINNING AND REARING UP OF MIXED HARDWOOD PLANTATIONS.

The rearing up of hardwood plantations to anything approaching natural perfection, requires much more attention and practical knowledge from the manager than fir woods do.

DIAGRAM SHOWING THE MANNER OF DISTRIBUTING TREES IN A MIXED HARDWOOD PLANTATION



In a fir plantation, the trees are alike of an upright habit of growth, from which circumstance they are very easily regulated and kept in proper place and order; but in a plantation consisting of many different kinds of hardwood, all growing in a mixed state—some, as the elm, inclining to grow much to horizontal branches, and others, as the ash, tending to an upright growth—much attention is necessary for the first thirty years, in order to keep the rambling sorts within due bounds, and from overtopping and injuring their neighbours which may be less hardy in their young state. And as it is in the young state that hardwood plantations may be made to do well or otherwise, according as they may be attended to, it is a matter of the first importance in good forestry, that the manager be well acquainted with the circumstances which retard the progress of young trees, as well as those which are known to be favourable to their healthy development. Being myself well aware from past experience of the extensive damage which is done to young hardwood plantations in consequence of their being neglected in their young state, I shall here lay down at some length the method which ought to be pursued in order to have healthy and valuable hardwood trees—dwelling more particularly upon the system which ought to be adopted in rearing, till the trees attain thirty years of age; after which time, if they have been properly attended to, little care is required as regards trees individually, except to give them room as they advance in size.

Let the annexed diagram represent a piece of ground which has been planted with different sorts of young hardwood trees, at ten feet apart, the ground being made up between them with firs to act as nurses, so that the young trees stand over all at three and a half feet from each other.

In the diagram, the different sorts of trees are represented by marks differing either in colour or in character, thus:—

Oak trees, planted at twenty feet apart, are represented by a red circle.
Ash trees, planted at twenty feet, by a black circle.
Elm trees, planted at twenty feet, by a red cross.
Sycamore trees, planted at twenty feet, by a black cross.
Larch nurses, planted at three and a half feet from hardwood, by a red point.
Scots fir nurses, planted at five feet from hardwood, by a black point.

Upon examining the diagram, it will be found that each sort of hardwood tree is planted in such a manner that each tree of the same sort is exactly twenty feet from the next of its own species. This is an important point to attend to in the planting of mixed hardwood plantations; for it may ultimately be found necessary to cut out the whole of one sort; and in this case, the others which were left would stand at equal distances after these had been removed. The ash and sycamore are planted within ten feet of the oaks, while the elm is kept fourteen feet off them. This is another point of much importance to attend to in the planting of mixed hardwood plantations. For example, supposing that the oaks, which are planted at twenty feet apart, are intended to remain as the only ultimate crop, then the ash and sycamore, which are of an upright habit of growth in a close wood, could grow for a longer time close upon the oaks than the elm could safely do, which is of a spreading habit; therefore the elm, at fourteen feet distance from the oak, would be as close upon the oaks at thirty years' standing, as the ash and sycamore at the same time. The larches are planted three and a half feet from the hardwood plants. The reason of this is, that the larch, from its light and airy habit of growth, is found not to hurt the hardwood plants so much as the Scots pines would do at the same age; for which reason, also, the Scots pines are for the most part planted five feet from the hardwood plants. Besides, the larches, being planted next the hardwood, are likely to be taken out first in the way of thinnings; and in this case they are of far greater value when cut at an early stage than the Scots pines. The four larches which are planted next each hardwood plant can be all taken away in the way of thinning a considerable time before it is found necessary to cut a Scots pine; and by this arrangement the Scots pines can be allowed to stand and grow till they become of some value.

We shall now suppose that a pretty large tract of ground has been planted with young forest trees exactly in the manner represented in the diagram. We shall further suppose, that the ground so planted has been properly drained and rendered congenial for the future welfare of the plants; for let me again observe, that much of their future success depends upon this. A very indifferent soil, if well dried, will produce much better timber than a good soil having a superfluity of water in it; hence the importance of a thorough clearing of the ground from all superfluous water before planting forest trees upon it. Presuming that the ground has been well drained by means of open drains put on at consistent distances, and that the young trees have been properly planted according to directions, as formerly given in this book, the next question which naturally occurs is, At what stage of the growth of such a young plantation should thinning commence? This is a question which has given rise to a great deal of useless discussion among those who have the management of plantations; all this arising from not taking into account the effect of altitude upon the growth of young trees; and not only the effect of altitude, but even the effect of soil and aspect, and in fact many other local circumstances which cannot always be accounted for. For example, in districts of the country pretty far inland, and upon estates of a generally level nature, four hundred feet above the level of the sea, I have seen foresters thinning their young plantations for the first time at eight years old from the time of planting; while, on the other hand, upon the west coast of Britain, upon estates within a few miles of the sea, and at four hundred feet above its level, I have seen young plantations, under excellent management, not ready for thinning when they were ten years old, and that although the young trees were planted at the same distances from one another in both cases. Now, this at once points out, that, independent of altitude, other local circumstances must be taken into consideration; as, for instance, if the ground planted be upon a level part of the country, the trees will grow quicker than they could do in a hilly district, even supposing the altitudes of both to be the same; while, again, trees grow much faster in a glen or hollow than upon a common level piece of ground. And, with regard to soil, when it is of a light or sandy nature, young trees grow very quickly upon it for a few years, and soon arrive at maturity; while, at the same altitude, upon a heavy or clay soil, trees will be longer in getting away, but will ultimately be far superior to those planted upon the light soil.

Every intelligent forester who has had the management of plantations upon an estate of considerable extent and of a varied surface, will have had occasion to remark the great difference that occurs in the growth of plantations, even within the bounds of one estate; and that according as the plantation may be situated upon a sudden rising height, upon flat level ground, in a hollow or glen, upon sandy or light soil, or upon heavy clay soil; and I may say also, according to shelter received from surrounding plantations, &c. It will then at once appear evident, that to give anything like a rule for the time at which a young plantation should be thinned at first, is a thing, properly speaking, impossible, as I have learned from practical experience. There are, indeed, men whom we may properly term theorists, who pretend to lay down exact rules for the thinning of young plantations at any given stage, and who even state the exact size that a tree should be at a given age, without having any regard to local circumstances affecting the growth of trees; all which arises from the want of experience, and from ignorance upon the subject of growing trees: for even a person unacquainted with forest matters will at once admit that, in some sheltered situations, trees will be fit for a given purpose at twenty years from the time of planting, while others of the same age, planted upon an exposed part, will not be nearly so large.

Upon the estate of Arniston, the plantations are situated upon land varying from four hundred to thirteen hundred feet above the level of the sea. A considerable portion of these are growing in glens or hollows — a portion on level ground, about the home domains—and another portion growing on a high moorland part of the estate. Having such a varied surface for the growing of plantations upon this estate, I shall here, for the guidance of those who may not have similar opportunities, lay down the different ages at which I have thinned plantations, mentioning at the same time the nature of the soil, and the altitude of each.

First, In a hollow or glen, four hundred feet above the level of the sea, planted with oaks at twelve feet distances, and made up with larches to four feet over all, I have found it necessary to thin out the firs at seven years from the time of planting. The soil in this instance was a light sandy loam, with, in many places, rocky projecting points, with very little soil.

Second, Upon a level part of the estate, about seventy feet higher than the glen above mentioned, is a mixed plantation of the same kind as the above, and planted at the same distances, which I found necessary to thin at eight years from the time of planting; the soil, in this instance, being what may be termed a clay loam, and having been, before being planted, under agricultural crops.

Third, Another young plantation, consisting of oaks planted at eight feet distance, and made up with Scots and spruce firs to four feet over all, was thinned when of nine years' standing. The height of this plantation was five hundred feet above the level of the sea, situated on a level part of the estate, the soil being rather a stiffish clay.

Fourth, Upon the same level with the last-mentioned plantation, but in a hollow, I thinned larches from among the hardwood for the first time at eight years old. The soil here was much the same as that last stated; but the situation being in a hollow, the young trees came more rapidly forward from being sheltered.

Fifth, A young plantation, six hundred feet above the level of the sea, consisting of oaks at ten feet apart, made up with larch and spruce firs, I thinned for the first time when of ten years' standing. The soil, in this instance, was very variable; in some parts approaching to clay; in others, sandy loam; in others, gravelly; and in others, mossy: consequently, from the great variety of soils contained in this plantation, it was not generally alike at the same time ready for being thinned. On the dry sandy soil I found the larches had grown very rapidly, while on the more clayey parts they had not come nearly so rapidly away. On the clayey parts, and particularly where the moss and clay approached each other, I found the spruce firs had far outstripped the larches in the rapidity of their growth.

Sixth, In a pretty large glen, situated six hundred feet above the level of the sea, is another plantation of eight years' standing, which I found necessary to have thinned at that stage. The trees consist of oaks planted at eight feet apart, and made up with larch and spruce firs to four feet. The soil is a sandy loam, and in many places sand very much predominated.

Seventh, A number of plantations, situated seven hundred and fifty feet above the level of the sea, and upon a rather exposed northern aspect, I found not requiring to be thinned for the first time before they were twelve years old. The crop of trees in these is mixed hardwood, at ten feet apart, made up with larch, Scots and spruce firs, to three and a half feet; and the soil in general is a sharp sandy loam, and in many places gravel. Generally speaking, all the plantations upon the estate of Arniston, which are situated between seven hundred and fifty and nine hundred feet above the level of the sea, I have not found necessary to thin, although the trees are planted at three and a half feet apart, before they are twelve years old; excepting, indeed, hollow parts, where there is natural shelter produced. In such hollows, even at eight hundred feet of altitude, I have found it necessary to thin at nine and ten years of age.

Eighth, At one thousand feet above the level of the sea, where the natural surface soil is of that description known among foresters by the name of *sandy moss*, producing short bushy heath, I have never found it necessary to thin for the first time, even when the trees were planted at three feet apart, till they were fourteen years old: at the same altitude, that is, one thousand feet, where the soil is of a loamy nature, and adapted for the growth of hardwood, I have found it necessary to thin larch from the hardwood at from twelve to thirteen years.

Ninth, In fir plantations, planted upon goodish loamy soil, at twelve hundred feet above the level of the sea, having a northern aspect, I have not found it necessary to thin trees planted at three feet apart before they were fourteen and sixteen years old; excepting, indeed, in any hollow glen, where, of course, from the effects of natural shelter, two or three years may be gained.

Now, from the above statement, it will appear evident that altitude has much to do in the bringing of trees to a given size within a given time. Those, therefore, who say that every plantation should be thinned at such and such a time, only expose their own want of knowledge in the matter, and ought not to be trusted as guides in forest operations.

We shall now suppose that we have in hand a plantation of fifty acres in extent, which has been planted with a mixture of hardwood and firs, exactly in the proportions pointed out in the diagram. This plantation we shall suppose to be upon a moderately exposed situation, say eight hundred feet above the level of the sea, and pretty far inland, having a soil of moderate capabilities. Such a plantation will in all probability be ready for the first course of thinning when from ten to twelve years old; but before commencing to thin out any of the larches, it will be necessary, in the first place, to have an eye to the state of the hardwood plants, which of course are intended as the principal and ultimate crop upon the ground.

In the rearing of plantations generally, and more especially in the case of those in which it is intended to rear up a supply of various kinds of hardwood for general usefulness, independent of a particular sort which is to remain as an ultimate crop upon the ground, the forester requires to watch them continually, in order to keep them in a constantly healthy growing state. The trees, after they have got properly established in the ground, must not be allowed to become so crowded together as to impede the free action of air among them; neither must they at any time be thinned so severely as materially to cool down the usual temperature of the whole as a plantation, as is too often done. A forester, therefore, in order to raise plantations profitably, should have the present state of every plantation under his charge continually in his eye; for unless this be the case, matters will without doubt go wrong. The forester will then, in the case of such a young plantation as we are now discussing, observe at what time the points of the side branches of the larches begin to touch those of the hardwood plants next them; and as soon as this ensues in the plantation generally, it is time to give the hardwood plants a prune, which should in all cases be done before any thinning of the firs takes place. In the case of such a plantation as is now under our consideration, this pruning will in all probability have to be made in the eighth or ninth year, independently of other prunings they may have received when younger.

In pruning the young hardwood trees at this stage, have all strong branches that may have the appearance of gaining strength upon the top shoots of each tree, cut clean away from the bole. At this early stage, and while the plants are in a young and sapling state, they are much improved by a judicious lopping off of all large branches; for immediately after such treatment, the trees push upwards in a vigorous healthy manner, making double the progress that others do under like circumstances, which have not been pruned of their superfluous side branches. Having thus gone over all the hardwood plants, and pruned them in the manner stated, have any of the side branches of the larch plants that may be likely to interfere with the hardwood soon, cut away with a hedge-knife, taking care, however, to do so carefully: that is, do not cut the branches close to the bole, but only about half-way in upon themselves; for were these branches to be cut close in upon the surface of the bole, the young larch trees would in all probability lose much of their sap at the wounded parts, and consequently the health of the trees would be much impaired. This pruning of the hardwood trees should be done in the months of April, May, and June, and never later than the last week in July. If this be not attended to, the wounded parts will not heal up properly before winter set in. I have frequently had occasion to observe, that young trees which had been pruned in September, were much injured at the wounded parts during the frost of the following winter; and the consequence, of course, was, that the trees so dealt with were unhealthy for a considerable time afterwards, while the cause of their unhealthiness was attributed to anything but the truth. One man, with ease, will prune the young hardwood trees, and clear them from any side branches of the firs, upon an acre of ground, in one day; for at this stage the work is easily performed. Many object to the doing such work, on the ground of its expense; but this is a very great mistake: at the very utmost, two shillings and sixpence an acre may be reckoned upon as the price of such work, which is, indeed, comparatively speaking, a mere trifle, considering the advantage derived from it.

I have myself two men who will, in the manner I have described, prune three acres in one day.

Having pruned the young hardwood trees, and relieved them from the points of any of the side branches of the firs, they will, from having the advantage of shelter all about them, make strong and vigorous shoots, and their side branches will, in the course of two years after this pruning, have pretty far met with those of the larch. By that time they will have gained a confirmed healthy growing state, and have completely recovered from the effects of any pruning they may have received; consequently they are then in a fit state for being exposed to free air, as they always are after being thinned for the first time; while, if young hardwood trees be properly attended to in pruning them in the manner and at the stage above stated, they seldom or ever require much pruning afterwards. The great error which prevails among inexperienced foresters, at the present time, in the management of young hardwood plantations, is, that they both thin and prune at the same time. Now, no system of management can be more injurious to the health of any plantation than this; for, when a few branches are lopped off a young tree, it will often die when exposed suddenly to a temperature below that which it formerly used to exist in; and this lowering of temperature invariably ensues when thinning and pruning are executed at the same time. But if, when a young tree is pruned, the temperature be increased rather than otherwise, the tree is immediately improved by the operation, and decidedly attains a more vigorous constitution than it formerly possessed; and this, again, is exactly the case when pruning is done in the early part of summer, and a considerable time previous to thinning. We may herein see at once the evil of both pruning and thinning at the same time, and the great propriety of pruning trees a considerable time before exposing them suddenly by thinning.

I said above, that, in the course of two years from the time that the hardwood received the pruning, their side branches would be pretty far met with those of the larches. This is a stage in the culture of young hardwood trees to be closely observed by the intelligent forester; for if the branches of the firs are allowed to encroach too far upon the hardwood, they will very soon hurt them by lashing and crushing them down; for let it be kept in mind, that the larch grows much more rapidly than the hardwood does; and the firs are not planted with the view of doing injury to the hardwood plants, but, on the contrary, to nurse them up and protect them. Again, on the other hand, there is a possibility of injuring the hardwood plants by taking the firs too early away from them; and this also ought to be avoided as much as keeping them too close. Every forester of extensive experience will have observed that hardwood trees, when at the stage to which we are now adverting, if kept too far from their nurses, (the firs,) are extremely apt to become of a branchy coarse habit, and not inclined to grow upwards so much as to grow to strong side branches. This is an evil of very great magnitude, and ought in all cases to be guarded against where clean healthy timber is the object. There is, therefore, a medium course to be followed; and the question is, by what feature can an inexperienced person decide upon the proper time that he should begin to thin away firs from the young hardwood? The right answer is not so easily given as many would suppose. To the eye of an experienced forester the matter is indeed simple, but to convey his experience upon this point to the mind of an inexperienced stranger, is not such a simple matter.

The best rule for guidance in this matter is, to go carefully through among the trees, and mark particularly the state of the hardwood plants; observing particularly if the branches of the larches are lying upon and interfering with those of the hardwood; and if this be the case, thinning should be commenced. Having, then, decided that thinning is necessary for the welfare of the hardwood trees, the first step in the work is to have the firs marked which are considered necessary to be taken out; and in order to do this properly, considerable practical judgment is required. All theoretical men, who have had little practical experience to form their judgment with regard to thinning young plantations, maintain that, at a certain age of a plantation, a certain number of trees ought to be cut away from each hardwood plant; thus reducing practical forestry to a few rules of practical geometry. This theory sounds all very well in the ears of other inexperienced men, but when reduced into practice, it proves an utter absurdity. Plants are, like animals, often found to die suddenly, and that, too, without our being able to give a reason for it; besides, nothing is more true than that all trees of the wood do not grow alike; and seeing this, we must, in the case of thinning, judge for ourselves, and, from practical observation, choose which should stand and which come out.

In practical forestry, the operator will very generally find that of the four larches planted about each hardwood tree, (*see Diagram*,) one or two may be of a pretty large size, and others of a smaller; one or two may be lying too much upon the hardwood plant next them, and others be found not doing it harm, but, on the contrary, sheltering it; and these may therefore be very properly left for a time. This at once points out the harm that would be done to plantations were we to thin them according to any theoretical rules. On this point also the theorist says, "at the first thinning, cut away all the four larches that stand next the hardwood in each case." Now, I have already said, that when young hardwood trees are allowed to have too much space in the plantation, they naturally incline to spread their side branches, and do not grow so tall as they ought to do in order to make clean valuable timber. In such a case as this, much pruning would be necessary in order to keep the trees in shape and put them into balance; and this severe pruning is always injurious to the health of trees; and were we to cut away all the four larches at once, this would be the precise state of the hardwood trees. A single glance at the diagram will show the tendency of such treatment. The four larches stand at three and a half feet distance from each hardwood. Now, were these taken away at once, what a severe check would the hardwood receive! Before the thinning took place, these nurses were close upon, and even touching, the branches of the hardwood plant; whereas, by their removal, there would be a space of five feet between the hardwood plant and each of the Scots firs on the one hand, and another space of seven feet between them on the other. This would not be nursing up timber upon right principles, but the very way to retard its growth.

I would not have adverted so much to this, were I not aware that there is a class of men who term themselves foresters, whose views have a tendency to deceive proprietors by such statements as I have given above; they never having had any practical experience of their own even to prove the evil of the opinions which they hold in forest matters. I am, therefore, anxious to put proprietors upon their guard as to how far they give heed to them.

Having, I think, pointed out the evil which would arise from going to work in forestry according to theoretical rules, it is evident that practical experience is the only schoolmaster for the person who is to mark the trees which should be taken out of a plantation at any period of its growth; and seeing that no invariable rule can be laid down as a guide, the operator may safely go to work conformably with the following directions:—

He will first provide himself with what is termed a *hand-bill*, with which to mark the trees which are to be taken out; and with this implement in his hand, he will take his station on the most sheltered side of the plantation to be thinned. My reason for beginning upon this side is, that all trees have fewer branches upon what is termed the *storm side*, than they have upon the other; consequently, the firs growing upon the storm side of the hardwood plants will have their inner branches, or those upon their sheltered sides, more abundant, and more lying upon the hardwood, than those which grow upon the sheltered side of the latter. Now, the operator, from keeping this in view, and beginning upon the sheltered side of the plantation, sees much more readily, as he advances, the branches of the firs which grow upon their sheltered sides, and can more easily judge of the extent of the injury they may be doing to the hardwood trees.

Being thus stationed with a hand-bill for the purpose of marking, he will walk up to the first hardwood plant at the point where he intends to commence; and having done so, he will examine which of all the larch trees about it has its branches lying most upon it, and which will, without doubt, be the one that stands most directly between the hardwood plant and the storm point. Having decided upon this, and marked it with the bill, by simply breaking off a few of the branches, or by taking a *spale* of the bark from it, he will have a man following him with an axe, whose duty will be to cut each tree as it is marked. In the cutting of it, the operator will with his axe prune a few of the lower branches from it, in order that he may the more readily get his implement to the root of the young tree; and this being done, he will cut the same as low as possible, beating away any of the grass with the head or heel of the axe, if that be any obstruction to his getting it cut sufficiently low. The tree, as soon as it is cut, should be hauled out by a boy present for the purpose, and laid down upon the nearest road in the plantation, where another boy should be stationed for the purpose of taking off all the branches with a hand-bill. Small trees of this description should be pruned out to the very points, and put in bundles or small lots, for the conveniency of removal.

We shall now suppose that one larch has been marked, cut, and carried out, the one which had been hanging most upon the hardwood plant. Now, from this one tree having been removed, the person whose duty it is to mark the trees will see more clearly how the hardwood tree may be affected by the removal of the one. He will after this be more able to judge as to which of the others should be taken next; and if the branches of any of the other three larches, which are yet supposed to be growing about the hardwood plant in question, are found to hang upon, and are like to injure it, let it be marked and cut away also.

At this early stage of the growth of such a plantation as we are now speaking of, it will very seldom be found necessary to cut away more than two firs from each hardwood plant, and in many instances even one may be enough to take away at once, with the view of retaining a regular proportion of shelter throughout the plantation, as well as of doing justice to each hardwood tree. Therefore, at this stage I would advise that where any of the larches are not actually pressing upon the hardwood plants, or having their branches lying upon them, these should be left for another year, or even two, if the situation is exposed to severe winds. By such a cautious method of procedure, the trees will succeed much better, and not receive any sensible check.

My own method of going to work—and I now find the advantages of it—is to go regularly through all young plantations, after I have begun to thin them, once in two years, until the hardwood plants are properly established, and of a good size: this will generally be from sixteen to twenty years old, according to local circumstances of soil and situation.

In the same manner as has already been pointed out for the relieving of the first hardwood tree, do to the whole in the plantation, paying no respect to the firs themselves, but having the attention constantly directed to the relieving of each and every one of the hardwood. The firs, in this instance, are merely planted with the view of rearing up the hardwood plants; and when they begin to hurt them by their pressing too close upon them, they must, of course, be removed. The person who marks the trees need not wait in all cases till he sees the one which he marked cut down; this would be a tedious business: but if he has never marked any trees before, as I am at present assuming he has not, it is but proper that he should begin cautiously, and see the effects of his judgment before he proceed too far. This he may properly continue to do for a day or two; by which time, if he is an intelligent and observant person, he will be able to go on marking before the cutters. He may now and then take a walk back upon the ground he has gone over, and see the effects of his work; and if anything presents itself that he could improve upon, such as marking a few extra trees which may appear to be too close upon the hardwood, this will have the effect of improving his judgment in the work he has on hand, and make him more attentive in future. In marking the trees, let it be done invariably upon one side; for if this be not attended to, the person who comes behind to cut them will lose much valuable time in looking for the marks; while, if the trees are all marked upon one side, he will have no difficulty in finding them out.

After the trees have been all carried out and pruned of their branches, as has been already directed, they should be removed from off the roads by means of a horse and cart, and stored in any convenient part until sold. If they can be sold beforehand, so much the better, as by this means considerable trouble will be saved in their not having to be carted and stored past at home. The size of these larches, at about ten years old, will, in a moderately exposed situation, eight hundred feet above the level of the sea, be from eight to ten feet in length, and from an inch and a half to two inches in diameter at the middle. They should, on an average, be worth 1½d. each, and in most districts sell very readily for various kinds of fencing purposes, handles for agricultural implements, poles for training flowers upon, &c. &c. On the estate of Arniston, we are in the habit of cutting many thousands of these every year, and I find that they pay us well, there being a great demand for them: this year (1849) we have not been able to supply more than one-half of the demand. They are sold at 3d., 2½d., 2d., and 1½d., according to size; this showing that small larch thinnings, apart from their use in nursing up the hardwood trees, are, when cut down, a valuable commodity to the proprietor, and very soon come in to pay him the rent of his land. I am the more desirous to draw attention to this, from being aware that some think that young thinnings do not pay the proprietor his expense of planting and rearing them up. This is, of course, a decided error, and only indicates bad management on the part of those who have found it so.

In two years from the time that the plantation had received its first thinning, it will again be necessary to look over the hardwood plants, and take away from them all the larches that hurt them. At this second thinning, it is very possible that all the latter will require to be taken out; for, if we now suppose the plantation to be of thirteen or fourteen years' standing, the Scots pines which stand within five feet of the hardwood (*see Diagram*) will be strong and healthy young trees, and will, from their massy foliage, prove shelter enough to the hardwood. This, however, must not be taken as a rule; for even at this stage, upon any prominent high part of the plantation, it is very possible that the hardwood trees may not have advanced so very rapidly as might be imagined. In such cases, therefore, it will be proper to leave a few of the larches for another year or two, in order to shelter the hardwood and bring them into shape; for, if they be exposed at this stage, they will not be easily got into shape afterwards. But in all moderately level parts of the plantation, and more particularly in any hollow, all the larches may at this time be, without hesitation, taken out; while, by the time the plantation has arrived at sixteen years of age, the larches may all be dispensed with, leaving the nearest trees to the hardwood, namely, the Scots firs, at five feet distance from them. (*See Diagram.*) In taking out all the larches, have the work done exactly in the same manner as I have already described for the first course of thinning; except that, when they are come of a pretty large size, they will require to be pruned of their branches on the spot where they fall, and the tree carried out to the roads, while the branches can be gathered up and burned afterwards.

In practical forestry it is found that the whole number of the trees that may have been originally planted upon the ground, cannot be accounted for in the course of thinning and training up; and this observation I make here, in order that the inexperienced may not have too sanguine hopes as to the results of after profit. Having myself now had the management of thinning a vast extent of woodlands at all possible ages, and having kept accurate notes of the results of each as I went on, I have found, that even under very good management, 5 per cent will be found amissing when the season of thinning commences; and even after the trees have arrived at the stage of growth we are now speaking of, I have frequently found many go back. The reason of such deficiencies occurring is, that, while the plants are in a very young state, say during the time that they are under five years of age in the plantation, they are liable to be attacked by vermin of every description, such as hares, rabbits, mice, squirrels, moorfowls, &c., &c. Hares and rabbits destroy young trees, both firs and hardwood, by gnawing the bark upon the stems and branches. I have often seen young trees, three quarters of an inch in diameter, completely cut through by such vermin; consequently such trees were rendered useless if of the fir tribe; but, of course, hardwood trees, although gnawed over, would again come away from the bottom part. Mice and squirrels injure young trees by eating out the buds. If the winter and spring happen to be a severe one, they also peel the bark from young trees wherever they can reach it; and when severe frosts set in, trees so injured very frequently die in consequence of the frost affecting the tree at the peeled part. Moorfowls are very destructive to young Scots pine plants by picking out all their principal buds; and from this cause alone I have seen very many young trees killed. It will thus appear evident to the young forester, that he must not be disappointed although he cannot find all the trees which he knew were originally planted upon the ground; and this I am the more particular in mentioning, seeing that there are theoretical *foresters*, or rather men, who say that no tree should go back under good management. We may as well say that no medical practitioner should be called in to see a patient who cannot cure every disease in the human subject, or that no medical man is perfect who cannot cause his patients, every man and woman, to live till they are a hundred years old. Theorists will appear in every branch of science, and in every professional business, and will lay down rules which, in their own estimation, are infallible; but in every profession it is the practical man alone that is to be depended upon as a guide. From my practical experience as a forester, I am led to state, that, as a medium, 5 per cent of the trees planted will be found amissing by the time that a plantation is fifteen years old.

At this stage of the growth of the young plantation, the method of training up which I am now endeavouring to explain, it is necessary that the forester should examine if all the hardwood plants are really worthy of being kept as the permanent crop; and in examining this, let him be particular, not so much as to the shape of each plant, as to the state of its health. In every case where a hardwood plant does not appear to have made young wood freely for some years past, and is of a stunted habit of growth, (and this will sometimes occur,) let him cut it away and give place to one of the nearest firs; this being a larch if possible, as it will ultimately become of more value than a Scots pine would do, provided the soil be good. It is also, from its upright habit, better adapted to stand as a permanent tree among hardwood. All the above points having been attended to, it will again be necessary, at eighteen years, to look over the whole;

for at this stage a few of the Scots pines will be encroaching upon the hardwood. These should be taken out, on the same principles as already detailed regarding the thinning out of the larches; the attention not being given to the taking out of any given number of trees from each of the hardwood, but merely taking out those that are really pressing upon them. By going to work regularly once in the two or three years with this course of thinning, by the time that the plantation has arrived at twenty-five years old, every one of the Scots pines which were growing at the distance of five feet from the hardwood will have been removed, thus leaving one Scots pine plant standing in the centre of the square formed by each four of the hardwood plants; consequently, at this age the hardwood will be seven feet from the nearest Scots pine in each case. (*See Diagram.*)

By the time that the plantation has reached twenty-five years old, the hardwood trees will be all of a strong healthy habit, and very probably may average twenty feet in height, with an average diameter, at five feet from the ground, of four and a half inches, having abundance of moderately strong leafy branches upon them for two-thirds of their height. Now, at this stage of the growth of hardwood trees, they ought to give prospect of their future worth. In the state above mentioned, the remainder of the Scots pines should be allowed to stand till the oaks are about thirty years of age, when another thinning should be commenced, by taking the Scots pines away from the oaks. This thinning too, as well as all the former ones, should be done gradually, and not all at once, as some recommend; and I may say that, in general cases, by the time that the plantation is thirty-two years old, every fir, excepting, indeed, any that may have been left instead of any bad hardwood, should be removed from among the hardwood, leaving them among themselves at ten feet apart. (*See Diagram.*)

In any high and exposed point of a plantation, it is wisdom in the forester to have a considerable portion of the firs left standing. They are more hardy than the hardwood sorts; and, when growing upon an exposed site, such as the outside and towards the storm-point of a wood, they form a protection to more valuable trees in the interior. In the act of thinning such parts, where it is considered necessary to have the firs left, it must be kept in view to have a portion of the hardwood taken out, and firs left in their place; as, of course, they could not grow up all together.

As it is, from experience, found that all the hardwood trees do not advance at the same rate, I may remark here, that even at the time that the last of the Scots pine are being taken out, it may be found necessary, in sheltered parts of the plantation, to take out a few of the hardwood also. Of course this will take place in such parts as were first relieved of the Scots pines; for, in sheltered parts, and upon a pretty good soil, the very same circumstances that cause the quick advance of the firs will cause the like quick advance of the hardwood. This point also must, therefore, be kept in view by the intelligent practical forester; and in taking out a few of the hardwood trees at the stage we are now referring to, he will first carefully note which sort has the appearance of attaining the most valuable development as an ultimate crop upon the ground. In the case now under consideration, we shall suppose that sort to be the oak; consequently, in taking out any of the hardwood trees at the period referred to, care must be had to see that they be given every advantage to. Again, at the same time, care must be taken to see which sort of the hardwood trees is the most unhealthy, and has the least chance to become of a healthy and valuable size. We shall suppose that sort to be the ash; and being satisfied upon this point, the forester must act accordingly, taking out the ash as the first thinning of the hardwood. By this method more place will be given to others that have the appearance of becoming more valuable upon the ground.

In the cutting down of the Scots pine trees from among the hardwood at the advanced stage of about thirty years, great care must be taken to see that no damage be done to the hardwood by their falling upon them. In order to avoid this, it is only necessary to have the pruning-chisel at hand, and by means of it to take off any heavy branches from the firs before cutting them down; and when their tops are lightened by this means, an expert woodman will cause them to fall to any given point very exactly, which point must, of course, be that of the greatest opening in the neighbourhood of the tree to be cut down. In carrying out trees that have been cut from a plantation at the stage we are now referring to, the work should be entirely performed by a few men, and no horses should be allowed to draw them out, as is often done, to the great damage of many of the standing trees. This damage is occasioned by the cut trees, while being roughly drawn out along the ground, coming in contact with the stems of the standing ones, and taking the bark off them. At the stage now referred to, therefore, the cut trees should be carried out by the woodmen, either upon their shoulders as they may be able, or by means of handspokes, to the nearest part of the roads.

As the hardwood trees will all be making rapid progress between thirty-two and thirty-five years of the age of the plantation, we shall now suppose that, by the time it has arrived at the latter named period, all the ash trees have been removed for the purpose of giving ample space to the oaks. It will be observed, by looking at the diagram, that the ash trees are situated alternately with the oaks in one line, while the sycamores are situated in like manner with them on the other line of view. Ash trees, at the age we are now referring to—namely, at from thirty-two to thirty-five years old—are in a very fit state for many country purposes, and particularly for handle-wood; and will, if growing in a favourable soil and site, sell at a good price. I am this year (1848) selling ash handle-wood at 2s. 6d. per foot cube; but allowing that, upon an average, only 1s. 6d. can be got for it, then each ash tree, at thirty-five years old, will contain about five feet of wood, and thus make each worth 7s. 6d. Again, by the time that the plantation has attained from thirty-eight to forty years of age, it will next be necessary to have the greater part of the sycamores taken out, leaving the oaks at about twenty feet apart. It may be necessary to remark here, that, in taking out the sycamores, it may in many instances be found advisable to leave one near to an oak of a weaker growth, and, at the succeeding course of thinning, it can be decided which should remain as the permanent tree. This matter must be left to the judgment of the forester in charge. But, with the view of illustrating the case now before us, we shall suppose that the sycamores have all been removed, and the oaks left twenty feet apart from each other on the one hand, and fourteen feet from the elms on the other. (*See Diagram.*)

In the course of five years after, say when the plantation is about forty-five years old, it will be necessary to have the greater part of the elms taken out also. At this stage they will be of good value, and fit for coach naves, trams, and many other valuable purposes, and may be worth, at an average, about 20s. each. In removing the elms, as well as in the case of the sycamores, it may be found necessary to leave a portion as I already explained relative to the sycamores; for no thinning of the trees should be done suddenly, or to exact rule: in many cases the whole may be required to come away for the sake of the oaks, while in others a few may be required to remain for a time longer. In the present case, we shall suppose that by the time the plantation has attained the age of fifty years, the trees in general will be left standing at about twenty feet apart from each other all over the ground. Hardwood trees, of fifty years old, standing at twenty feet apart, will have ample room to develop themselves in a vigorous healthy manner till they are about sixty years old, when another course of thinning will be necessary; and at that stage—namely, when the trees have arrived at their sixtieth year—if they have succeeded according to expectation, a few trees will require to be taken out in order to relieve others of a more vigorous growth. In this case no rule of distances can be given; for the trees will in some instances be very close upon one another, and in others, according to their growth, they may have quite enough of space, and stand freely. In the same manner the plantation may be gone over regularly at periods as occasion may require, till there are left upon the ground about fifty trees per acre; which will in all probability be when they are about eighty years old. They may then most properly be left for a period of other twenty years, which would make them about one hundred years old, at which age they will be suitable for any purpose for which large oak is required. In all cases where it is considered necessary to take out the roots of large trees in order to convert the land into agricultural fields, the roots should be taken out with the trees at the same time they are taken down. By this means a great advantage is gained, by having the tree as a lever for lifting the roots out of their places; consequently, the work can be much cheaper done than if the trees were cut over by the surface, and the root allowed to remain till the trenching of the land took place.

There is also the case of neglected hardwood plantations to be taken into consideration; and, indeed, cases of this nature too often come under the observation of the forester who may have extensive practice. I have often had to deal with plantations consisting of hardwood and firs, mixed and growing together in the proportions formerly mentioned, which had never been thinned up to the time that I examined them—and they were then thirty years old. The hardwood plants were then about ten feet high, and from two to three inches in diameter; and the firs, which had grown rapidly, were large massy trees, fully thirty feet high. On consideration, I concluded that no remedy could be used in order to recover the hardwood plants, seeing they had been so much stunted and crushed down. There was, indeed, one way in which they might have been made to grow to advantage, but it must have been at the expense of the firs; but as they were good trees, the operation would have been a decided loss to the proprietor. The only way to have saved them would have been, to have cut them all down to the ground, and to have made them all spring from the root afresh; but in order to have given them a proper recovery, one half of the firs must have been sacrificed. In several instances where I have had to deal with plantations consisting entirely of hardwood plants, so old, and so much drawn up together from the want of thinning, that they had actually become mere poles of thirty feet high, and not more than four inches diameter, I have cut the whole plantation over to the surface of the ground, because thinning was out of the question; and, in such cases, I have had an excellent growth of young trees from the old stocks, which, in ten years after, formed a first-rate plantation of trees, they having been all thinned out to regular distances in due time, and not allowed to rise too thickly again.

In all cases of neglected hardwood plantations, where it may be considered advisable to cut down the trees in order to cause them to send up fresh young shoots to form trees, care should be taken to see that the ground be made perfectly dry by a proper course of draining; for if this point be not attended to, disappointment may possibly be the result.

Wherever hardwood plantations are found to be in a bad state, from having been neglected for a period at or beyond thirty years, there is little hope of their recovery by any course of thinning, however cautiously it may be gone about, unless the trees evidently show symptoms of a sound constitution, which may be the case where the soil is good and dry. Therefore, in all such cases, unless symptoms of health be remarked in the trees, the proper and only way is to cut all down and plant anew; and if the situation be one exposed to the view of the mansion-house or pleasure-grounds, where a complete clearing away of the mismanaged plantation would cause a bad effect, a few of the best and healthiest trees might with propriety be allowed to stand for a time, in order to give effect to the landscape, until the young trees had attained a considerable size.

What I have said above, relative to the rearing up of hardwood plantations, is only applicable to them when grown for the sake of their timber; but upon proprietors' estates, hardwood plantations are more generally raised with the view of being ornamental upon the lawns and home parks, than simply for the sake of the value of their timber.

Every proprietor who lays out new grounds in the neighbourhood of his mansion-house, if no plantations exist upon those grounds at the time, will, in accordance with good taste, and with the view of affording shelter, plant extensively upon them. And every proprietor of sound natural taste will, in a case of this nature, plant the different sorts of hardwood, with the view of their becoming ultimately his permanent standing trees, and make up with firs, simply with the view of acting as nurses, until the hardwood sorts arrive at a size sufficient to insure their welfare, independent of the firs; and not plant firs in a body by themselves, in any plantation near the mansion, or in the grounds immediately in view, for these always give a place a mean and highland appearance.

I am aware that many proprietors in Scotland, whose seats are upon high-lying and rather moorland districts in the country, are of the opinion that hardwood trees will not grow with them to a size worth cultivating with the view of becoming ornamental lawn-trees. Upon this point, my experience points to quite a different conclusion. In all high-lying situations in Scotland, where the Scots and spruce firs are found to succeed well—the former on the heights and the latter in the hollows—the beech, oak, elm, and ash will thrive well also, and become trees of no mean magnitude. This I have observed in Aberdeenshire, and other northern parts of Scotland, as also on the highest-lying districts in the south of Scotland and north of England; therefore no proprietor, if he can produce upon his estate Scots firs of good size, should hesitate to plant the kinds of hardwood trees above named. All that he has to do, in order to insure success, is to plant firs as nurses along with the hardwood, and remove them by degrees as the others advance.

It is allowed by all people possessed of good natural taste, that firs, when planted in a mass, and forming a plantation near to a gentleman's mansion, without a proper body of hardwood trees, give that place a cold, heavy, alpine appearance, although it may be situated in the most fertile part of the country. And it is my opinion, that every proprietor of land should endeavour, as much as possible, to cultivate all the different sorts of hardwood within the range of his home parks, which will give his grounds a fertile and cultivated aspect, although the situation he may occupy be naturally one of an opposite character. All fir plantations should be kept out upon the poor high grounds of an estate; and by the arrangement of having the hardwood trees in the centre of the property, and the firs upon the outer grounds, the whole will have a most natural and imposing effect.

Wherever a young plantation is made of hardwood and firs, with the view of their ultimately becoming ornamental lawn trees, they should, in every respect, be treated in the same manner as already advised for forest hardwood trees, until they arrive at the period when they require to be thinned for the first time. The hardwood which are intended for lawn trees should also be brought into shape by receiving a judicious pruning previous to being thinned for the first time, as has been advised elsewhere; and when those which are intended for lawn standards are thinned, they should have, at all stages, much room and space to spread out their branches and develop themselves according to their nature, which is the state in which trees always appear to best advantage. In order to allow the young hardwood trees to attain their natural shape as much as possible, the firs which may be planted about them should be kept well off them, and never allowed even to touch their branches, but placed so as merely to stand by their sides, and give the benefit of their shelter. As soon as they approach each other too closely, the firs should at once be sacrificed. At the same time, however, care must be taken that this is done gradually; perhaps looking over and taking out a few firs every year, as occasion may require, and as the hardwood trees advance.

The great art in rearing up hardwood trees for lawn scenery is, first, not to prune off any branch after the trees are fairly established in the ground, and about eight or ten feet high. Second, the firs, which act as nurses, should never be allowed to spread themselves upon the branches of the hardwood, but should merely stand by, for the sake of shelter. Third, observe what sorts of hardwood trees appear to thrive best upon the ground, and encourage those most which appear to do best; and, at the same time, wherever any particular sort of hardwood does not appear to do well upon the soil, leave firs in their place: a few good specimens of firs look well among hardwood. Fourth, when the hardwood trees have advanced so as to require all the firs to be removed to give them room, and when they begin even to encroach too much upon each other, cut out several of them also, and continue to do so until the trees have attained the age of from forty to fifty years, after which period it will not be found necessary to thin much, if they have been well attended to previously. Fifth, in the act of thinning out trees intended for park and lawn scenery, care should be taken that picturesque openings be made here and there, for the sake of distant objects to be seen from the mansion; such as a particular plantation upon a height, a romantic view of an old ruin, or a sheet of water in a neighbouring hollow; all of which are beautiful objects in landscape scenery, and should never be hidden from the mansion and grounds of the proprietor; for, however beautiful trees may be in themselves upon a lawn, they form but a dull and monotonous scene if well-chosen openings be not left among them, through which other interesting objects may be seen.

SECTION V.—REARING UP AND THINNING OF OAK PLANTATIONS.

The oak being the most valuable of all the timber-trees grown in Great Britain, is generally cultivated with more care and attention than any one else; therefore I consider it necessary and proper to treat of the manner of rearing it under a distinct head.

Three different systems of rearing young oaks are practised among foresters of the present day, each of which is advocated and upheld by a considerable number of practical men, who put each his own system into operation according as his views of the matter direct him, without paying due consideration to place and circumstances.

The three different systems are these:—First, that of sowing the *acorns* or seed at once upon the ground where it is intended the trees are to grow up and become timber; Second, that of transplanting the trees from the nurseries in the usual way, and, in one year after being planted, when their roots are established in the ground, cutting each tree over by the surface of the earth, and allowing the *stump* so cut to stand for two or three years, when a number of young shoots are produced immediately from the earth, strong enough to allow a choice to be made of one to stand for a permanent tree when all the others are destroyed; and, Third, the system of planting the young trees in pits, as is usually done, and allowing them to come away in their own natural way. Each of these systems has its peculiar advantages and disadvantages; and, in order to point out these clearly, and in such a manner as to render the statement of them practically useful to the forester who wishes information, it will be necessary to make a few observations upon each of the systems referred to.

With regard to the first—namely, the system of sowing the *acorns*, or seed of the oak, at once upon the ground where it is intended the trees are to grow up and become timber—this is undeniably acting according to the laws of nature, to which we ought always to attend in the rearing of forest trees. Those who advocate the general introduction of this system say, that the best specimens of oak trees to be found in Britain are those sown by the hand of nature. But this assertion seems to be far from fully authenticated; for, of the many famous oaks mentioned in the history of our country as having existed until lately, it is uncertain whether they were remains of an old natural forest, or whether they may have been planted artificially by the hands of man. The managers of the Government forests in England have adopted this method for the rearing of their oak for the supply of the navy; and I understand that the trees so raised are doing well, and likely to become trees of the first magnitude; but still, I am not aware that they are succeeding better than transplanted trees would have done, had they been planted instead of the acorns at the same time. I have sown acorns in forest grounds, with the view of ascertaining if plants raised in such a manner did grow much more rapidly than those brought from the nurseries and transplanted in the usual manner; and from what experience I have gathered upon this point — which, be it understood, has been but upon a small scale, (upon five or six acres of ground,) where they were merely intermixed among transplanted trees, the experiment being made simply with the view of satisfying myself as to the utility of the system—I am convinced that the trees, raised from the *acorn* sown in the forest ground, grow for the first few years more rapidly than the others, and are brought into proper form with very little artificial aid as regards pruning; but I have found also, that where much game exists, as is almost always the case upon gentlemen's estates, it is almost an impossibility to get the young tender shoots of the plants, as they rise above the ground, kept from being eaten down by hares and rabbits. Some years ago I was very much inclined to commence the sowing of acorns in all our plantations where oaks were required to be raised. Being convinced, from a former trial in another situation where I was, in which I was very successful, that they, when got up without any damage befalling them, formed the handsomest and fastest growing specimens, I was the more bent upon making another trial upon an extensive scale. Having communicated the scheme which I then had in view to an old forester of forty years' experience, asking his opinion previous to making the attempt, he advised me strongly not to sow acorns immediately in forest ground, with the view of raising trees in any new situation, until I had proved the utility of the system by sowing first upon a small scale. Acting upon his advice—for he was a man of the soundest judgment in all forest matters—I sowed *acorns* in pits dug by the spade for the pupose, and had the pits, in the act of making them, well cleaned from all root-weeds, so as to give them every chance of success; and the soil being a fine dry sandy loam, I calculated upon success. I sowed the seed in the month of February, and, upon looking over the ground in a week or two afterwards, I was mortified to find that rabbits had visited the fresh earth of the pits before me, and had fully one-half of them burrowed through. On looking for the acorns, I found the shells, indeed, but the mice had eaten the kernels; and on examining the state of the pits generally, I found that very few of them had escaped the ravages of vermin of some sort or other: I even caught pheasants in the very act of scraping up the acorns. On seeing all this, I was indeed thankful to my old friend, the forester, for his cautious advice, and was also happy that I did not sow extensively upon ground which was so much overrun with game and other vermin. As I had sown only about an acre of ground in the manner above stated, I could indeed easily have prevented the ravages of the larger animals, but against those of the mice there was no possible resource. Therefore, this being only a trial upon a small scale, I determined to give nature her own way in the whole business, and consequently did not go back to inspect the state of the pits in which the acorns were sown till about the middle of May, when I found great difficulty in tracing out the exact spots where they had been sown: the grass and weeds which were natural to the soil had grown rapidly, and almost hidden the red earth. I immediately had the weeds, &c., all cut away from about the pits, and at the same time had the surface of the pits weeded by the hand; but there was no appearance of any oaks as yet in them. About the middle of June I again had the surface of the pits weeded, when I observed about twenty young oak plants rising upon a whole acre of ground; and before the autumn, there were none left excepting two, which I protected, which are indeed doing well now, but not a great deal better than others transplanted about the same time, in the usual manner, from the nurseries.

Besides what I have detailed relative to my attempt to rear oaks from the acorn in the natural forest ground, I have also since sown in many places of our woods without digging the ground at all, merely paring away the turf from the surface of the ground slightly, and then putting in the acorns with a common garden dibble; and I did this with the view of disturbing the natural soil as little as possible, thinking that the rabbits and mice would not be tempted to burrow in the soil when they found it firm. The ultimate issue, however, was the same; for what plants were allowed to come above ground, and had escaped the ravages of the mice and pheasants, were greedily sought after and devoured by the hares and rabbits when they came into leaf. Therefore, in the mean time, and until I have further experience upon this point, I am induced to think that the system of rearing oaks at once from the acorn in the forest ground, is not at all adapted to the present state of forest lands. I confess that I am convinced of the propriety of raising trees in the forest at once from the seed, in order to have the best specimens of timber trees; but it is very likely that a period of fifty years must elapse before our forest grounds are put into a proper and fit state for raising trees to advantage by such a system. Were it practicable to have all our forest ground ploughed and cleaned in the same manner as in agricultural operations, I would unhesitatingly say, that all forest trees ought to be raised from the seed at once sown in the ground they are intended to occupy; but until then, the system is quite impracticable.

I conclude my observations upon this head by remarking, that the *advantages* of the system in question are, that the trees so raised never receive any check in their growth, as must be the case with all transplanted trees: they grow much quicker, and come sooner to the size of trees, than those raised by transplanting; they grow taller in habit from not having their *tap roots* cut, and are seldom found to require much pruning, as is the case with the others.

The *disadvantages* of the system are, that the seed, when sown in a detached form in pits in the common forest ground, is extremely liable to be destroyed by vermin before it vegetates; while, after the plants appear above ground, they are in equal danger from hares and rabbits eating them over. They are also liable to be destroyed from the effects of rank-growing grass and other weeds choking them while in their young and tender state; and in order to avoid this, much expense is incurred in keeping the plants clean. Trenching the ground for the reception of the seed would be the proper plan; but the expense of such an operation, to any extent, puts it out of the question.

I now proceed to the second system of rearing the oak when young—viz., that of transplanting the young trees from the nursery into the forest ground; in one year after, when their roots are fairly established, cutting them over by the surface of the earth; and when a number of young shoots are produced from the stumps, choosing the strongest and healthiest for a permanent tree in each plant.

This system is very much practised by foresters who have to raise hardwood plantations in high-lying districts of Scotland, where it is well known that young hardwood plants are apt to suffer a severe check when newly lifted from a sheltered nursery, owing to the cold cutting winds which prevail in such quarters. Indeed, in all cases, young hardwood trees which may have been reared in some of the public nurseries near large towns, when they are removed to, and planted in, a high moorland county, seldom do much good for three or four years after their removal. The whole part of the plant situated above the grass or foggage of the ground becomes stunted, and gradually dies down to within two or three inches of the surface, which part remains fresh, because sheltered by the foggage from the winds; and, indeed, if the plants are left to themselves in such a situation, they, about the third year after being planted, and after the roots have properly established themselves, send up a number of young shoots from the live part about the surface of the ground, which young shoots ultimately become trees of inferior magnitude; but if those young shoots be thinned out to one individual, a tree of the usual magnitude will be the result. Now, this system of cutting over is only assisting nature; and if, instead of allowing the young trees to lie dormant for three years, as is the case when left to nature, the forester cuts each tree over by the surface one year after they are planted, he places himself by his art two years in advance of nature as left to herself; for as soon as the trees are cut over, they each send up from three to six vigorous young shoots, which, when they are of sufficient age, can be removed, with the exception of one, which is left as a permanent standing tree. I have, by adopting this method, had strong vigorous young shoots of two feet high the second year after planting; while, where I have not had them cut over, four or five years elapsed before I had shoots of the same strength.

I was acquainted with a forester who had the management of extensive plantations in Aberdeenshire, who, upon receiving his young hardwood plants from the nurseries, of whatever species they were, cut each down to within three inches of the roots, and planted them in this state in the pits which were prepared for them in the forest. His reason for doing so was, that he asserted he gained young shoots a year sooner than if he had allowed the plants to remain for one year in the ground previous to being cut over, as is the usual way. But upon examining the state of his young hardwood plants, which had been planted one year before I visited him, and inspected his system of going to work, I found that all his young trees which had been so cut previous to planting them, produced but very weak shoots the first season, and, as I apprehended, they in fact made no vigorous growths till the second year. In this case, therefore, something was lost instead of gained; for until the roots of the young plants are fairly established, very little young wood can be produced. The plants require the first year in order to establish their roots; and if they are forced to make wood during that year — as is the case when they are cut over at once—the wood seldom or never ripens, but is weak, and apt to be nipped by the first frost of winter; but when the plants are allowed to have their own natural way for the first season after being planted, and when the stem is allowed to remain and push out a few leaves in order to elaborate any sap drawn up by the roots, these roots become during this period properly and firmly settled in the earth, and are rendered strong and vigorous for being called into action the year following. Hence it is that young trees cut down the year after being planted always make more vigorous and stronger shoots in that one season, than trees of the same character cut down when planted, and having two years' growth upon them.

In conclusion, this system ought always to be practised with oak, or indeed with any other hardwood plants, when planted out in a high district, and after being removed from a sheltered nursery; but in no other case is it necessary.

The third system of rearing the oak when in its young state, as formerly mentioned, is that of planting the young trees in pits, as is usually done, and afterwards allowing each to come away in its own natural way.

This is the system practised in all moderately sheltered districts for the planting of oaks as well as all other sorts of young trees, and need not be enlarged upon here. I may mention, however, that in all moderately sheltered districts, young trees of any sort receive very little check from being transplanted, if they are not above four feet high, and if the soil is one adapted for the growth of the trees planted, and the work carefully and properly done; but if the soil is not of first-rate quality, and if the situation is one much exposed, the trees always receive a violent check, and, consequently, the bark upon the young trees becomes hide-bound, and will not carry on its natural functions; but the roots being as healthy as formerly, they, when the old tops are gone, send up young shoots to supply the place of the former, which, as they grow up, become habituated to the climate and situation, and consequently form trees adapted to it. Therefore, the planter, when he meditates to bring up a plantation of young oaks or other hardwood, must judge for himself as to which of the two last-mentioned systems he should adopt; and that, of course, must be regulated by his grounds being exposed or sheltered.

Many different opinions continue to prevail among foresters as to the distance at which oak trees should be planted at the offset, where it is intended to rear up an oak forest. There is no doubt that a difference of opinion will still continue to prevail, according to the views of the proprietor and his forester conjointly; but this does not form a definite answer to the question which has often been put to myself by proprietors—namely, At what distance ought oak trees to be planted with the view of realising the greatest possible profit from the land in the shortest possible time after planting?

This question cannot be answered to all proprietors alike; for in one neighbourhood young oak trees are of considerable value, and in another they are comparatively little; in one neighbourhood young larch firs are of more value than young oaks as thinnings, while in others the reverse holds good.

In the rearing of oak plantations in exposed parts of the country, where these do not grow rapidly, it is absolutely necessary, for the protection of the young oaks, to have a considerable quantity of firs among them, and that, too, till they are considerably advanced; while in more sheltered districts, where there is little doubt of the oaks growing rapidly, fewer firs are required. In the laying down of oak plantations, I am myself in the habit of taking all the above points into consideration; and from having had experience as to the growing of oaks in almost all possible situations, I find that, in order to grow the oak to advantage, it is necessary that every forester should do the same, and by no means go to work according to one set of distances. It is in this way that these differences of opinion relative to distance have arisen; for every experienced forester finds that one system of going to work will not answer all parts; and, judging for himself, he acts accordingly: while, on the other hand, the man without experience advises to plant in all cases according to one set of distances, and the natural consequence is, that a failure is as likely to be the result as a crop. Having premised the above, the determination of the question relative to distance will now be more easily understood, and I shall answer it according to my own method of practice in different situations.

When a proprietor meditates planting a part of his grounds in the form of an oak forest, without any mixture of any other sort of hardwood, let him first ascertain if young oaks, when cut down in the process of thinning, will sell to advantage in his neighbourhood, and if they will pay him better than any other sort of wood of the same age. We shall suppose that young oaks, of the size generally termed spoke-wood, sell well in his neighbourhood; therefore, in such a case, I would advise him to plant the young oak trees at seven feet apart, and make up the ground with firs to three and a half feet between them. By the time that the firs are all taken out and the oaks properly brought into shape, they will be very valuable as spoke-wood, independent of the bark. For coach and cart spokes I am in the habit of getting, for the former twenty-two shillings, and for the latter thirty shillings, per hundred; this giving nearly two shillings and sixpence per cubic foot of the cut wood, which is nearly double the price that could be received for larch wood of the same age.

Again, if on full consideration it is found that oak in the young state above referred to—that is, from twenty to twenty-five years of age—will not sell well in the neighbourhood, while larch as thinnings will be much more valuable, then plant fewer oaks per acre, say at ten or twelve feet apart, and make up with firs to the proper distance. In this way, by the time the larches, &c., are all taken out, the oaks will be of a pretty large size, and fit for many valuable purposes, before the cutting of any of them is found necessary.

Again, where it is found practicable to have an oak forest in an exposed part of the country, it will be necessary to plant a good many firs among them for the sake of producing shelter through the whole plantation, until the oaks have arrived at a good size; and in a case of this nature, from ten to twelve feet is quite wide enough for the distance between the hardwood plants, making up with firs in the former instance to three and a half feet over all; and in the latter, that is at twelve feet apart, making up to four feet over all. In the same plantation I very frequently plant at both of the distances above mentioned—that is, in exposed parts of a wood I plant the oaks at ten feet, and make up between them to three and a half feet over all; and in more sheltered parts of the same plantation I plant the oaks at twelve feet, and make up with firs to four feet.

The above, which is my own system of going to work as regards distance, will, I think, form an answer to the question formerly quoted; and it now remains for me to enter a little into the practice of rearing up such a plantation as I have pointed out above.

Suppose that a tract of ground has been planted with oak at ten feet apart, and the intermediate spaces made up with firs to such a closeness as to leave the whole plauts over the ground at three and a half feet distance, the oak trees will, when the plantation is about eight years old, require to be carefully looked over, and pruned in all cases where found necessary, but not severely; for the oak, at no stage of its growth, agrees with much pruning: the wood is of a hard cross nature, and any severe wound made by the knife is not easily healed, even although the plant is young; therefore, pruning should be sparingly practised upon them. All that is necessary at the stage above mentioned, is to prune away one top in all cases where two exist; or where more than two tops appear upon one individual tree, to choose the best, and prune away all the others; to lop off a part of any strong branch that may have the appearance of gaining undue strength upon the regular proportions of the tree; and to clear away any small spray shoots from the lower part, so as to form a clear stem or bole. If this pruning is properly done when the trees are about eight or ten years old, when the wood is in its softest state, no damage will be done; and if the work is properly done at this stage, little or no pruning will ever be afterwards required.

The oak not being a rapid-growing tree at any stage of its growth, as compared with many other sorts of hardwood trees, the young plants will not, at eight or ten years' standing in a plantation, have attained a large size, probably not above six or eight feet high; but if the firs which were planted among them for the purpose of giving shelter have thriven well, the oaks will be deriving benefit from their shelter, and progressing rapidly. In fact, young oaks never do come away well until the firs rise up around and afford them shelter; more especially if the situation in which they are planted be an exposed one, or the soil naturally of a cold bottom. As an instance of the great advantage gained by planting firs among young oaks, in order to shelter them in their young and tender state, and to bring them away as rapidly as possible, I may mention a case which I witnessed myself in one situation where I acted as assistant forester. There we had about twenty acres of rather stiffish clay ground converted into a plantation, situated upon what was considered rather a level and sheltered part of the country, although there was no other plantation near it. The ground was fenced by a young hedge all round, protected by a three-barred paling; and as the proprietor wished the plantation to be one of oak, without any admixture of other trees, the ground was planted entirely with oak plants in the usual way, at three feet apart, and without any firs whatever to act as nurses. The oaks thus planted remained in a dormant state for three years after they were planted: not only did they make no young shoots whatever, but, on the contrary, fully one-third of the plants died out. On seeing this state of things, the forester thought that the whole would turn out a failure upon his hand—set us to work, and had fifteen hundred Scots fir plants planted to the acre, mixing them regularly among the oaks. In two years after this planting of the Scots firs, or five years from the time that the oaks were planted, the former began to make considerable shoots, so as to give a little shelter over the surface of the ground. The oaks now began to throw up healthy shoots from the tops of their roots, or rather at that part where the roots are thrown out from the stem; and in many instances where it was thought that the young plants were dead, they sent up excellent young shoots as soon as shelter was produced. In fact, after this period, the whole plantation throve remarkably well, and the oaks kept pace with the firs during all the time they stood among them; but in a few years they were mostly cut down again in order to give the oaks room as they advanced.

From this example I would draw the attention of the planter to the great necessity in all cases of planting firs among oaks in order to nurse them up while in their young and tender state, the firs being thinned out by degrees as the oaks advance in strength.

Having pruned the young trees in the plantation of oaks in the manner formerly referred to, and that two years previous to any thinning of the firs from among them being required, the next step in the rearing of such a plantation is to thin away any firs as soon as they encroach upon the oak plants. This thinning, in the rearing up of oak plantations, must at all times be more severe than when thinning away firs from among the common kinds of hardwood. And, indeed, this particular forms the only difference worth mentioning between the cultivation of the oak and the cultivation of hardwood in general; that is, the oak trees, after they are once properly established in the ground, and brought into proper shape by a judicious pruning, must, through the whole course of their culture afterwards, have more room and air than any other species of hardwood trees. The reason of this difference as regards the cultivation of the oak is this:—The oak is a valuable tree both on account of its wood and bark: the wood is more valuable when grown of proportionable diameter than when of great length, and it is also of more durable quality when freely exposed to the air than when drawn up weakly and to a great height: thence arises the necessity of giving the trees free circulation of air in order to have valuable wood. The oak is also valuable on account of its bark, as I have already mentioned. Now, in order to produce bark, a tree must have extent of wood, whether that be in the form of trunk or branches. I have seen an acre of oak trees, one hundred years old, cut down and sold for the sake of both wood and bark, which had been cultivated upon the principle of drawing up the trees tall and without branches; and according to my note-book, which contains an account of the transaction of the sale, that acre of ground, which contained two hundred trees, sold for £360. On the other hand, upon a neighbouring estate I attended a sale of oak trees only ninety years old, and which had been cultivated on the principle of giving free air and room to the trees as they advanced; and upon one acre of ground, which contained a part of those trees sold, I counted one hundred and four trees, which brought altogether £868;* making the oak trees which were cultivated upon the principle which I have recommended—namely, that of giving free air and room—nearly three times the value of those which were drawn up weakly. When oak trees have free room for expanding themselves, the lower branches form into bends for ship-building, which is a valuable object. The trees also being more branchy in themselves, possess a greater surface for the production of bark; and the bark itself, having free air, becomes thick and heavy upon the tree. It is perhaps not generally known that oak bark produced upon trees having free air about them, weighs almost double that of an equal surface taken from a tree confined and not having air; and, at the same time, bark of such weight is always more valuable, because containing a greater proportion of tanning matter.

What I have here said relative to the cultivation of the oak, I regard as sufficient to convince any proprietor of the necessity of keeping his oak forest thinner of trees than any other of his woods. I need only add, in conclusion, that in every other respect oak plantations are to be managed upon the same principles as other hardwood ones. Oak trees are never reckoned of full age till they have attained from eighty to one hundred years; therefore, after a plantation of oaks has received its final thinning, it should be allowed to stand until that age before cutting down.

* This was in the year 1820, when oak wood and bark were both selling very high; and the soil being very favourable, it was an extreme case of the value of oak.

CHAPTER V.

Management of Coppice-wood generally—Management of Oak Coppice-wood—The drying of Bark used for Tanning.

SECTION I.—MANAGEMENT OF GENERAL COPPICE PLANTATIONS.

THE raising of coppice plantations is, of all others, the most simple, and requires the least practical knowledge in the forester. Excepting oak coppice, this sort of forest cropping is seldom cultivated in Scotland; whereas in England it is very much cultivated, and forms in many counties the principal crop grown in the form of wood. This is the more necessary, particularly in those inland counties where all kinds of fuel are scarce; there, where neither coal nor turf can be easily got, the inhabitants must resort to wood as a substitute; and, in such cases, all small rubbish in the form of wood becomes of importance.

In many parts of England, all hedge prunings and small twigs from the branches of larger trees are carefully gathered up and disposed of in the form of faggots for firewood; while, on the other hand, in Scotland and in the north of England, where coal and turf abound, such small wood is considered useless, and is invariably burned up as mere rubbish. As, therefore, the growing of wood in the form of coppice is necessary in many parts of Britain, I shall devote the present section to a few remarks as to the best mode of growing the greatest possible quantity of coppice upon a given space of ground in a given time.

All coppice plantations must, in the first instance, be raised from young trees. The young trees, when planted for this purpose, ought to stand till they are from five to six inches diameter at the ground: this may be, according to the kind of trees planted, and according to the soil and situation upon which they are growing, at from fifteen to twenty years of age. In order to convert a plantation of young trees into coppice, it is only necessary, when they have arrived at the stage mentioned, to cut them over by the surface of the ground, when, in the following season, they will send up from each *stole* or *stock*, a number of young shoots, these constituting what is termed coppice-wood.

All trees do not equally possess the property of sending up young shoots from the *collar* of the *stock;* therefore, the choice of the kind of trees is to be taken into consideration by the grower of coppice-wood. The fir and pine tribes do not send up shoots at all when cut over, and the beech does it but slightly. The kinds of trees best adapted for coppice plantations, are the ash, elm, oak, poplar, willow, chesnut, lime-tree, mountain ash, maple, sycamore, birch, alder, hazel, and bird-cherry. These again, according to the uses they are generally applied to, may be divided into four classes—namely, First, *coopers' ware and bobbin-wood*—ash, elm, oak, chestnut, maple, hazel, and sycamore. Second, *charcoal wood*—birch, alder, poplar, lime-tree, and mountain ash. Third, *bark for tanners*—oak. Fourth, *basket-ware*—the willow. In the above division of the kinds of trees best suited for coppice, I have not included firewood, because all the sorts may be employed for that purpose, although not with like effect—the ash and birch being more useful than any of the other sorts; but as, in general cases, it is only the refuse of the coppice which is applied to the purpose of firewood, it is unnecessary to designate a class exclusively for that purpose. I may also state that, although I have mentioned mountain ash as being adapted for charcoal, it is one of the best also for coopers' ware; and although I have included hazel among those adapted for coopers' ware, it is also excellently adapted for charcoal. Similar differences of application might also be stated relative to several others of the trees. In what remains of this section I shall point out the best method for the cultivating of each division, so as to produce the greatest possible crop upon the ground.

In laying out a plantation with the intention of its becoming coppice, it is necessary to take into consideration what sorts of coppice-wood will sell to the best advantage in the neighbourhood; and having determined this point, the next consideration will be, whether or not the ground to be planted is of a nature qualified to produce the kind which is in demand. This I would particularly draw attention to; for to plant those kinds of trees which are not adapted to the soil, although it should be well known that they would sell well when of size, would be the most effectual way of defeating the end in view. For example, were ash, elm, lime-tree, or poplar, planted upon a dry thin soil, with the view of becoming profitable as coppice—or, on the other hand, hazel, mountain ash, or birch, in a cold damp, heavy soil—disappointment would assuredly be the result.

Having fixed upon the situation upon which trees are to be planted for coppice, have it laid off, fenced, and drained, in the same manner as has already been advised for other plantations where it is in view to raise large timber.

We shall suppose that a plantation of five hundred acres in extent is laid out for this purpose, and that it consists of various hilly tracts, with a thin, poor, yet dry soil, with also considerable portions of good loamy soil, and in the hollow swampy mossy parts, which have been effectually drained of all superfluous moisture;—we shall further suppose that all sorts of coppice-wood sell to advantage in the country in which this plantation is situated;—and by this means we will have the advantage of illustrating the whole system within the bounds of the one plantation.

First, then—In all the bare hilly parts, the soil of which is light, and not above four inches deep, plant, at seven feet apart, birch, mountain ash, and hazel, and make up between them with larch or Scots pine, to three and a half feet over all. The latter are to act as nurses for a time, in order that the plants which are intended for the future coppice may grow up the more rapidly, and come the sooner into use.

Second, Upon all the hilly parts which are less elevated than the first, the soil of which may be from five to eight inches deep, plant maple, sycamore, oak, and chestnut, at about eight feet apart, and make up between them with firs to four feet over all.

Third, In all the portions of good loamy soil, having an elevation less than either of the two former tracts, plant ash, elm, lime-tree, poplar, and oak, at from eight to ten feet apart, and fill up with firs to three and a half or four feet over all, according to the distance of the hardwood plants.

In planting the different sorts of trees in the different soils and situations above stated, each sort should be planted in a mass by itself, and by no means mixed, as is too often the case, to the great disadvantage of the crop in general. The latter system is the cause that, in general coppice plantations, where the kinds of trees have been promiscuously mixed in the first planting, we so often find so light a crop of the whole per acre upon the ground at the end of a given period. For example—were mountain ash, birch, and hazel, all mixed together in a coppice-wood, the mountain ash, from being a more rapid and luxuriant growing plant than either of the others, would very much retard their growth, and hinder the development they naturally would attain under different circumstances. This I have very frequently had occasion to observe; and from the experience that I have had upon this point, I may state further, were three acres planted with a mixture of the above three sorts, and other three planted each with one of the sorts separately, the latter would have, at the end of a given period, one-third more weight of wood upon it than the former. Trees are like animals: they, as it were, like to associate each with its own kind; and this is also observable in natural forests. There the best timber of any sort is always found where one sort prevails; while, on the contrary, where a mixture exists in the natural forests, few good specimens of any individual sort are to be found; and the very same holds good in most cases in the artificial forests of our own country. Many plantations are to be seen where several sorts of trees are mixed and come to full age; and in such cases it is invariably found that one sort has an ascendency over all the rest, both as to healthy appearance and general magnitude. I have seen numerous examples of the same thing holding good in coppice-wood plantations; and any proprietor or forester who may doubt what I assert here, has only to examine his own plantations, and he will there see its truth exemplified. In all cases, therefore, each sort of tree, which is meant to stand as a permanent crop, should be planted in a mass by itself, and that to such an extent upon the ground as may be considered necessary. When coppice plantations are conducted on the principle of growing each sort of tree in a mass, another important point is gained, namely, that of each sort answering a certain purpose better than another at a given period, and therefore each division will be found the more valuable to any purchaser who may wish to buy coppice of a certain kind and size. For example, were a man to come to a proprietor of coppice plantations, and say that he wished a certain quantity of hoop-wood for the market, of a particular size, and if the purchaser saw twenty acres of hazel all of the proper size for his purpose, would he not give double the sum for it per acre, seeing it was so equal, which he would do for other twenty acres of a mixed character, from which, very likely, he could not get one half of the wood to answer his purpose? The same may be said of oak coppice: a person might give a good sum per acre for oak coppice in a mass, while, if he found it mixed with other sorts for which he had not much use at the time, he might give comparatively little.

In planting the permanent trees, let the greatest extent be given to such sorts of hardwood as are known to be most valuable and most sought after in the market, in so far as the nature of the ground may be qualified to bring them to perfection; and at the same time, with regard to the firs which are planted for the purpose of producing a temporary shelter, let very few of them be of the evergreen sorts, such as Scots pines, or spruce firs, but give the preference to the larch, because it is of a light and airy habit, and not apt to draw up the hardwood trees as the more massy branches of the others are known to do. It is a bad feature in the management of young trees intended for coppice when they are drawn up tall and without proportionable girth. In converting young trees into coppice, it is most desirable to allow them to attain as much diameter at the *collar*, or that part of the trunk situated nearest the ground, as possible; therefore, with a view to this end, the plants ought by all means to be sheltered so as to make them grow rapidly, but by no means so much so as to draw them up weakly. Were the hardwood plants allowed to grow without the benefit of nurses, they would be some years longer in coming into use as coppice; and besides, the spaces between them would be a profitless business to the proprietor; but when firs are planted among the permanent hardwood, besides bringing them forward, they are of considerable value when cut down and sold as thinnings.

In high exposed parts, where the hardwood plants are likely to suffer from the effects of storm, about one-third of the whole number of the firs per acre may be Scots, in less exposed parts one-fourth; and where the ground is generally of a sheltered nature, the whole of the nurses may be larch.

In portions of the plantation having a good deep loamy soil, with rather a sheltered situation, or at least with the prospect of being well sheltered as the other parts of the plantation rise up, osier coppice may be made; but unless the soil be of a good deep loam, with considerable shelter, it will be in vain to expect a good crop of osiers from it. In laying down a piece of ground for the cultivation of osiers or willows, it is indispensably necessary that the ground be trenched to the depth of thirty or thirty-six inches; and before planting the willows upon it, it should have a good manuring, and be cleaned by a crop of turnips or potatoes being taken off it. When the ground has been thus trenched and cleaned, the next step is to plant the willows in rows from thirty to forty-eight inches apart, according to the kind to be cultivated; the plants themselves being from twelve to eighteen inches distant in the row, according as the sort cultivated may be of a small or large character; for there are many varieties in cultivation for basket-making, hoops, &c.

The willow plants must at all times be kept clean from weeds, and the ground dug regularly in the autumn or spring, or at least after the crop has been cut and removed. If this keeping of the plants clean be not attended to, the yearly weight of the crop, instead of increasing as it ought to do, will be found to decrease, as I have frequently seen to ensue where they were under bad management. No nurses are planted among this sort of coppice; for, the ground having to be dug between the rows of the plants, these could not exist.

In any hollow, swampy, or mossy part of the plantation, where, from the dull inert nature of the soil, the other sorts of hardwood would not succeed well, have alders or birch put in, from six to eight feet apart, according as the natural situation may be exposed or not. If exposed, have the ground between made up with Scots pines; but unless the ground have been thoroughly dried, the Scots pines will not succeed in such a soil. If charcoal do not sell well in the neighbourhood, ash, or even poplar, will succeed very well in a mossy soil; but, in the present instance, and for the sake of illustration, we shall suppose alder or birch to be the tree that is to be planted.

Having premised the above, relative to the disposal of the trees upon these different soils and situations, we shall now follow out the management which should be adopted during the growth of the trees to the period at which they are in a state for cutting over for coppice, and also state the manner of disposing of the crop as it comes to full age.

In rearing up a plantation of young trees for coppice, the forester must in this case, as well as in that of rearing up trees for timber, carefully guard against the hardwood plants, in particular, being choked by long grass, or any rank growths of weeds, during the first three years of their age: he must also be careful, as they advance, to have all firs taken away as their branches approach those of the hardwood. In this case, never allow the branches of the firs even to lie upon the points of those of the hardwood plants; for, if they are at all allowed to encroach, the latter will very likely be drawn up rather weakly, and, consequently, will not grow proportionably to diameter of trunk—the great point required in order to make a valuable coppice plantation.

Having attended very carefully to keep the firs duly off the hardwood plants, and having merely allowed them to stand by and give shelter to them for a time, the firs will, by the time the plantation is from fifteen to twenty years old, have been all removed from the ground, and at the same period, viz., from fifteen to twenty, or even twenty-five years, according to soil and situation, the hard-wood plants will be from five to six inches diameter at the bottom, but not of a tall habit, having intentionally been kept in a rather exposed state. When they have attained this size, they will then be in a proper condition for cutting over for the purpose of being converted into coppice *stocks* or *stoles*. I am aware that, in the cultivation of general coppice plantations, many are in the habit of cutting over the young trees at a much earlier period than that mentioned above; but such a system of management is decidedly injurious to the future bulk of the crop, and tends to weaken the stoles rather than to strengthen them. I am decidedly of opinion —and my opinion is the result of experience—that in moderately sheltered situations, the trees should not be cut over until they are as nearly as possible six inches diameter at the bottom: if cut over of a smaller size, the future crop will be proportionally lighter and weaker. By allowing the young trees to attain the size of from five to six inches at the base before cutting over, they will afterwards send up strong and healthy shoots, while these will also be numerous; but if cut over of a much smaller size, the shoots will be few in number, and proportionally weak.

Having fixed upon the time or period at which the young trees in a plantation should be cut down as a preparation for future coppice-wood, the next thing to take into consideration is the proper manner of doing the work.

Several methods are in practice among foresters. Some cut them down with the axe, and leave the stoles in the sloping form, represented in Fig. 92, this sloping position of the stole being meant to throw the water off it, and prevent rot from taking place. I object to this method, because, in the cutting over of a young tree by repeated strokes from an axe, the stole is much damaged, and apt to be split longitudinally; consequently, rot is sure to commence early. Fig. 93 represents another method frequently practised, which is, to cut over the tree by means of the saw, leaving the stole flat on the top.

FIG. 92.

FIG. 93.

I object to this method also; because, when they are cut over in this manner, from the circumstance of the stole being flat on the top, rain is sure to lodge upon it, and cause rot at an early age. Fig. 94 represents the form in which all stoles should be made which are meant to keep sound, and produce a healthy crop of coppice, and is that which is employed by all superior foresters. The following is the method of procedure:—

FIG. 94.

Have a young lad with a sickle, such as is used for cutting down grain, and cause him to go before the men who are to cut the trees, and clear away all long grass, &c., from the base of each tree to be cut. This he should do to the distance of about two feet all round each tree; and in doing this, he must be made to cut the grass as short as possible, in order that there may be no obstacle to having the trees cut low. When the boy has got the first tree cleared at the base, two men with a light cross-cutting saw follow him. The saw should first enter upon one side of the base of the tree, which, of course, should be the side to which the tree is intended to fall; and having cut at least two inches through upon that side, and about two inches up on the base of the tree from the ground, they then take out the saw, and cut the tree through from the opposite side.

My reason for not cutting the tree through with the saw from one side is, that when this happens to be done—and it is too often done—and when the tree has just begun to fall, the bark upon the side of the tree opposite to where the saw was entered, is liable to be torn away, with very often a part of the outer wood; and this will the more readily occur if there be a little wind blowing at the time; this almost invariably taking place before the men have time to cut the part clean through. Now, this evil can at once be avoided, by simply cutting, in the first place, a part of the base upon the side to which the tree is to fall. In this manner the boy, with the two men following, will prepare and cut down the trees, observing to cut each stole so that it may be, as nearly as possible, about two inches high above the surface of the ground. Next in order, there will be required another man with an axe, whose duty is to *snead* or prune the branches from each tree as it is felled; and the branches, again, as they are cut off, are to be assorted for different purposes, according to the local demand. These are, in general, fence-wood, ton-wood, fuel, besom-sprey, &c.; and the branches, as they are cut off and assorted, should be carried out to the nearest road in the plantation, and laid in convenient lots, each according to its kind, in order for sale: this sort of work can, in most cases, be performed by women and boys. The trees, also, as they are cleared from their branches, should be carried out to the roads, and assorted according to their sizes.

In this way the whole work of cutting down and carrying out the trees and their branches should be performed, taking care that the workpeople in the act of carrying out the wood do not put their feet upon the stoles; for by their doing so, the bark would very likely be broken from the edges, which would of course be injurious to them. The work of carrying out the wood should therefore be carefully performed; and, in order to see this done, a careful man should superintend it.

The trees being all cut, and their produce carried away, from a certain tract of ground, so as there need be no cause for apprehension of danger to the stoles, another man with a *sharp adze* will round the edges of each stole. In doing this, he must attend to go close down to the surface of the earth with the adze, taking with it both bark and wood, sloping it up neatly all round to the centre of the top of the stole. He must, at the same time, be most careful that the bark and wood have the same slope, for if this is not attended to, water may lodge upon the bark and cause rot there. He must also be cautious not to separate the bark from the wood.

All the work relative to which I have now been speaking, ought to be performed by the proprietors' own people, and not let to contractors, as is too often done, to the great hurt of the stoles, and consequently of the future crop of coppice. Another serious obstacle to the welfare of coppice-woods in England is, the bad practice that prevails of allowing purchasers of coppice plantations to cut it down themselves. Now, I beg to say that, in the articles of sale, the proprietors ought to reserve the cutting in their own hands, which would be greatly in favour of their woodland property.

What I have said above is only applicable to those sorts of trees, the wood of which is not used for powder charcoal, nor the bark for tanning. Of course, in the cutting of the trees and the preparing of the stoles, the same rules are to be observed in all cases. But the oak, the bark of which is an important article, must be peeled as the trees are cut down. (For a description of how this work is to be performed, see section headed *Peeling and drying of bark used for tanning.*) But even in the case of peeling, the wood must, in the first place, all be carried out to the road where the operation is to be performed. There is also the birch wood, the bark of which is used for tanning, and the wood for charcoal; and the alder, the bark of which is of no use, but the wood requires to be peeled before being sold to the powder manufacturers: the wood, after being peeled of its bark, sells at from 20s. to 25s. per ton, according to demand. Hazel and mountain ash are also much sought after by powder manufacturers: the bark of these two is useless; but the wood must be peeled, in which state it sells at the same price as the birch and alder. In all cases of making charcoal, it is not necessary to peel the wood for that purpose. At Arniston I have made a considerable quantity of charcoal for colour and paint makers; and as it is not necessary that it be of so fine a quality as when used for gunpowder, it is generally made from wood with the bark on. As many foresters may have occasion to make charcoal in the same manner as I have to do at Arniston, I shall here, for the guidance of those into whose hands this book may fall, give my method of proceeding; and as the system which I practise is the same as that detailed in the *Encyclopædia Britannica*, I shall quote the description from that work.

"The wood being collected near the place intended for the operation, and cut into billets, generally about three feet in length, the pits, or stacks, are generally formed in this manner:—A spot adapted to the purpose, of from about fifteen to twenty feet in diameter, of a conical form, is selected, and, being properly levelled, a large billet of wood, split across at one end and pointed at the other, is fixed in the centre of the area, with its pointed extremity in the earth, and two pieces of wood inserted through the clefts of the other end, forming four right angles. Against these cross-pieces, four other billets of wood are placed, one end on the ground, and the other leaning against the angles. A number of large and straight billets are afterwards laid on the ground, to form a floor, each being, as it were, the radius of the circular area. On this floor a proper quantity of brush or small wood is strewed, to fill up the interstices, when the floor will be complete. And in order to keep the billets in the same position in which they were first arranged, pegs or stumps are driven into the ground, in the circumference of the circle, about a foot distant from one another. Upon this floor a stage is built, with billets set upon one end, somewhat inclining towards the central billet; and on the tops of these, another floor is laid, in a horizontal direction, but of shorter billets, as the whole is intended when finished to form a cone. The whole is then coated over with turf, and the surface generally plastered over with a mixture of earth and sand. Previous to the operation of setting fire to the pile, the central billet in the upper stage is drawn out, and pieces of dry combustible wood substituted in its place, to which the fire is applied. Great attention is necessary during the process in the proper management of the fire, and in immediately covering up the apertures through which the flame obtrudes itself, until the operation be concluded, which is generally effected in the space of *three or four days*, according to circumstances. When the charcoal is thought to be sufficiently burned, which is easily known from the appearance of the smoke, and the flames no longer issuing with impetuosity through the vents, all the apertures are to be closed up very carefully with a mixture of earth and sand; which, by excluding all access of the external air, prevents the coal from being any farther consumed, and the fire goes out of itself. In this condition it is suffered to remain till the whole is sufficiently cooled, when the cover is removed, and the charcoal is taken away. If the whole process is skilfully managed, the coals will exactly retain the figure of the pieces of wood. Some are said to have been so dexterous as to char an arrow, without altering even the figure of the feather."

It will now be necessary to say something as to the management of the willow or osier beds; which, of course, has not been included in what has been stated with regard to the other coppice.

The ground for this crop of coppice having been trenched, dunged, and cleaned, and the willows planted in the manner formerly stated, they must, whether intended for the basket-maker or cooper, be allowed to remain uncut for two years, with the view of strengthening the stoles; but being cut over at the end of the second year, the crop produced from the stoles will be ready for the basket-maker one year after; that is to say, one years' growth is what is used by them; if the crop should be meant for coopers' hoops, growth of two years will be required. The best time of the year for cutting over the willow is the month of February. In cutting them over for the first time, three buds should be left from the bottom, and the cut should be made in a sloping direction; but at the after cuttings, the shoots should be taken away, leaving only the swelled parts from whence they issued. The willows as they are cut should be immediately carried off the ground, assorted into three sizes, and tied in bundles of two feet in circumference within a foot of the lower ends; in which state they are sold. When they stand two years and are fit for coopers' hoops, they should be trimmed from any side-branches, and tied up in bundles of six scores, in which state they are ready for sale. As soon as the crop is carried off the ground, it should be dug, and in the summer kept clean from all weeds.

We shall now suppose that all the trees which were planted with the view of becoming coppice-wood, have been cut over for the first time, in the manner which has been directed above; and shall now follow the progress a little in the coppice state, which is the end we have in view in the present section.

If the trees were all cut over in the months of February and March, (excepting the oak, which must be cut in June, for the sake of its bark,) the stoles will, by the middle of June, have sent up a large supply of young shoots from the collar all round. These are termed coppice shoots, of whatever kind the tree may be. In the autumn of the same year, the whole plantation which was thus cut over, will form a coppice of one year's growth. In England, where this sort of forest cropping is more extensively cultivated, such a plantation, at the period we are now referring to, is generally left entirely to nature; but this is by no means the proper way of going to work. Where it is intended to have valuable coppice, such plantations should have each stole thinned of all superfluous growths at the end of the second or third year, according to the rapidity and strength of the growths; but in general, we may say, that when the coppice is of two years' growth, each stole should be thinned out, leaving from three to six of the best shoots upon each, according to its strength, to bring them forward. This should be done to every sort of young coppice, excepting the willow, which we do not here take into consideration. Allowing, then, that the stoles in the plantation have all been thinned at the above period, and the thinnings, as cut out from each stole, sold for hamper and crate stuffs, much profit will be at the time derived from those thinnings, without taking into calculation the superior value to be derived from the future crop by such a method of procedure. As to the period at which coppice plantations should be cut over, no definite number of years can be stated as sufficient to bring them to a certain size. For example, taking the oak as a standard in our calculation, in Herefordshire oak coppice is as bulky at twelve or fourteen years as it is in Argyleshire at twenty-five years; and this points out that all depends upon the nature of the soil and the shelter. Besides, as to the time of cutting down the crop of coppice, much depends upon the nature of the demand for the crop; thus, in some parts of England, where much of the coppice is used for hamper, crate, and coopers' stuff, it is cut over at two and three years of age; in other districts, where much of it is used for hop-poles, it is cut over at four, five, and six years old; and in others, where it is used for fencing, and many other country purposes, it is cut over at from ten to fifteen years of age. In Scotland, again, where oak coppice is chiefly grown for the sake of bark and spoke-wood, it is left till it is from five to seven inches diameter at the base. At whatever age coppice may be cut over, the work should be done by the proprietor's own people, allowing the purchaser to dispose of the wood as he pleases.

In cutting over the coppice, the saw should in all cases be used where the shoots are above four inches diameter at the base; but when they are of a smaller size, they may very properly be cut over with the hand-bill, which should be kept in a sharp state for the purpose. In cutting away the shoots, they should be hewn closely in upon the swell at the base, and neatly rounded off, so as to present no inequalities or roughness for the lodgment of wet. At the same time, attention should always be given to keep the centre of each stole higher than the margin, in order to throw off the water and preserve them in a sound state. This can only be effected by the woodman, at every cutting of the coppice, dressing the stoles all round close to the earth; taking care, however, not to loosen the bark upon the tops of the roots; for if this be done, rot will be sure to take place there; nor should any earth be allowed to be put over the cut part, as this also would encourage rot.

In the course of time, when several cuttings have been taken from the same plantation, it invariably happens, under bad management, that the stoles extend themselves to an extraordinary size, spreading themselves wide in circumference, and becoming rotten and hollow in the centre. This state of things should be guarded against; and under good management it seldom takes place to any great extent, at least for a very great number of years. The only way to prevent it is, by cutting close to the old stoles at every period when cuttings take place, and being very careful to smooth over the whole, so as to prevent the wet from making lodgment upon it. In order to renew old and worn-out coppice plantations, the only sure and effectual way is to replant; and, indeed, this will be found in the end the most profitable way, at least in instances of extremely old coppice-woods. In all oak coppice plantations, I find, from experience, that no cutting should be allowed after the 1st of July—that is to say, if a healthy growth of young shoots is valued for a future crop.

I now come to say a little relative to the value of coppice-wood as a forest crop. This, of course, must in all cases depend a great deal on the nature of the soil and situation upon which the stoles grow, and also upon the management they may have received while in their young state. Much as has been said by some authors relative to the great profits arising from oak coppice, I have not myself found this species of crop nearly so valuable to the proprietor as that of rearing the plants to full timber size; and from this circumstance I am led to recommend to proprietors the rearing of timber plantations in preference to coppice ones. From the experience I have had in the sales of oak coppice, 30s. per Scots acre is about the average yearly rent of the land derivable from such a crop. Birch and alder coppice I have found to produce, at an average, about 22s. per acre; ash coppice, 48s. per acre. Coppice of a general mixed character I have never found profitable, seldom realising more than 15s. per acre per annum. The above valuations are taken from coppice cut down at periods between twenty and thirty years.

In some extreme cases, I have known oak coppice, at twenty-five years old, sell at £66 an acre; and I have seen alder and birch, at the same age, sell as high as £40: but these must be considered as extreme cases, and I have oftener seen them sold at a rate much more below the average I have given than these are above. In Lancashire, even though there is a great demand for coppice-wood stuffs in Manchester and Liverpool, the land under such a crop seldom produces above 30s. an acre to the proprietor, while much oftener it is from 15s. to 20s.; and that, too, upon land which, if put under good forest management for the cultivation of large timber, would without doubt realise three times the sum. Having myself witnessed this state of forest matters in England, I shall conclude this section by pointing out the manner in which coppice plantations might be converted into profitable timber plantations.

In the converting of any coppice plantations into one which is to be trained up as timber, the sooner after the cutting of the crop of coppice this is had in view, the better. The not having attended to this point is the cause that several coppice plantations, which have of late years been turned into timber ones, have not succeeded according to expectation; the reason of the failure being, that the coppice was allowed to grow up in the usual manner, and until the usual period for the cutting of it, before a selection of proper shoots was made for becoming ultimately timber. With the mistaken view of taking as nearly as possible a full crop of coppice shoots from the stoles before converting them into timber-bearing ones, some foresters have recommended the system of leaving, at the time of cutting down the coppice, only as many good shoots as will ultimately become timber trees upon the ground, at distances from twenty to thirty feet, and advising, at the same time, to allow all the coppice stoles cut over to bring forth another crop, while the shoots that are left are becoming timber; thus endeavouring to carry on both systems upon the same piece of ground, until those that are meant to become timber are large enough to fill the ground themselves. Than this, no system could be more certain to frustrate the end in view.

How can the shoots of trees be expected to succeed so as to form timber, which are for a number of years confined in a close plantation, and all at once suddenly exposed, as is the case when they are chosen to stand, and all the rest of the shoots which formerly sheltered them are cut away? We might as well expect a child to grow up to healthy manhood, who, from being closely confined in a room, was at once taken out and set down upon a bare moor. Unreasonable as this system must ever be, it is, notwithstanding, frequently practised—of course, to the sure failure of the trees so dealt with. I have seen this system practised in England; and, from receiving such bad treatment, the trees, of course, were in an unhealthy state, while the cause of the unhealthiness was not attributed to the system, but to the bad character of the soil.

The only sure way of converting a coppice plantation into healthy standing timber is this:—When the regular coppice has been thinned for the first time, say at three years old, have in view the raising of a regular portion of the best of the shoots for ultimate timber; and with this view, thin out all the weakly shoots and such as are badly formed, and leave none but the choicest, and those rather thinner upon the stole, than if the plantation were merely thinned with the intention of its remaining under coppice. Having thinned the coppice rather severely at three years' standing, at six years let it receive another good thinning, by taking away from each stole the worst of the shoots, leaving none but the best, and not more at that age of these than from four to five upon the most healthy of the stoles. At ten years of age give another regular thinning; at about fifteen, a fourth; and at twenty years, there should upon no stole be left more than one shoot, which is designed to be trained up as a timber tree. After this period, such a plantation may be treated exactly in the way which has already been directed for hardwood plantations. The advantages of this system are evident. First—the trees are trained up gradually and naturally, and never suffer any check; second—a better selection can be made, from there being a continual choice of shoots at the command of the forester as they grow up at different stages; and third—by this method of selecting and training up, the plants, or trees as we may term them at twenty years old, will be twice the size that others would when merely chosen from the body of a thick coppice-wood and exposed all at once; and by the time that they are thirty years old, they will be three times as large, and, I may also add, three times more healthy and valuable.

As cases may occur where proprietors may wish to convert a coppice plantation of some years' growth into a timber one, I may state for their guidance, that at whatever age they may wish to do this, they should never commence to cut down suddenly, and expose the shoots they wish to rear up as trees. The only sure way in a case of this kind is, to select the very best of the shoots at proper distances from one another, and have them pruned and kept clear from the other shoots upon the other stoles. Those also should alone be selected which appear to come away from the earth, and not those which have the appearance of coming away from the collar of the stole; for such never will come to make good trees. As those that are made choice of advance in size, give them room gradually, and eventually a good standing timber plantation may be formed in this way, cutting away all the rejected shoots betimes, in the same manner as in the case of thinning away nurses from among young hardwood trees in any other timber plantation.

Upon the estate of Arniston we have oak coppice shoots, somewhat above forty years old, measuring forty feet high, and three feet in circumference five feet from the ground.

SECTION II.—MANAGEMENT OF OAK COPPICE.

Plantations of the description termed oak coppice are now so common in Scotland, that there are few landed estates of any considerable extent upon which there is not less or more of them. In the West Highlands there are many extensive plantations of this kind; and within the last thirty years many fine old oak forests have been cut down in the midland counties which also are, for the greater part, now converted into plantations of this description—being trained up from the young shoots which have arisen from the stocks of the old trees that were cut down. Seeing, then, that this description of wood crop is on the increase upon the estates of landed proprietors, it may not be out of place here briefly to detail the best modes of its management, more particularly with the view of pointing out the most profitable manner of going to work in the converting of old oak forest ground into healthy young coppice-wood.

When a plantation of old oak trees is cut down, and when it is the intention of the proprietor to convert it into a coppice-wood, for the purpose of raising a crop of oak bark upon the ground, the work must be proceeded with in the following manner:—First, the whole of the wood of the original trees, when cut down, should be removed immediately, as also all the bark taken from them, in order that no damage may be done to the young shoots as they arise from the newly-cut stocks; for, if the wood be allowed to lie long upon the ground after it is cut, the young shoots will have grown to a considerable height, and they, being extremely tender, will be easily broken in the act of removing the wood at a late period. In order, therefore, to prevent this taking place, if the wood have been sold to any neutral person, say about the 1st of May, he should be bound by the articles of sale to have the whole of both wood and bark removed by the 1st of July at the latest. If this be not done, much loss will certainly be sustained in the after-crop of the coppice-wood, seeing that it is impossible to remove heavy timber from the ground without rolling it over the suckers in their tender state.

This part of the work is always best done by the proprietor's own servants, and under the superintendence of an experienced forester; because, in such a case, the people who cut the wood are paid by the proprietor, and being so, will look more to his interests, or at least will attend more to the orders given them, than strangers from a distance would do, whose only interest is that of getting the wood cut down at as little expense as possible, without any regard to the future value of the plantation. It is also necessary to notice here, that in cutting down any large oak tree, the stock of which is intended to push up young shoots for the formation of coppice, great care is necessary to see that the bark is not injured below that part where the tree is cut over; for if the bark be hurt and ruffled there, so as to separate it from the wood, moisture will be lodged between it and the wood, and, consequently, rot at that part will be apt to take place. In order to prevent this, it is always a good plan, previous to commencing the operation of cutting down the trees, to employ a cautious trustworthy man to go before the wood-cutters, who, with a *hand-bill* and wooden mell, should be instructed to cut the bark right through to the wood, in the form of a ring all round the circumference of the tree, about three inches above the surface of the ground. This first ring being cut all round, another should be made in like manner about twelve inches higher up on the boll of the tree, when the piece of bark situated between those two cuts can be removed, and the woodmen made to saw each tree across exactly by the lower mark, or bottom of the peeled wood. This forms a guide to the men not to injure the lower part left with the bark upon it, as well as, when any difficulty is experienced in bringing the tree down, avoiding all waste of bark.

As soon as the wood and bark have been removed, all rubbish and useless underwood should be carefully cleared away, excepting any young healthy shoots, or young plants which may be considered worth leaving upon the ground, with the view of their ultimately becoming trees. And immediately after the ground has been cleared of rubbish, the stocks or stools of the old trees should be dressed with the adze, in order to cause the young shoots to come away as low down, and as near to the surface of the ground, as possible. If the young shoots of the oak, which are intended to grow up into coppice, be allowed to proceed from that part of the old stock which rises two or three inches above ground, these shoots will always partake more of the character of branches than of trees, and never will make a valuable plantation; but if made to come away from that part of the stock where the roots join with the main stem, and which lies immediately under the surface of the soil, they will partake of the character of trees, and, independent of the nourishment that they receive from the parent stock, will also send out roots of their own, and derive nourishment from the common earth, and form pretty large trees, if desired. Now, in order to cause the young shoots to issue from this point, the long grass should be all cleared away round the stock, and itself dressed off with an adze. In executing this, care must be taken that the part where the roots issue from the main stem be not injured; but supposing that three inches of wood have been left above ground upon the stock, the workman should commence by levelling his tool upon it fully two inches down upon the wood, and hew off this part all round, gradually lessening the depth of his cut as he nears the centre or crown of the stock, which is left untouched, thus leaving a fall from the centre to the circumference of fully two inches, and forming a convex crown. This form prevents the lodgment of moisture, as well as causes the young shoots to come away as near to the earth as possible, which should always be aimed at; and in this manner every stock which may be intended for the rearing up of coppice-wood should be managed. The sooner the operation is done after the trees are cut, the greater is the hope of a good crop of healthy shoots: the forester, therefore, ought not to delay this until all the other work of clearing away the trees and rubbish be finished. The whole ought, indeed, to be gone on with according to the time that I have above stated, but still the whole may be proceeding simultaneously. My way of proceeding with work of this kind is:—I have a party of men with horses and carts, who begin upon one side of the ground, and clear away all the valuable wood as they proceed, which is delivered to the sawyer or otherwise as the case may be. Immediately following this first party I have a second, consisting of women and boys, headed by a man to superintend them, who gather up all the rubbish that is left by the men with the carts, and carry it to convenient openings, and burn it at once, unless some other more valuable use can be made of it. The ground being cleared by this second party, I have a man, or men if the grounds be extensive, following them dressing the stocks in the way described; and in this manner the whole work can be made to go on at once without losing any time.

If the stocks of the old trees which were cut down are not numerous upon the ground, as is more than likely to be the case if the trees were of any considerable age, there will not be enough for a permanent crop upon the ground. If, for instance, they were eighty years old, there will not be more than one hundred trees to the acre, making them about twenty feet one from another. Now, to have a piece of forest ground with that number of stocks upon it to the acre, would never pay the proprietor the common rent of his land: therefore, in order to take advantage of the ground forming the vacant spaces between the stocks, and to make the whole pay ultimately as any other plantation would do, the ground should be properly drained wherever found necessary, and a crop of young oak trees planted all over it wherever there is room. In this case, the young oaks which may be put in, together with the old stocks, may be made to stand, as nearly as possible, eight feet apart. All the intermediate spaces between them should be filled up with larches, so as to make the trees over the whole plantation stand about four feet one from another; that is, taking the old stocks into account also.

By filling up the ground in this manner, the old stocks will ultimately become of more value than if they had been left in an exposed state; while, from their growing more rapidly than the young trees, they will produce shelter to the latter in their young state; so that, putting the whole together, a plantation of this kind grows more rapidly than one altogether planted with young trees.

When the young shoots from the old stocks have been allowed to grow undisturbed for two years, they should then be carefully looked over, and all small ones removed, leaving the strongest, all round the circumference, not closer than six inches one from another. These again should be left for other two years, when a second and final thinning should be made, choosing the strongest and healthiest shoots to remain, and in no case leaving more than six shoots to stand as a permanent crop upon any individual stock, or fewer still if the health and strength of the parent require it.

I am aware that many foresters are in the habit of not thinning their oak stoles at all, until the shoots have attained a large size, when they thin them out and peel the bark from them, supposing that by this system there is a gain from the sale of the young bark produced. I entirely dissent from this system of management; for, when the shoots are thinned out as I have advised, they very quickly attain a large size; whereas, when they are not thinned out until a late period of their growth, the shoots become stunted, and shortly indicate a want of vigour in their constitution; consequently, at the end of a given number of years, instead of an advantage being gained by letting the shoots grow up until they are fit for peeling, there is a decided loss. I have compared two plantations which were managed upon these two different systems, and found the one managed upon that which I have recommended, at the end of twenty years, worth nearly a half more than the one managed upon the opposite system.

When the young shoots have received their second course of thinning, as has been pointed out, they should at the same time receive a judicious pruning, in the same manner as has already been recommended for the pruning of young oak trees. The larch firs, as they grow up, should be thinned away by degrees, in order to give room to the oaks as they advance, whether to relieve the old stoles or the young trees; and in every respect this thinning of the firs should be done as has already been recommended for the management of oak plantations generally.

Seeing that the value of oak bark has fallen so much during the last twenty years, I do not consider the growing of oak coppice so profitable as it has been. About twenty-five years ago, the price of oak bark was £16 per ton, while in 1850 the highest price given in Edinburgh was £5, 10s.; making its value at the present time only about one-third of what it was twenty-five years ago, and consequently reducing the value of oak coppice plantations in the same ratio. On this account, I think that proprietors should not, at the present time, rear up oak plantations with the intention of converting them into coppice, as has in many instances been done of late. I have seen plantations of healthy oak trees, about thirty-five years of age, cut down for the sake of the bark they produced, and with the view of converting them into coppice-wood, so as to have a crop of bark every twenty-five years afterwards. Now, had those trees, which were cut down at thirty-five years of age, been allowed to grow for other forty or fifty years, they would, of course, have attained their full magnitude, and been worth to the proprietor, at the end of that period, more than three times the money that he could get as the produce of the same plants if cut down and disposed of in the form of coppice-wood, at periods of twenty-five or thirty years.

The safest and best plan, with regard to all plantations, is, to allow the trees to attain their full magnitude in the usual way, when the timber will in all cases find a ready market, and at a fair price. No doubt, where old plantations are cut down, it is right and proper that the stocks of them should be converted into coppice-wood; for this is taking advantage of growths which can be converted to use, and which would otherwise be lost; but to raise up trees to a certain age, and then cut them down prematurely for the sake of their bark, is, at best, an enormous loss to the proprietor, as well as to the country in general.

SECTION III.—THE PEELING AND DRYING OF BARK USED FOR TANNING.

The peeling and drying of bark used for tanning, being a part of forest operations in which an inexperienced person may be the cause of much loss to his employer through bad management, I have considered it right to devote the present section to giving some information relative thereto; and in this

I shall merely detail the method by which I am in the habit of doing the work myself.

There are, properly speaking, only three sorts of wood, the bark of which is *now* used for tanning purposes—namely, the oak, the larch, and the birch. About thirty years ago, when the demand for bark was very great, I have seen saugh, chestnut, and mountain ash all peeled, and the bark sold to the tanners; but now that there is a large supply of oak bark imported into this country from the Continent, tanners will not use these, seeing they can get plenty of good oak bark at a very moderate rate; and it is in consequence of this large supply from the Continent that the price of bark has fallen so much of late.

To illustrate the method of peeling and drying the bark, we shall now suppose that we have to commence operations of this nature upon a *hag* of oak of considerable extent. We shall further suppose that this hag, or plantation of oak, has been trained up for some time with the view of becoming a timber plantation ultimately; that the shoots or trees are about twenty-five years old from the stole; and that, at the thinning which we are now referring to, there is only intended to be one left from each stole.

A few days before commencing the cutting and peeling, the forester will go through the plantation himself, and mark all the shoots he intends shall be taken away. This I advise him to do, in order that he may have time and leisure to mark quietly by himself; because, if the plantation be extensive, and many hands employed, he will find enough to do, when the people have begun, to keep them properly at their several employments, without marking. Where many hands are to be employed, therefore, the forester should have all his trees marked previous to beginning to cut and peel, by which means he will be enabled to give his undivided attention to the conducting of the workpeople. We shall suppose that the business of marking the trees which are to be taken out has been despatched by the forester, according to the rules already laid down in another part of this book. He will next consider as to the number of people he will have to employ in order to have the work done within a given time; and this of course must be regulated by the forester's own views as to the time he has on hand. But as an inexperienced forester may find some difficulty in arriving at something like accuracy as to the time it may take him to have his work of peeling done, I shall here give him for his guidance the rule by which I myself determine this.

When I wish to know, as nearly as possible, the weight of bark that I am likely to have from a plantation, I first take three of the shoots or trees which are to be cut—say of three different sizes—one of medium small size, one of a middle size, and one of a medium large size. These three trees I get peeled, including the branches upon them; and supposing the bark taken off the three weighs 39 lb., this gives 13 lb. as an average of the raw bark which may be expected from each tree to be cut. Having ascertained thus far, the next thing is to find the number of trees to be cut in the plantation. This of course the forester ought to know by the act of marking them; and this he may keep in view as he proceeds with the marking. Supposing, then, that he numbers 7466 in all to be taken out, then, if we assume that the raw bark in drying loses about one-third of its weight—this being my principle of calculation—we have only about $8\frac{1}{4}$ lb. instead of 13 lb. as the weight of bark off each tree when dried; and multiplying 7466, the number of trees to be cut, by $8\frac{1}{4}$, the number of pounds of bark supposed to be taken from each tree, we have in all 61,594 lb., or 27 tons. From the above method of calculation, the forester may come very near the truth; and I generally myself come within 5 per cent of the truth by going to work in this way. Having ascertained that 27 tons of bark are likely to be taken from the plantation, the next point is to ascertain what number of people will be required to peel this in 27 days, to which we shall suppose the forester is obliged to confine himself:—

By calculations made from cases of peeling bark of the age stated above, I find that, in order to peel one ton of bark in the day, and carry out the wood as it is cut to the roads, a distance of one hundred yards, where it is to be peeled, the following workpeople are required:—

Two cutters, at 2s. 6d. per day, ...	£0	5	0
Two pruners, at 2s. do. . . .	0	4	0
Four chatters, at 1s. 6d. do. . . .	0	6	0
Three men carrying trees, at 2s. per day, . .	0	6	0
Three boys carrying branches, at 1s. per day, .	0	3	0
One man putting up ranges and keeping bark on them, at 2s. per day, . . , . .	0	2	0
One boy carrying bark to ranges, at 1s. per day, .	0	1	0
Twenty women and boys peeling, at 1s. each per day,	1	0	0
Cost per ton, ...	£2	7	0

In order, then, to cut and peel the number of trees above mentioned, in the space of twenty-seven days, thirty-six people will be required as above stated; and these the forester ought to have in readiness, by a previous appointment, to meet him at the given time and place. Before bringing the peelers to the ground, the forester should attend to have the *cutters*, *pruners*, and *chatters* employed during the afternoon of the previous day, in order to have a supply of wood ready for peeling when the women and boys arrive; for if this be not attended to, a great deal of time will be lost, from the peelers all having to wait till wood is cut and carried out for them. We will suppose that the two cutters have been engaged upon the afternoon of Monday, as also the two pruners or *sneaders*, with the four *chatters*, and that there is a supply of wood ready for the peelers commencing with upon the morning of Tuesday.

Before stating the manner in which the women, or people who are employed for peeling the bark, are to be set to work, it will be proper to begin with the cutting the trees, and then go on progressively with each department in its own place, according to the regular course of the work.

Let the two men who are engaged for the purpose of cutting down the trees proceed each to a separate stole, and with his axe cut down each shoot upon the stole having a mark upon it. But if any of the shoots or trees are of a size about or over six inches diameter at bottom, they will require to join together, and cut them down with the cross-cutting saw, observing, in either case, to cut each tree down to the surface of the earth as nearly as possible, paying particular attention not to do any injury to the bottom of that shoot which is left in order to become the future tree. In this way they will proceed from stole to stole in regular course, cutting every shoot having a mark upon it in their way; and as the marks ought to be all made on one side, and facing one way, they will have no difficulty in quickly finding them out. Another point which these men ought particularly to attend to is, to see that none will fall upon the shoots which are to stand, they always endeavouring to lay them over in an open part. In this manner the two men will continue to cut down the trees, paying no attention to the pruning of any of them after they are fallen, their particular charge being merely that of properly cutting down the trees marked; and that the forester ought to see them do in a clean, workmanlike manner.

As the trees are cut and laid down by the two men as already stated, they should be followed in close succession by other two men, who may be of an inferior cast as workmen, as their duty is not of so important a nature. Their duty is to prune, or, as it is technically called, *to snead* the trees of their branches as they are felled; and in cutting the branches from the trees, they must be instructed to cut them off in such a clean manner as not to destroy the bark upon the main stem of the tree. That they may do this the more readily, they should be furnished with axes of a lighter description than the common wood-cutting axes. If the wood-cutters lay down the trees with the axe, each working separately by himself, then each will be followed by one *sneader;* but if they use the saw, both working together, the two sneaders will follow them accordingly, each taking a tree to himself in turn, clearing it of all its branches, and cutting off the top of the tree where it is from two to three inches in diameter, leaving the trees and their branches lying as they were cut; and these will again be taken up by another party coming behind them.

Immediately behind the two last-mentioned men, four young lads will follow, each having a *hand-bill* in his hand, (see Fig. 95,) which is kept sharp both on the curved side, *a*, and upon the straight face, *b*. With an instrument of

Fig. 95.

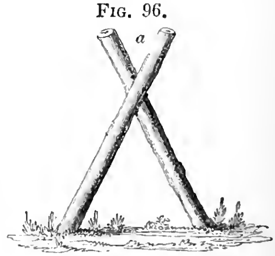
this description in the right hand, each lad will take up a branch in the left, by the thick end, and with the hand-bill prune off all the smaller branches; and those branches which they thus cut off may be subpruned again, if they are of a size equal to the middle finger of a man's hand: in short, it must be the duty of these four lads to prune out all the branches down to the size mentioned. As they prune them out, the lads must be careful to put them into bundles in a regular manner, that they may be readily lifted and carried out of the wood by another party behind them. It will be the duty of the forester to see that these lads do not pass over any of the branches; for this they are very apt to do, in order to keep up with the men in front; and if such omissions are once allowed to slip, they will, as young lads are very apt to do, put off their time, and still keep up with the men in front. It must, therefore, be particularly seen to, that they do not pass over the branches, and thereby lose a considerable portion of bark. Young lads performing this operation are generally termed *chatters*, or *subpruners*.

After the three parties above mentioned are well begun, another party of three men and three boys will commence to carry out the wood, the trees and branches, namely, as they have been prepared by the foregoing parties, and lay them down along the nearest road in the wood, in order to their being peeled. In carrying out the wood which has been cut, the three men will carry out the trees, two of them carrying the heaviest upon their shoulders, and another the lighter ones by himself, while the three boys carry out all the branches as they are pruned and collected into heaps by the chatters. In this way the whole of the trees marked are to be cut down, pruned, and their branches subpruned, and carried out to the nearest road, in order for peeling; the one party following the other in regular succession, clearing the wood as they pass along.

In laying down the trees and branches in order for peeling upon the roads, the carriers must attend to divide them in such a manner as to accommodate the number of people who are to be employed in peeling. Thus, in the present case, where twenty people are supposed to be engaged in the latter, one-third of that number will be sufficient for the peeling of the *trees* as they are brought out, while two-thirds will be required for the *branches*. The forester will, therefore, cause the carriers to lay down the trees in three divisions along the side of the road, (not across it,) and at each of these three divisions two people will be employed, it requiring two people to peel the trees to advantage; and thus one-third of the people—namely, six—will be engaged in the peeling of the larger wood. The other fourteen people, again, will be engaged in the peeling of the smaller wood; therefore, fourteen heaps or divisions of small wood must be laid down for them, so that each person may have his or her own heap to work on. By going to work in this manner, it will be at once seen by the forester who works to advantage, and who does not; for if a number of people were set to the peeling of one heap or compartment of sticks, the forester could not so well detect a bad hand from a good one. This is a point that every forester, engaged in the peeling of bark, should direct his attention to, to deal out his work so as to be able to detect a lazy from an active worker, and he ought in all cases to reward them accordingly. Every one who has had experience in the peeling of wood, where a number of strangers are brought together, will coincide in what I have here stated.

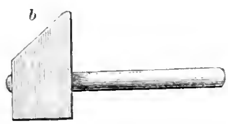
The wood for peeling being laid down along the side of the road as has been described, it will be necessary for the peeling of the trees to have a pair of what are termed *horses*, erected at each of the three heaps. (See Fig. 96.) This is simply done by driving two strong stakes, of about three inches in diameter, into the ground, as represented in the figure. Two of these are put up alongside the trees to be peeled, about eight or ten feet apart from each other, and they may stand thirty inches high. They are used to lay the ends of the small trees upon, as at *a*, by which means the peelers can the more readily get the bark taken from the trees so placed, without rolling them about upon the

Fig. 96.



ground. These being prepared by some of the men previous to the women having arrived for peeling, the next thing is to have them brought forward to the ground. On the arrival of the peelers, the forester will have in readiness for each a small mell, of the form represented by Fig. 97, the head of which must be made of a piece of good ash wood, but the handle of Scots fir, as it is more soft and cool for the hands than any other sort of wood. The flat part of these mells, *a*, is for beating the bark upon the wood till it separates easily from it, and the sharp part *b* is for cutting up the bark so as to open it for the purpose of introducing the peeling chisel, another little instrument which every peeler must have in hand, and which must also be provided by the forester for them. It is represented by Fig. 98.

FIG. 97.

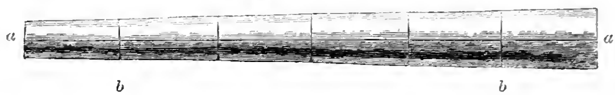


The mell may be made about four inches square on the flat part *a*, and about six inches deep from *a* to *b*, the handle *c* being about ten inches in length. The chisel should be made of good iron, three inches by two and a half in the face *a*, and the hose *b* may be about four inches in length, while the handle *c*, which is of wood, may be about eight inches long. Those who are occupied in peeling the small wood should be provided, in addition, with a stone from eight to ten inches square on the top, and about six inches deep, and as smooth as possible on the one side. Such stones may be got from any old dyke in the neighbourhood of the plantation, or in the bed of any small watercourse near at hand. We shall now suppose that all the people who are to be engaged in the peeling of the wood are in readiness to begin, with the tools described above; and we shall also suppose that they are all strangers to the work, and have to be instructed in it by the forester before they can make a beginning. First, then, the forester will pick out six of the stoutest from among the others, whether these may be women or young stout lads, and set them to the peeling of the trees; that is, two to each lot, as was formerly mentioned when speaking of the manner of laying out the trees upon the road. He will cause them to lift, first, the heavy end of

FIG. 98.

one of the trees upon one of the wood horses prepared for the purpose, and then the small end upon the other. When this is done, one of them will take a hand-bill, of the description shown in Fig. 95, and with it cut the bark right round the tree, into lengths of about three feet, beginning at the thick end. This being done from end to end of the tree, dividing the bark upon it into lengths of about three feet, he then, with the same instrument, cuts it longitudinally, from the one end to the other,—the bark thus being divided as shown in Fig. 99, *b b* representing the trans-

Fig. 99.



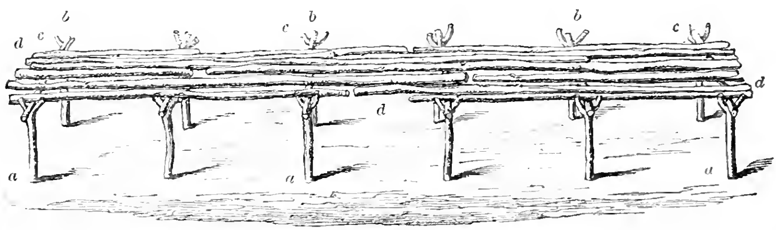
verse cuts, and *a a* the longitudinal one. Now, in order that, while the one person is engaged in cutting the bark in the manner described, the other may not be idle, he will, with his mell, using the flat end, beat the surface of the bark upon the tree all round, beginning at the thick end, and following his neighbour in regular course. This beating of the bark must not be done in a rough or severe manner, for such a course would injure its colour when dried; but regularly, so as to cause the bark to *start* from the wood. The thinner the bark is, the less beating will be required; consequently, at the bottom of the tree, and upwards to the middle, a pretty smart stroke of the mell will be required; but as the bark becomes thinner from about the middle of the tree upwards, a more gentle beating will do. All this the people who are employed should be made aware of; as the more knowledge the people have of the real nature of the work, the more profitable they are as workmen. As soon as the person has got the bark cut into lengths in the manner described, he will put aside the hand-bill and take his chisel, and with it he will follow his neighbour, and separate the bark from the wood, taking it off in pieces corresponding to the cuts he made with the bill; and as he takes off each piece, he will lay it carefully and regularly to one side, so that it may not be in the way of the work in general. In this way the one will follow the other in close succession; and as soon as one tree is stripped of its bark, they will join in removing it to one side, and putting a fresh tree upon the horses; always observing to lay the peeled wood to the opposite side from the unpeeled, as this will prevent confusion.

We shall now suppose that the forester has shown the parties who are to peel the larger portion of the wood, how to proceed. It now remains for him to direct those who are to peel the smaller wood. In order to this, the best method is for the forester to show them himself by his own example. He will therefore call them all round him, and make them observe how he performs the work. He sits down upon the ground, keeping the bundle of small wood to be peeled upon his left side, and placing the stone upon the ground close by his left side also, with the smoothest side uppermost. He will next take an oak branch in his left hand from the bundle to be peeled, and lay the thick end of it upon the flat stone, and with the flat part of the mell he will beat pretty firmly till the bark opens from the wood, doing this from the one end to the other before laying down his mell. As soon as he has thus opened the bark from the one end to the other, he will lay it down by his right side, and commence at the thick end of the stick, and take it off in as long lengths as possible; that is to say, have as few small pieces as possible, because they are very apt to be lost. If the bark will not separate easily when laid hold of with the hand, he will take the chisel and separate it from the wood, and as it is taken off, have it laid in a regular manner upon the right side; while the peeled sticks should be thrown aside, so as not to interfere with the unpeeled wood. When the forester has shown, by his own example, the method of peeling, he will cause them all to sit down and perform the work in the same manner.

The next part of the work is to have a *range* put up, upon which to put the bark as it is peeled. This should be entrusted to a careful person, who has had some experience in such work before. It should be done thus:—From among the peeled sticks collect a number, of the form shown in Fig 100: these may be from two and a half to three inches in diameter, and about three and a half feet long. When a number of these are collected and carried to the place where the bark is to be put up to dry, which should be in some open and airy part of the plantation, or if possible upon the outside of it, where a free circulation of air will be continually had, have the sticks driven into the ground in pairs right opposite to one another, and in two rows, as represented in Fig. 101. In the figure, *a a a* represent a front view of the forked sticks as they are driven into the ground, and *c c c* the tops of the row behind and opposite to them. The distance between the two rows may be about thirty inches. *b b b* represent pieces of the peeled sticks resting between each pair in their forked tops; and *d d d* small trees of about two or three inches diameter, laid along on them for the purpose of supporting the bark. The distance between these forked sticks, when driven into the ground, may be about four feet in the row;

Fig. 100.

Fig. 101.



and in order that the rain may fall readily off the bark on the range, the front row should be driven in with their tops about five inches lower than the back one.

The range for the bark being in readiness, a boy with a small sheet of any coarse stuff, will regularly carry it away from the peelers as they take it off, and bring it to the person who has the charge of keeping it in order. In laying the bark upon the range, great care should be taken to put it on in a regular manner, and lying all one way, like drawn straw. A few large pieces of bark should be put on the top of the range first, in order to keep the smaller parts of it from falling through. The whole bark should be put on in a loose state, and by no means pressed together, but kept open in order to allow the air to pass freely through it; and it should not be laid on thicker than about eighteen or twenty inches. On the top of the whole, as it is finished, large pieces should be laid, in order to keep rain from going down through it. As the person who has the charge of the bark range will not have constant employment about it, he ought to assist at times any other of the parties who may appear to be falling behind. When the bark has stood three or four days upon the range, it ought to be turned over, and mixed properly; and in the act of turning it, all the whitest pieces should be kept to the top. If the weather continues fine, the bark may be dry enough in the course of fourteen days from the time of peeling; but if it is dull and cloudy, twenty-one days may not be enough. Its being properly dry may easily be known by all the natural sap being out of it, and its being hard and refusing to bend. When properly cured, it should be of a cream colour inside. When of a dark or brown colour, it is plain that the bark has been injured by wet; and when it is so, a lower price will be given for it. Great attention should therefore be given to see the bark properly dried; and this can only be done by repeatedly turning it in fine weather. The more quickly it is cured, the better it is in its tanning qualities. When dry, it may be either carted off the ground to the tan-yard at once, or be built up in a stack upon the ground till a convenient opportunity. When oak bark is to be sent to a considerable distance to the market, it is chipped into pieces of about three inches square, in which state it is put up into bags.

In the peeling of birch bark, the same process is gone through as with the oak; but from its being more easily dried than the oak, it is seldom found necessary to erect a range for it; merely putting a few sticks under it upon the ground, and laying it regularly upon them, being sufficient.

Birch bark being less valuable than the oak, it is never chipped and put into bags, but sent from the wood to the nearest tan-yard, on the carts, as soon as it is dry.

In peeling larch bark, none is taken from the branches of the trees, but merely that from the trunk; and in peeling it, the mell is seldom found necessary; but when cut into lengths upon the tree, it comes off easily with the chisel. It is more easily dried than the oak, and is treated in the same manner as the birch, being seldom put upon a range, and is always carted off to the tan-yard at once when dry.

In peeling the bark from any of the trees mentioned, the best time is when the young leaves are expanding from the bud. The larch and birch generally peel about the 1st of May, and the oak about the middle or end of the same month, much depending upon the earliness or lateness of the season. Oak bark peeled after the 1st of July is never so valuable as that done during June.

If wood is allowed to lie more than one day unpeeled after being cut, it will not part with the bark so easily as when newly cut. The forester, therefore, should observe this point, and be careful not to allow one party to fall behind another so as to keep the wood lying for any time unpeeled. Much of the quickness of getting through with the work will depend upon this. The more healthy any tree is, the more easily is the bark removed from it, and the earlier in the season will it be ready for peeling. An unhealthy tree never parts with its bark readily. Much of the success, therefore, in peeling wood will depend upon the healthy nature of the trees; and the unhealthiness of a tree may be known very easily by its being longer in coming into leaf than others of its own species which are in a healthy state.

CHAPTER VI.

Trees best adapted for growing to useful size upon land termed moss—Cause of disease among Larch fir plantations—External symptoms of disease upon forest trees generally, and causes of the same—Periodical increase of timber in the different species of forest trees—How to find the transferable value of any plantation of trees.

SECTION I.—TREES BEST ADAPTED FOR GROWING TO USEFUL SIZE UPON LAND TERMED MOSS.

As there is, both in Great Britain and Ireland, a large extent of waste land of the description termed moss or *peat*, and as such tracts of land are not very susceptible of rapid improvement for agricultural purposes, it has now become a question of considerable interest among landed proprietors, what sorts of forest trees will grow to most useful dimensions upon moss. This question has of late been very often put to myself by extensive proprietors, whose woods I have been called upon to inspect, as well as by others who feel interested in the improvement of waste land, which has made me turn my attention more particularly to the gaining of information upon a point in forestry of so much importance. With this view I have visited a number of estates upon which plantations had been made upon moss land, and I am now prepared to state the results of my observations, which may be useful to those who are projecting to plant such tracts.

Moss or peat soil consists, in general, of decayed vegetable matter, which has accumulated in a flat or hollow part, having always a retentive bottom. In a state of nature, such moss is always full of water, which cannot escape downwards in consequence of the retentive nature of the stratum upon which it lies.

The water contained in moss soil can escape only by evaporation from the surface; and from this it is evident that its surface must at all times be cold as compared with others lying upon an open or porous subsoil. It is also in consequence of this cold nature of moss land, in its natural state, that we never find any valuable or useful plants growing upon it, but only a few birch or alder trees, or it may be some heath or rough grasses. Moss land, even after being dried by draining, is found of a dull and inert character, and not apt to give life and energy to the growth of useful plants that may be put upon it. This is the more observable in such moss lands as are purely of a vegetable character, and without any considerable mixture of inorganic matter; such being generally known by the name of *flow* or *soapy* moss.

In my investigations relative to the growth of trees in moss land, I have found three different descriptions of this soil; namely, moss holding a portion of clay—moss holding a portion of sand—and moss of a purely vegetable character; and upon each of these I have found forest trees grow differently.

In moss holding a portion of clay, any tree will attain to more useful and healthy dimensions than in either of the other two kinds, whatever the depth may be. In soil of this description, where it was from three to five feet deep, and resting upon a bed of clay, I have found very good and healthy oaks, poplars, willows, and spruce firs; in which case the soil had been well dried by open parallel drains nearly three feet deep. The plantation being nearly thirty-five years old, the poplars and saughs were, at an average, about twelve inches diameter ten feet from the ground, and the spruce firs were about eight inches diameter at the same height; but the oaks, although apparently in a fair state of health, had not made proportionate progress, being on an average about six inches diameter six feet from the ground, and of a branchy habit. Many of the oaks were much larger, several of them nine inches in diameter; but the above was the average of them. In the same plantation, along one of its sides considerably exposed, I saw a few larch trees growing, which had not attained to anything like a useful size, while they were also much covered with moss and of an unhealthy cast.

The plantation above referred to was in a high-lying district in the north of England. In the immediate neighbourhood of it I found a considerable extent of ash coppice upon soil of the same description as the fore-mentioned, in a very healthy state; and in this ash coppice plantation, there were a number of old trees of the same kind growing, which had been left as standards; but these were extremely unhealthy gnarled things. On first consideration, I thought that the unhealthiness in the case of the old ash trees might be accounted for from their having been often suddenly exposed by the cuttings of the coppice; but on further examination, I found that even where they had had every advantage of shelter, they were unhealthy, and the wood of a short-grained nature. This at once pointed out to me, in a very forcible manner, that upon a moss soil, although ash will grow well in the form of coppice, it will not attain anything like valuable quality or dimensions as a timber tree. Again, having been lately called to inspect and report upon the condition of plantations on an estate in Berwickshire, I had an opportunity of seeing ash of a considerable age (nearly fifty years old) growing upon a soil of much the same nature as that above referred to. In this case also I found the trees unhealthy, being low and branchy in their habit, and the wood of a short-grained nature. In the same plantation, however, I found the Scotch pine in excellent health, and the timber apparently of good quality. From these, and several other examples of like bearing, I am led to say, and that with confidence, that poplar, willow, spruce fir, and Scotch pine, will thrive well upon mossy soil containing a portion of clay—that is to say, where the soil has been properly drained from all superfluous moisture; but oak will thrive indifferently, and ash badly, unless where these are kept in the state of coppice; and in such a state, from examples that I have seen, I am led to conclude that they will both succeed well. I may here state also, that upon the estate of Arniston, I have cut down excellent oak timber from moss land about two feet deep, resting upon a bed of sandy clay, and also excellent larch timber under the same circumstances. This points out that, where the roots of trees, planted upon moss, can get down into a subsoil congenial to their nature, two feet of moss on the surface is little obstacle when properly dried.

In moss soil, free from clay, but holding a portion of sand, trees do not grow so well as in a moss having an equal portion of clay. This I have verified from a number of observations made in the same manner as those referred to in the case of the soil containing clay. On the estate of Arniston there are several plantations upon what we term a sandy moss, not more than three feet deep. They consist generally of larch, Scotch pine, and spruce fir; and I find that upon that soil the trees grow pretty quickly till they arrive at about thirty-five years of age, when both the larch and spruce begin to take heart-rot, while the Scotch pines remain good.

Some hardwood trees are also doing moderately well upon the same soil, particularly the elm; and a number of birch trees, which have been planted along with the others, are thriving beautifully, and are evidently in their congenial soil.

Relative to moss land of a purely vegetable character, I have seen at Scoon, in Perthshire, Scots pines growing well upon it, as also spruce fir and larch, for a time; but as soon as the two last-mentioned sorts arrive at above thirty years old, they begin to decay in the heart, and consequently decrease in value. I have also seen oak of a pretty healthy character upon pure moss; but the wood of such trees is always found of very inferior quality. On the estate of Arniston we have oaks growing upon a pure vegetable moss, which are not in a vigorous state, but stunted and small of their age; and on soil of the same description we have spruce firs and willows of excellent healthy development; but as they are only about thirty years of age, I am not prepared to say how long their health may continue. From their present appearance, however, they promise to become of good size.

From the above statements, relative to the growth of trees upon moss soil, it will appear that Scots pines and spruce firs, willows and birch, stand first in order as trees adapted for growing upon it to useful size. This statement must, however, be understood with the qualification, that if the situation be high and exposed, spruce firs and willows will not do well. Under such circumstances, Scots pines and birch would be more commendable, as being hardy and adapted for a high situation. It may be farther observed, that the hardwood sorts, and more especially the ash, do not thrive well as timber trees upon moss land, but do well in the form of coppice. The quality, also, of hardwood timber grown upon moss land is very inferior as compared with the same sorts grown upon soil of a different description.

SECTION II.—CAUSE OF DISEASE AMONG LARCH PLANTATIONS.

It is my opinion that there is no tree cultivated in Britain more worthy the attention of landed proprietors than the larch. I am not aware of any purpose for which oak is now used, for which larch would not answer as well. It is a rapid-growing tree, and attains maturity long before the oak. I have seen larch trees, little more than thirty years old, sold for 60s. each, while oaks of the same age, and growing upon the same soil in the same neighbourhood, were not worth 10s. each; and this at once points out the advantage of planting larch where immediate profit is the object. The larch has been held in high estimation in former times, as we learn from several old authors. The first mention made of the cultivation of this tree in England is by Parkinson, in his *Paradisus*, in 1629; and Evelyn, in 1664, mentions a larch tree of good size at Chelmsford, in Essex. It appears to have been introduced into Scotland by Lord Kames in 1734. But the merit of pointing out to the proprietors of Scotland the valuable properties of the larch as a timber tree for our climate, appears to be due to the Duke of Athol, who planted it at Dunkeld in 1741. The rapid growth of these, and of others of the same species, afterwards planted in succession by that nobleman, as well as the valuable properties of the timber of the trees that were felled, realised the high character previously bestowed upon the larch by foreign and British authors, who were followed in their opinion by others, such as Dr Anderson, Watson, Professor Martyn, Nicol, Pontz, Sang, and Monteith—all confirming, and further extolling, the valuable properties of the tree. It is no wonder, therefore, that the larch has been planted so extensively in Scotland of late years, in almost every kind of soil and situation, and under every variety of circumstances capable of being conceived in forest management, seeing that its culture has been so much recommended by men in whose opinions landed proprietors put much confidence as regards forest matters. I say that it is in a great measure owing to the advice of such men as I have above named, that the larch has been so extensively planted within the last fifty years in Scotland. According to their opinion, it was one of the hardiest, and most easy of culture, among our forest trees; and proprietors, relying too implicitly in this matter upon the soundness of these opinions, planted larch too indiscriminately, upon all kinds of soil, without having due respect to the nature of the tree: for the larch, as well as every other tree, is influenced by a natural law, which restricts it to particular states of soil, in order to develop itself fully and perfectly; and from neglect of this the disease now so prevalent in the larch has originated. It is well known that, in many instances, whole plantations of larch trees have died—I may say almost suddenly; and in many instances, the return made by it has been far inferior even to the Scots fir.

For some years past, much has been said and written relative to the nature and cause of that disease, now so prevalent among our larch plantations, generally termed the *heart-rot*—or, as some writers term it, *dry-rot*, (*merulius destructor*;) but, despite all that has been written upon the subject, I am not aware that anything as yet really satisfactory has been the result, at least in so far as to cause any likelihood of a really permanent improvement in the cultivation of the tree for the future. I may, therefore, here be allowed to give my opinion, as a practical forester, as to the cause of a disease which appears still to prevail extensively among one of the most useful of our timber trees. Many who have written upon this most important subject assert that, from the circumstance of the larch not being a native, it is fast degenerating in our country; and, in illustration of their argument, they point out the healthy development of many old original specimens yet remaining in different parts of the country. Such an argument as this is scarcely worthy of being confuted; for we may as well say that the *plane tree*, which is not a native of Scotland, ought to be fast degenerating also, which we know is by no means the case. Another answer to this assertion is, that in many places we find healthy larch plantations, and in other places unhealthy, both, nevertheless, being of the same age. Now, if the larch is indeed degenerating, why is it found to succeed well in one place and not in another, and that, too, even within the bounds of the same gentleman's property? The only reasonable answer that can be given to this question is, that wherever the larch is found thriving well, it must be growing in soil and circumstances agreeable to its constitution; and wherever it is not thriving, these must be unfavourable to it. Therefore, in our further inquiries as to the cause of the *rot* in the larch, we must first ascertain the nature of the circumstances which affect the tree in both cases.

The larch is a native of the south of Europe, and also of Siberia. It inhabits the slopes of mountainous districts, in the lower parts of which it attains its largest dimensions. In its native mountains, the larch is never found prospering in any situation where water can lodge in the ground in a stagnant state; nor is it ever found of large dimensions in any extensive level piece of country having a damp retentive bottom or subsoil. On the other hand, the larch in its native localities is found luxuriating upon a soil formed from the natural decomposition of rocks; for there the surface soil rests upon a half-decomposed stony subsoil, through which all moisture passes freely in its descent from the higher grounds. In this state of things, the roots of the trees always receive a regular supply of fresh and pure moisture, and, at the same time, the ground in which the trees grow is kept in a cleansed and sweet state, not having any stagnated gas or water lodging in it; and this forms, in my opinion, the perfection of soil for the cultivation of the larch.

On making some inquiries at a gentleman who had travelled among the mountainous districts in Germany, where the larch is found in its native state, I learned that, upon level and dry-lying parts of the region mentioned, the larch does not succeed well, being upon such parts always more stunted in its growth, and apparently not enduring so long, as when found with moisture passing freely among its roots. This is exactly in accordance with the state of our larch plantations in Scotland; for, wherever disease is found to prevail, there is either a want of or too much moisture in the soil.

Now, until on inquiry I was made aware of these circumstances relative to the larch as found in its native localities, I never could satisfy myself as to the cause of the disease which has appeared among the larch plantations in Scotland; but since I have been made aware of the above circumstances, and have compared them with examples of healthy and unhealthy plantations on several estates where I have had the opportunity of examining for myself, I am now perfectly convinced as to the cause of the disease in question; and I am further convinced, that any man who will compare the state of the ground upon which a healthy plantation of larch is found in Scotland, (that is to say, one which has arrived at a considerable age, and is in a sound state,) with what I have stated relative to the healthy state of trees of the same species as found in their native regions, will at once see the same circumstances acting in each case. Thus, in all cases of healthy larch plantations in this country, where the timber has attained large size, and is sound in quality, we find them growing upon a soil through which the water that may fall upon it can pass away freely; as, for instance, upon the slopes of hills, and even in hollows, upon a strong clay soil, but where there is a proper drainage for the ready and free passage of the superfluous water; and I have even cut down larch timber, of large size and sound in quality, growing upon a light sandy moss, two feet deep, which rested upon a stiff clay. In this case the moss was drained, and the water passed freely through the light soil; and the situation being upon a slope, there was a continual circulation of moisture passing along upon the top of the subsoil or clay. In short, I have found good larch timber growing upon almost all varieties of soil; but I never found it upon one which had not its particles constantly cleansed by the continual circulation of water passing through it, either by natural circumstances or artificial drainage. On the other hand, in all cases of diseased larch plantations, where the trees have become stunted and rotten in the hearts prematurely, we shall find that the soil has either been badly drained, or not drained at all. There must be ingredients lodging in the soil which act against the health of larch trees growing upon it, and which can be carried off only by an effective system of drainage, in order to make it fit for the healthy rearing of this tree.

In a plantation on a level piece of ground upon the estate of Arniston, I had occasion to cut down some larches in the way of thinning. The plantation is about forty years old, and consists of a mixture of larch and Scots firs. I found those which were cut in the central parts of this plantation, without exception, rotten in the heart, which was exactly what I anticipated, for the soil had never been drained; while some which were cut upon one side of the plantation that formed a sloping sandy bank, were found every tree sound, and of excellent quality of timber; and, at the same time, every tree in this position was at least three times as large as those planted in the interior level parts of the plantation, although all were of the same age. Now, the cause of this superiority of the trees which grew upon the sloping bank may at once be seen, from what I have already said upon the point. Again, another side of this plantation was bounded by a deep ditch, forming a fence upon the edge of a field; and all along this ditch upon the side of the wood, larch trees of excellent size and quality were growing. Nothing can be more convincing than this, that in order to grow larch timber of sound and good quality upon land which formerly grew diseased trees, all that is required is to drain it, when success will be the result.

I have always found larch trees succeed better when growing among hardwood trees, than when growing by themselves or among other firs, even although planted upon soil in the same state in both cases. The cause of this I conceive to be, that the roots of the hardwood, from their penetrating deeper into the earth than those of the fir, have a tendency to divide the soil, and open it up for the more ready circulation of the water through it. It is, indeed, well known to almost every forester, that the roots of the hardwood trees will penetrate through the stiffest soil, and considerably break up and improve it to the depth of about two feet; and when the trees are of any considerable age, with their larger roots spreading far and wide, I have often seen the water running along the beds of such roots in considerable quantities, showing that they acted as conductors for the water through the soil. It is to this that I attribute the superior health of such trees found growing among hardwood, as compared with those among their own species upon the same quality of ground.

On the south lawn at Arniston House, there are about twenty larches yet growing, of very large dimensions. They are generally above eighty feet high, and a few of them contain upwards of a hundred cubic feet of timber; one in particular contains two hundred cubic feet, and is apparently in good health. The soil upon which these trees are growing, is a light sandy loam of about fifteen inches deep, resting upon a stratum of yellow sand. They are, as nearly as I could calculate from the appearance of one which was cut down lately, nearly one hundred years old, and must have been among the first of the species planted in the lowlands of Scotland.

These fine specimens are growing among hardwood trees as tall as themselves, but probably at least twenty years older. My opinion is, therefore, that the hardwood trees had been a considerable length before the larches were planted among them; and owing to this circumstance, the ground would be well prepared by the roots of the hardwood for the reception of the larches; which must, in a great measure, be the reason that most of our original specimens are the finest trees of the kind at present in the country—they having always been planted in favourable localities, and near the residence of the proprietors.

From what I have said above, it will appear evident, that the disease in the larch is attributable to the want of proper drainage of the soil. Since I came to Arniston as forester, I have recovered a considerable extent of young larch plantations, which were fast going back, and that simply by draining the soil, in order to draw away from it superfluous water, as well as to cleanse it from bad qualities which were natural to it, and formerly prevented the healthy development of the larch tree. These young larch plantations were under fifteen years of age when I drained them; but I cannot say if draining would recover plantations of older standing. In all cases where it is desirable to cultivate sound larch timber, the land should be drained with open cuts at from thirty to fifty feet distance, according to the nature of the soil, and not shallower at first than eighteen inches deep; and as the plantation advances in age, the drains should be gradually deepened, and kept properly clean, and stagnant water never allowed to remain in them; for however well land may be drained at first, if those drains are not kept in a clean running state, they will ultimately be of very little benefit to the rearing of healthy larch.

SECTION III.—EXTERNAL SYMPTOMS OF DISEASE IN TREES, AND GENERAL CAUSES OF THE SAME.

Trees, like animals, are subject to various diseases, which, if not arrested by removing their causes, often either make them die suddenly, or retard their growth to such an extent, that prematurity is speedily brought on. Disease in trees, like disease in animals, in all cases throws out external symptoms by which it can be detected; but in order to this the experienced eye is required. To the inexperienced, trees will often appear healthy, while in reality they may be the reverse. I have, in many instances where I have been called upon by proprietors to inspect their plantations, found them entertaining high expectations as to the future welfare of some favourite plantation, while I found it my duty to give them reports quite opposite to what they expected. I refer to this here, because I am well aware that plantations are often looked upon as being in a good state, while the contrary is the truth. Disease in trees, as in animals, is confined to no particular stage of their existence; from the sapling in the nursery-row to the full-grown tree in the forest, it may often be detected, causing premature decay in the subjects. Although this is a fact too often observable, and, I may say, too little attended to by professional men, yet, generally, trees are not apt to die either suddenly or prematurely when planted and existing under favourable circumstances as to soil and situation; and any failures which do take place, can, in most cases, be traced to the true cause, that being either in the nature of the soil, climate, or management of the cultivator. Moreover, trees, like animals, although they should grow up healthily and arrive at the most perfect state of maturity the soil and situation upon which they grow admit of, will begin to experience the gradual approaches of natural decay; the life principle of the trees will cease to act; and if not cut down before this stage arrives, which will, of course, be different according to the species and nature of the soil, they will, in the case of some soft-wooded trees at least, soon moulder into their original earth.

The healthy development of trees, like that of animals, depends much upon the wholesome state of their food, and, at the same time, upon the want or excess of it; that is, if a plant, like an animal, receive too little food, its development will be irregular and stunted, and if too much of any particular ingredient, that excess must prove the parent of disease in its system, and of disease more fatal than the want of it altogether would have caused.

Every tree in full health, and considerably under the age of maturity, produces annually an elongation of all its branches, and an increase in the diameter of its body proportionate to its species; and the external bark, more especially in the hardwood sorts, should be clean and smooth. The amount of the increase of growth in any given time is not, however, always a true criterion of its health. For example, I have often had occasion to remark, in cutting down trees, that one which was rotten in the heart, had made, up to the time of its being cut down, greater annual layers of young wood upon the bole, than another beside it which was perfectly sound and healthy. This will, no doubt, appear, at first sight, doubtful to the inexperienced, but it is, notwithstanding, the truth, and I merely refer to the circumstance in order to show that the increase in the annual layers of young wood upon the bole does not always indicate the true state of the tree. Even in such a case as this, however, there are always outward symptoms by which an experienced eye can pretty readily detect the inward rottenness: there is an indescribable something stamped upon the general bearing of the subject which betrays the hidden disease. Again, relative to this point, a tree upon an exposed situation may be making but small annual layers of young wood as compared with one of the same species in a sheltered part, and at the same time they may be both equally healthy; therefore, in judging aright of the health of any tree or plantation, the circumstances above mentioned must be taken into account. I said that the external bark of trees in full health should be clean and smooth; but relative to this, also, caution is necessary ere we judge by the assertion simply as it stands. A tree may be in good health, and yet have the external bark even somewhat *fogged* and rough; for smooth and clean bark is more an attendant upon rapid growth than of sound health, properly speaking. I could point out trees, having a clean and smooth bark, considerably damaged by inward disease; while, on the other hand, trees may be shown with a rough, mossy, and furrowed bark perfectly healthy and free from all disease; thus pointing out, that smooth bark is not altogether to be relied on in passing judgment on the state of a tree, but that other attendant circumstances must be taken into account. These statements may, to the inexperienced forester, appear contradictory, but such is often the case; and I merely advert to them to show, that any single mark of either disease or health is not in all cases to be relied on; for the apparent marks of both health and disease may exist on the same patient at the same time; and it may even require a close investigation from the most experienced of either foresters or vegetable physiologists before decidedly saying what state it might be in. Having thus premised, it is not my intention here to enter into details regarding, or even to refer to, all the diseases to which trees are liable in our climate. This would of itself be matter for more than one volume of ordinary dimensions: it is, in fact, more a subject of vegetable physiology than one belonging to such a work as the present, which is, strictly speaking, a plain, practical work on the rearing of forest trees. It is, however, necessary that I should here advert a little to such diseases in forest trees as are generally the offspring of bad management in the forester; and, accordingly, I shall point out the external symptoms of such diseases, the general causes of the same, the means of cure most likely to succeed where the trees are infected, and those of prevention where no disease may have yet appeared.

The principal diseases likely to be brought on forest trees by bad management are—1st, *Bark-bound;* 2d, *Moss upon the bark;* 3d, *Staghorn tops;* 4th, *Scale;* 5th, *Premature bearing of seed;* 6th, *Dropsy;* 7th, *Ulcers;* 8th, *Wounds;* 9th, *Stunted growth of the young wood.*

Any of the above-mentioned diseases may, to a considerable extent, be brought on trees by mismanagement in their cultivation; and with regard to the first mentioned—namely, *bark-bound*—it may very frequently be found to exist on hardwood trees in any soil or situation where they may have been injudiciously managed, either in the way of planting, pruning, or thinning. The external appearance of a tree in the state termed *bark-bound*, may be thus stated: Outer bark hard and compressed, and of a dry coreacious texture; the bole of the tree, as also the larger branches, with young shoots springing out immediately from the bark, at irregular intervals. When the disease is not of long standing upon a tree, if a longitudinal incision with a knife be made in the summer in the outer bark, it will immediately contract upon each side of the incision, leaving the cut much wider than the instrument could make in the case of a healthy tree; but if the disease be of long standing, this contraction of the bark will not take place, at once indicating that the wood of the tree and its bark adhere so closely together, that the sap cannot flow between them. Another symptom of this disease in a tree is, that the proper lateral and top branches make small and weak annual shoots; and each year, as the disease becomes more confirmed, the annual shoots become the more weakly. The cause of this disease, as its name expresses, is the bark being *bound* or girded about the wood of the tree, thereby preventing the free flow of the proper sap from the roots to the leaves, and also arresting the descent of proper woody matter between the wood and the bark. In this case, if the cause of the disease be not removed in proper time, the vital fluids become gradually checked, till at last the passages become entirely closed, and, as the natural consequence, the plant dies.

I have already stated that "bark-bound" may be caused by injudicious planting, pruning, or thinning. As caused by injudicious planting, we have often occasion to witness it when any tree is planted upon a situation too high and exposed for its healthy development. For example, the spruce fir or the ash, in all cases where they are found planted upon an exposed and high part of the country, more particularly if growing upon the outside of a plantation, will be found of a short bushy habit, having their bark hard, and adhering to the wood, and scarcely showing any symptoms of vegetable life till far on in summer. In this state the trees are bark-bound, which disease is caused by the vital fluids being not strong enough to resist the cold and drying influences of the atmosphere; and in such circumstances the trees seldom assume anything like a respectable size. As to a recovery in a case of this nature, I have never been able to see how that could be effected: we may as well say that a geranium, which may have been planted in an exposed site, should be made to grow as well as one in a sheltered part. Of course, all that is required is protection; but this would be impracticable with regard to a spruce fir or an ash on the outside of a wood, and on a site too high for their health. The fault rests with the planter; for, in fact, the trees so situated, according to their nature, are not in a state of air adapted for their healthy growth: premature death must therefore be the result. The same results will follow in the case of any other kind of trees that may be planted upon a situation too exposed for their health; and the disease, under those circumstances, is incurable — at once showing the evil and ruinous effects of planting trees in a situation not adapted for them.

As caused by injudicious pruning, I have often witnessed this disease to a fearful extent, even where formerly the trees were in excellent state. Trees that may receive a severe pruning of their larger branches, more particularly if they are in a plantation which has been severely thinned at the same time, are almost certain to become bark-bound, however healthy they may have been before that operation was performed upon them. In this case the disease is caused by the severe denuding of the trees of their branches, the atmosphere being thereby cooled down suddenly about them; and the only rational remedy under such circumstances is, to allow the trees to regain their former shelter as nearly as possible, and afterwards to prune and thin more carefully. Trees under such circumstances, if under thirty years of age, are very likely gradually to recover; although they will never afterwards attain such valuable size as they would have done had they received no check from such disease; but if the trees are much above that age, they are not likely ever to recover, at least so far as to become valuable as timber. The results are much the same with regard to the disease, as it is often caused by injudicious thinning. When the atmosphere of the plantation is suddenly cooled down by a severe thinning, the sap is retarded in its ascent, and expended in keeping up the life-principle of the tree. The consequence is, that little woody matter is returned from the leaves, the bark gradually becomes dry, and the trees, if they do recover, do so slowly, and never afterwards attain the value they would have done had they been properly dealt with. Trees, although injured by severe pruning and thinning as above stated, may, notwithstanding, be in a great measure recovered, and that by two methods—namely, by removing the diseased outer bark from the tree, or by softening the bark by means of any moist substance. In attempting the recovery of bark-bound trees by removing the outer bark, it is only necessary to have this chipped or scraped off by means of any moderately sharp iron instrument. If the trees to be operated upon are young, with a thin smooth bark, care must be taken to scrape only; but if the trees be pretty old, with a rough thick coat of outer bark, it must be chipped off. I have frequently seen an old hedge-knife used for this purpose, and that with great effect. In removing the outer bark, the operator must be careful not to injure the soft inner bark next the proper wood. I consider the month of April to be the best season of the year for performing this operation on trees. The foregoing method is frequently practised for the purpose of recovering trees diseased in the bark, but it is not nearly so effectual in bringing about a thorough cure as that of softening the diseased outer bark by means of some moist substance applied to it. Therefore, to those who may find it necessary to apply a remedy for recovering bark-bound trees, I would recommend them to proceed thus:—Have a quantity of good moss gathered from the woods, or from an old grass field, of the same description as is commonly used by nurserymen for packing, and have it well incorporated with nearly an equal bulk of fresh cow-dung, making the mixture form a complete plaster. With this, cover the bark all over the trunk of the tree affected, as also part of the larger branches, to the thickness of about one inch; and in order to keep this plaster on, have the whole wound round with ordinary hay or straw ropes. If this be applied in the autumn, and allowed to remain till the May following, the bark will be completely softened and in a pliable state; but in order that it may not receive any sudden check from the influence of the weather after the plaster has been removed, it is advisable to have the whole wound round again with fresh hay-ropes, these being allowed to remain till they become wasted and naturally fall off, when a complete cure will be found effected. In dry weather, it will be an advantage to syringe with water the ropes upon the trees, which will tend to keep the bark in a healthy soft state.

With regard to the second mentioned external symptom of unhealthiness in trees — namely, *moss upon the bark*—this may be found to exist upon trees in a variety of circumstances, soils, and situations, and is not always a symptom of unhealthiness. In any district of country where much rain falls, almost all trees will, to a certain extent, be found infested with moss; and notwithstanding the trees may grow vigorously and be found in good state, as I have frequently witnessed. Trees existing in a damp humid atmosphere, where they have not a free circulation of air about them, are generally much overgrown with moss upon their trunks. In this case a diseased state of the trees cannot be said to be the cause of the moss growing upon them: but such trees, existing in a state of air favourable to the development of the moss seeds upon their bark, may be ultimately much injured by the moss excluding light and air from the bark; and, in this case, draining of the soil, so as to carry off all superfluous moisture, thinning the trees judiciously, so as to admit a free current of air, and removing the moss from the bark, will generally completely restore them. But if those requisites of health have been too long neglected, it will be impossible to effect a cure. Trees existing in a high and exposed situation, more especially if the subsoil upon which they are growing is cold and damp, are almost always much infested by moss. In such circumstances, this is caused by the languid state of the juices of the trees, and their not being, as it were, sufficiently strong to resist a degree of decomposition in the outer bark. In a case of this nature, the only remedy is, to have the subsoil made wholesome for the roots of the trees by draining, and to preserve shelter as much as possible, by not over-thinning or unduly exposing the trees.

Again, any plantation, which may have stood for a considerable time in a confined state for want of thinning, may, after receiving a severe and injudicious thinning, become unhealthy in the outer bark; and, as a certain natural consequence, the trees will be much overgrown with moss. In this case, the cause of this growth is the sudden exposure of the trees rendering the bark diseased. I have frequently seen this take place where bad management prevailed; and after the trees had grown more closely together, so as to produce shelter throughout, the moss disappeared. We thus see that the appearance of moss upon the bark of trees is not always a symptom of decided disease in them, but may be occasioned by a temporary derangement in the natural functions of the outer bark; and if observed in time, like any other disease, may be removed by removing the cause before it has had time to become decidedly fixed in the constitution of the trees affected.

What has been said relative to the appearance of moss upon trees, is principally applicable to the hardwood sorts. As to moss affecting the pine and fir tribes, I shall speak of that shortly. In the mean time, I would remark here, that hardwood trees generally are more easily cured of any disease than pines or firs are; the reason appearing to be, that their juices are more pliant than those of the others. The juices of the pines and firs are of a thick consistency, and any sudden check to the life-principle of those trees at once stagnates their juices and renders them unfit for circulation; whereas, in the case of the hardwood sorts—such as the oak, ash, &c.—the juices are thin and of a watery consistency; and although those trees may receive an injury in their constitution, their juices will continue to flow to a certain extent, and thus keep up the life of the tree; and, as the cause of disease gradually subsides, they will regain their former strength.

Almost all trees growing in high districts, unless the soil be favourable, are less or more infested by moss, which is occasioned, I think, by the want of a full flow of sap in the trees to keep the bark in a soft moist state. The bark of all such trees, when they have arrived at any considerable size and age, is found dry and hard, and, as it were, in a half decomposed state ; thus becoming a favourable receptacle for the growth of the seeds of mosses ; yet the trees, under these circumstances, may be healthy enough in their constitution. It must, however, be admitted, that, under such circumstances, trees cannot grow vigorously or attain the valuable size they would do under more favourable circumstances. In all such cases, therefore, it would be a very great improvement to scrape off this outer diseased bark, and thus remove the moss and allow the trunks of the trees to expand more freely by the influence of light and heat penetrating more readily through the bark. On the other hand, almost all trees growing upon a sheltered district of country—unless, indeed, where the soil may be unfavourable to their growth—are generally found clean and free from moss; the reason of which appears to be, that the trees, growing in favourable circumstances of soil and situation, have a vigorous constitution, with a full flow of sap, which keeps all their parts in a healthy state, so that no opportunity is afforded to the moss seeds harbouring on them.

From what has been said above, it will appear plain that, where moss exists upon trees, it is in general a symptom of something wrong, although not always a symptom of decided disease, but possibly occasioned by some temporary derangement in the functions of the bark. The only way to prevent this appearance, is to keep the soil dry, to admit a free circulation of air, and not to give any sudden check to the bark by over-thinning.

With regard, however, to moss growing upon the bark of the fir and pine tribes, and where it is retained upon them without intermission the whole year, the case is very different. In these it is a certain indication of decomposition in the heartwood of the trees affected by it. In all my surveying of plantations in both England and Scotland for a few years past, I have seldom been deceived in pronouncing, relative to pine and fir trees, whether they were in a healthy or unhealthy state, and that by the appearance of the moss upon their bark alone. In doing this, however, there is an indescribable something which I am guided by in my own mind, and which I could not here explain for the guidance of others; it is, in short, a mere tact of observation combined with experience, which is inexpressible upon paper. I may say thus far, that wherever the moss is found to extend about two-thirds up the entire height of the bole of a tree, and is also spreading out upon the branches, and not falling off during the summer, decomposition in the heartwood is evidently going on. Such trees should at once be cut down, as the longer they stand they will become of the less value. There is also something to be founded on from the appearance and kinds of the mosses at different stages of disease; but this can only be explained by close observation upon the subjects.

The *third* external symptom of disease in trees is stag-horn top. This symptom is one easily distinguished from all others by the top and upper branches of the tree affected becoming dead and quite bare of all leaves and young twigs, having the appearance of stags' horns. This disease may be occasioned by dampness in the subsoil in the case of some sorts of trees, and by the want of sufficient moisture in that of others. It is generally preceded by one, and sometimes by both of the former mentioned, and is, I may say, in all cases, irrecoverable, except by draining and pollarding, by which means the tree affected may indeed be made to lengthen out its existence, but not to regain its former healthy constitution. Willows and poplars, which luxuriate in a soil rather damp than otherwise, generally become stag-horn topped when grown in a soil too dry for their healthy development, and that as soon as they have arrived at such maturity upon the soil upon which they may be growing, as its nature is capable of bringing them to. It at once indicates their premature state; and the wisest thing is to cut them down, seeing the soil is not adapted for their growth. Elm, oak, ash, plane, &c., generally become stag-horn topped when the soil in which they may be growing is too damp for maintaining them in a healthy state; and, in this case, if the disease be observed in time, draining the soil, and cutting off the parts affected, may produce a cure; but if the subject is old, and the disease have made considerable progress, it is seldom that recovery can be secured, at least so fully that the tree can ever become a valuable and healthy one.

The *fourth* external symptom of disease in trees is *scale*, which is a small white insect found clinging to the bark of some species. In forest trees it is most frequently found upon the ash while in a young state. This insect, like moss, is indicative of a constringent state of the bark, and may be often found upon the bark of young ash trees which have received an injudicious and too sudden thinning. I have also often seen it to a very great degree on ash trees growing upon a light gravelly soil, which is not congenial to their healthy growth. This latter case at once points out that the constitution of the trees affected, under such circumstances, is impaired, and that they will not succeed to anything worth, whatever means may be used for their recovery. Where it is evident that trees with scale upon them have been injured by a too severe thinning, the case is very different. These may be recovered by scraping off the outer bark with the scale, and allowing the trees in future to become more close among one another, so as to produce shelter sufficient for their health, as was recommended for bark-bound trees. The scale is easily distinguished by the appearance of the insect upon the surface of the bark. It presents itself as very numerous small white spots, like those on the bark of the birch; and if the observer take a stone and draw it roughly along the tree, he will kill many of the insects, and see their blood give a red tinge to the bark.

The *fifth* external symptom of disease in trees is premature bearing of seed. No tree, in a healthy rapid-growing state, is ever found to produce seed till it has arrived at a considerable age and size; I would say, that any forest tree bearing much seed under forty years of age, is not likely, ultimately, to arrive at anything approaching a valuable size. Any tree, however healthy a state it may be in, may be made to bear seed, simply by mutilating its roots, or by pulling it over; thus at once showing us that, before a young tree produces seed, it must be brought into an unhealthy state, either naturally or artificially. Being aware of this, it will at once be evident that, when we find a young tree producing profusion of seed, there can be no doubt but that it is in a state of premature decay; therefore, in all such cases we may be at once assured that such trees will not become valuable as timber. In short, when found under those circumstances, disease must have been going on for a considerable length of time, and I am not aware of any successful means that could be applied for their recovery. The premature bearing of seed in the larch I have in all cases found to be a sure index of heart-rot in the trees; and even in the case of pines of any kind, the bearing of seed in their young state at once points out a weakness in their constitution, and tells, to the observing eye, that such and such trees never will become valuable as timber, but that they will become decayed in the heart long before they can arrive at large dimensions.

The *sixth* symptom of disease in trees is dropsy. This disease most generally takes place in forest trees, either where the soil is too rich for them, or where there is an excess of moisture about their roots. The cause of it appears to be, that the roots take into the system of the tree an excess of juices, which the bark and leaves cannot assimilate. In this disease, unnatural swellings are observable on some parts of the bole, which begin to rot and throw off the bark. It often also happens that the leaves will be found dropping off in their green state, and then the tree will be found to die suddenly. I have frequently seen this the case with the oak, where planted in a very rich soil, with abundance of moisture. In this disease, where the bark becomes detached from the wood, there will be found a reddish coloured water between the wood and the inner bark. I consider it incurable; and the only thing is to prevent it by attention to the ground being well drained and not over-rich.

Seventh, Ulcers. This is a disease in trees which very much resembles the last; but it is mostly confined to the fir and pine tribes. Its appearance is that of a running sore upon the side of the trunk, where the natural juices escape in the form of a hard resinous matter. This disease is mostly found upon young trees of these tribes, and is occasioned by insects lodging their eggs in the inner bark, where the young live for a time, and destroy the alburnum. I have frequently observed this disease take place in young larch plantations where the soil was unfavourable to their growth; and in those cases wounds were the original cause.

Eighth, Wounds. It sometimes happens that trees will receive damage on their trunks by having the bark peeled off by accident in some way or other, which may prove injurious to their health, and not unfrequently be the cause of death. Any tree in a healthy state is not easily injured by any external wound upon the bark, unless, indeed, that be so extensive as completely to strip the tree of its bark all round at any given part, as is frequently observable in the case of cattle peeling the bark off to a considerable extent, when, of course, a tree must be much injured, and will gradually decline in health, and ultimately die. But this is an exception to wounds of a general nature; and any simple damage received upon the bark of a healthy tree in all cases soon heals up, and is only of a temporary nature. The case, however, is very different with an unhealthy tree which may receive an apparently simple wound, such as a piece of the bark, or even a large branch broken off. In a case of this nature, when the sap of the tree injured is in a diseased state previously, the wound made becomes, as it were, a running sore; rot will sometimes be induced at the part, and a gradual decaying of the whole tree will take place. This state of a wound in a tree does not often occur; but I have known it to take place, and that in trees which were in a state of dropsy. As I have already said, however, any simple wound made upon a healthy tree is seldom or never found injurious, but soon heals up.

Ninth, Stunted growth of the young wood. This state of a tree is at once apparent by the very short annual growth of young wood upon all the lateral branches, and may be in general the natural result of any of the diseases already described. Every healthy tree in a fair growing state, if not arrived at natural maturity, ought to make annual growths of new wood, upon the lateral and top branches, of from six to thirty inches, according to age and species. If, however, a tree of thirty years of age make shoots of twelve inches annually, and soon after that period is found to be making shoots of four inches only, there is reason to suspect that it has become suddenly unhealthy. The cause must be sought for in some one or other of the diseases already mentioned, and a remedy applied accordingly.

Every tree, when it has attained the full size and development of its nature, however healthy it may have hitherto been, gradually begins to fail in making young wood. This is the work of time, doing to the old tree what disease does to the young.

SECTION IV.—PERIODICAL INCREASE OF TIMBER IN THE DIFFERENT SPECIES OF FOREST TREES.

There is no part of a forester's education more neglected than that of having, as far as possible, a thorough knowledge of the size that trees ought to be, on a given situation, at a given age. Such a knowledge can only be obtained by close observation, and by extensive experience. For some years past, having myself been largely employed in the surveying and valuing of plantations, both in England and Scotland, and seeing that there was great want of data upon which to calculate prospectively the future value of plantations, I have applied myself particularly to gain information upon this point, which I shall, in the present section, lay down for the guidance of others who may be called upon to act as valuators of wood. For a number of years past, I have made it a point of duty, wherever I have been called upon to examine plantations, at the same time to take notes of the different sizes of trees as I found them to exist at a given age on a given situation; and having examined plantations of many kinds, upon a great variety of soils and situations, as well as under many descriptions of management, I have come to the conclusion, that the size of a tree at a given age, upon a given situation, does not depend so much upon natural circumstances as upon the artificial management it may have received. In illustration of this, I may mention, that I have surveyed plantations in England, which were growing upon a very favourable soil and situation, and which, compared with others of a like age in the north of Scotland, on a soil rather unfavourable, were, notwithstanding, far inferior to the latter; this being occasioned by bad management in the one case, and good in the other.

From such a case we may see that the cultivator of wood, as of any other product of the soil, has much in his power in making the crop profitable or not, even where natural circumstances may seem unfavourable. It would be impossible here to give the size which trees ought to attain on every variety of soil and situation, and under all circumstances of management—so much depending upon both artificial and natural local circumstances. For example, I have frequently seen a plantation of trees, which had been growing at a rapid rate, and making great progress in diameter of wood, suddenly checked in health by an overthinning, and afterwards, in consequence, making but little progress; while, on the other hand, I have as frequently seen the trees in a plantation, which had been for a time in a confined state, and had been in consequence doing little, which, after being judiciously thinned, had rapidly enlarged the diameter of their boles. Again, with regard to natural local circumstances, I have often observed trees growing on a situation much sheltered by older wood, &c., making great progress in the laying on of diameter of wood; while in another plantation not far distant, and upon the same description of soil and altitude, and under the same system of management as the other, but much more exposed to the free influence of the natural climate, trees of the same sort were making comparatively little advance. Now, on taking into account all those varied circumstances which affect the growth of trees, it will at once be evident, that to say such a kind of tree should, at a given age, and upon a given situation, be an exact given diameter, is a degree of perfection not to be arrived at, at least during the present century. In giving, therefore, my calculations in the present section, as to the periodical increase of timber in trees, I beg to be understood that these are given as an average of what ought to be the result at certain ages, and under fair circumstances of situation and management.

In taking my calculations of this periodical increase of timber, I have invariably measured them at about eight feet from the ground; and, for the sake of better illustration, I have reduced my calculations to three distinct bases of situation. The First is an average of the periodical increase of timber in trees growing on a favourable soil and site; the Second, of that increase in trees growing on moderately favourable ones; and the Third is an average of the growth of trees growing on unfavourable ones.

Having premised the above, I shall now give the periodical increase of the oak.

Ages of Trees.	Diameter in inches eight feet from the ground.		
	1st. On favourable Soil and Site.	2d. On moderately favourable Soil and Site.	3d. On unfavourable Soil and Site.
Oak at 10 years old,	½	¼	...
... 20 ...	4½	3	2
... 30 ...	9½	7	4½
... 40 ...	16	12½	8
... 50 ...	20½	16	9
... 60 ...	25½	18	10
... 70 ...	29	19½	11
... 80 ...	31½	20½	11½
... 90 ...	32¾	21½	...
... 100 ...	33½	22	...
... 120 ...	34¾	...	...

The foregoing statements relative to the oak have all been taken by me in cutting down timber at all the different ages specified; and the numbers given, under each head, are the averages taken from many trees of the same age. The most prominent feature of the statement is, that upon the favourable soil and situation, as stated under the 1st division, the oak not only grows more rapidly and attains a greater diameter of wood in a given number of years, but it also continues to grow healthily, and lay on a greater bulk of wood at a great age, than the others on less favourable soils and situations; that is, taking the oak, upon a favourable soil and site, at from ninety to one hundred years of age, we will invariably find it make considerable progress during that period; while the same sort of trees, as found growing upon a less favourable soil and site, will have almost ceased to make any perceptible amount of timber. Between ninety and one hundred and twenty years of age, the tree, in the former case, has increased its diameter to the extent of two inches; while in the latter, one half inch is made during that period of thirty years;—and again, in the third case specified, no increase has been made at all; and at this stage, the wood of such a tree must be in a declining state. We thus see that, on an unfavourable soil and site, if we wish to have the wood in its most valuable state, it should be cut between sixty and seventy years of age, and on the moderately favourable soil between eighty and ninety; while upon the favourable soil it may be left growing till perhaps one hundred and forty or one hundred and fifty years. At first sight it may appear that two inches in diameter is but a small amount of wood to be laid on by a tree during a period of thirty years, as in the case of the oak in the 1st class between ninety and one hundred and twenty years. But if we suppose the bole of such a tree to be twenty feet long only, we will have laid on during that period at least fourteen feet of extra timber, which, at 3s. per foot, gives £2, 2s. of additional value in wood laid on.

I shall now proceed with a corresponding statement relative to the larch; but, instead of giving the diameter at periods of ten years, as in the case of the oak, I shall take periods of five years. My reason for doing so is, that, in cutting down larch trees, their periodical thinnings are generally made at or within periods of five years; consequently it is an object of importance to have an estimate of the diameter which they should, in general cases, present at periods of five years.

Ages of Trees.	Diameter in inches eight feet from the ground.		
	1st. On favourable Soil and Site.	2d. On moderately favourable Soil and Site.	3d. On unfavourable Soil and Site.
Larch at 10 years old, .	1½	½	...
... 15	5	3	2
... 20	9	7	5
... 25	11	9	6
... 30	13½	11	7½
... 35	17	13½	8
... 40	21	15½	...
... 45	23½	16½	...
... 50	24½	17	...
... 55	25½	17½	...
... 60	27	18	...
... 65	28	...	...
... 70	29	...	...
... 75	30	...	...
... 80	30½	...	...

All those measurements are taken from trees cut down upon the estate of Arniston. They indicate to us that, on a favourable soil and site, the larch will continue to make wood till above eighty years of age, and will even then be of a sound constitution, as I have frequently had occasion to observe; while, on a soil of moderate capabilities, sixty years of age may be considered as the maximum of the larch; and in order to have the full value of the trees growing under such circumstances, they should then be cut down. Again, upon a soil and situation unfavourable, from thirty to thirty-five years may be considered as the maximum of the trees; and if not cut down at that age, the trees will begin to decay rapidly in the heartwood.

I shall next give a statement of the progressive growth of the Scots pine, as taken from specimens of the tree measured by me in the Highlands of Scotland, as well as others on the estate of Arniston.

Ages of Trees.	Diameter in inches eight feet above the ground.		
	1st. On favourable Soil and Site.	2d. On moderately favourable Soil and Site.	3d. On unfavourable Soil and Site.
Scots pine at 10 years old,	1	$\frac{3}{4}$	...
... 15 ...	4	3	$\frac{1}{2}$
... 20 ...	$6\frac{1}{2}$	$4\frac{1}{2}$	$2\frac{1}{2}$
... 25 ...	9	6	4
... 30 ...	11	$7\frac{1}{2}$	$5\frac{1}{2}$
... 35 ...	$12\frac{1}{2}$	9	6
... 40 ...	14	$10\frac{1}{2}$	$6\frac{1}{2}$
... 45 ...	$15\frac{1}{2}$	12	7
... 50 ...	17	$13\frac{1}{2}$	$7\frac{1}{4}$
... 55 ...	$18\frac{1}{2}$	$14\frac{1}{2}$	...
... 60 ...	$19\frac{1}{2}$	$15\frac{1}{2}$	...
... 65 ...	$20\frac{1}{2}$	$16\frac{1}{2}$	...
... 70 ...	$21\frac{1}{2}$	17	...
... 75 ...	22	$17\frac{1}{2}$	...
... 80 ...	$22\frac{1}{2}$	18	...
... 85 ...	$23\frac{1}{4}$	...	...
... 90 ...	24	...	...
... 95 ...	$24\frac{1}{2}$	...	...

The following represents the periodical increase of timber in the spruce fir, as taken from an average of trees measured on a number of estates in Mid-Lothian:—

Ages of Trees.	Diameter in Inches Eight Feet above the Ground.		
	1st. On favourable Soil and Site.	2d. On moderately favourable Soil and Site.	3d. On unfavourable Soil and Site.
Spruce fir at 10 years old,	2	1	...
... 15 ...	5	3	1⅓
... 20 ...	7	5½	3¼
... 25 ...	10	8	4½
... 30 ...	13½	11	5½
... 35 ...	15	13	6
... 40 ...	17½	15	...
... 45 ...	18¾	16	...
... 50 ...	20	17½	...
... 55 ...	21¼	18	...
... 60 ...	22¾	18¼	...
... 65 ...	23½	18¾	...
... 70 ...	24½	19	...
... 75 ...	25½	...	...
... 80 ...	26¼	...	...
... 85 ...	27	...	...
... 90 ...	27¾	...	...

The measurements in the first class of spruce firs, as above stated, were taken from trees generally growing in hollow sheltered parts upon a stiff heavy clay of a damp tenacious nature; and those in the second, from trees generally growing upon a fair loamy soil on flat parts of the country, well drained. Those in the third class, being upon unfavourable soil and situation, have all been taken from the average of trees found growing upon a thin gravelly soil with a high exposure, under which circumstances the spruce seldom arrives at any useful size, generally taking heart-rot when from thirty to thirty-five years of age, and then failing to make wood, as indicated in the table.

The following statements show the periodical increase in the ash and sycamore, taken from measurements of trees cut down by me on the estate of Arniston, as well as upon some other estates in Mid-Lothian—all which were, I consider, growing under moderately favourable circumstances of soil and situation. Not having yet got my measurement fully carried out upon first or third class ash and sycamore trees, I must, in the mean time, restrict myself, with regard to these trees, to the average of second class ones.

Ages of Trees.	Diameter in inches eight feet above the ground. The Sycamore, on a moderately favourable Soil and Site.	Diameter in inches eight feet above the ground. The Ash, on a moderately favourable Soil and Site.	Ages of Trees.	Diameter in inches eight feet above the ground. The Sycamore, on a moderately favourable Soil and Site.	Diameter in inches eight feet above the ground. The Ash, on a moderately favourable Soil and Site.
At 10 years old,	2	1½	At 70 years old,	22½	24
... 20 ...	5½	4½	... 75 ...	23½	26
... 30 ...	9½	7	... 80 ...	25½	28
... 35 ...	11½	9	... 85 ...	27½	30
... 40 ...	13	10½	... 90 ...	29	31½
... 45 ...	15	12	... 95 ...	30	33
... 50 ...	16½	14½	... 100 ...	31½	34
... 55 ...	18	17	... 105 ...	33	34½
... 60 ...	19½	19½	... 110 ...	34	
... 65 ...	21	22			

I shall now give a statement of the periodical increase of timber in the Scots elm and the black poplar. The elm is an average of trees growing upon a moderately favourable soil and situation, and the poplar of those raised in a very favourable one. As yet I have not been fully able to get enough of trees to enable me to give statements of the 1st and 3d class trees of the elm, or of the 2d and 3d of the poplar. In the mean time, therefore, I defer giving any more than the following, hoping that ere long it may be in my power to supply those particulars which are now left blank.

Ages of Trees.	Diameter in inches eight feet above the ground. Black Poplar, on a favourable Soil and Site.	Diameter in inches eight feet above the ground. The Scots Elm, on a moderately favourable Soil and Site.	Ages of Trees.	Diameter in inches eight feet above the ground. Black Poplar, on a favourable Soil and Site.	Diameter in inches eight feet above the ground. The Scots Elm, on a moderately favourable Soil and Site.
At 10 years old,	5	1½	At 55 years old,	40	19
... 15 ...	9	4	... 60 ...	...	21
... 20 ...	15	6	... 65 ...	...	22½
... 25 ...	21	8½	... 70 ...	...	23½
... 30 ...	26	10	... 75 ...	...	24½
... 35 ...	29½	12½	... 80 ...	...	25½
... 40 ...	32	14½	... 85 ...	...	26
... 45 ...	36	16	... 90 ...	...	27
... 50 ...	38½	17½	... 100 ...	...	28

We now give the beech and sweet chesnut, as taken from the average of a number of trees cut down on various estates in Mid-Lothian, on moderately favourable soils and situations.

Ages of Trees.	Diameter in inches eight feet above the ground. — Sweet Chesnut, on a moderately favourable Soil and Site.	Diameter in inches eight feet above the ground. — Beech, on a moderately favourable Soil and Site.	Ages of Trees.	Diameter in inches eight feet above the ground. — Sweet Chesnut, on a moderately favourable Soil and Site.	Diameter in inches eight feet above the ground. — Beech, on a moderately favourable Soil and Site.
At 10 years old,	2½	2	At 50 years old,	15	21½
... 15 ...	4½	4	... 55 ...	16½	22½
... 20 ...	7	6½	... 60 ...	17½	24
... 25 ...	8½	9	... 65 ...	19	25½
... 30 ...	10	10½	... 70 ...	20	27⅓
... 35 ...	11½	15	... 75 ...	21	28¼
... 40 ...	13½	17	... 80 ...	22	29
... 45 ...	14½	19½	... 85 ...	22½	30½

From the two statements given above relative to the periodical increase of timber in the sweet chesnut and the beech, it is very observable that, on a soil of moderate capabilities, the beech grows to a much larger size than the sweet chesnut; showing that, in order to bring the sweet chesnut to the large dimensions which we find in some parts of the country, it requires a very favourable soil and situation; a point of great importance to be kept in view by any person engaged in valuing wood for the transfer of property.

Having now given the foregoing statements relative to the periodical growth of our principal forest trees, in so far as my experience will at present permit me to do in a decided manner, I shall only state, in conclusion upon this point, that I have found these calculations of the greatest value to myself when called out to value plantations prospectively for the transfer of landed property; and I have no doubt but that they will also prove of value to others. There is great want of a far more extensive basis upon which to calculate the progressive growth of trees than is here given, and it would be of infinite advantage to all interested in timber growing, were every intelligent forester to turn his attention to this point, and lay up, at least for himself, from his own experience, as extensive data as possible relative to the periodical increase in the growth of timber on the estate upon which he may be employed.

Before concluding the present section, it may not be out of place to answer a question which has been very frequently put to me by proprietors of plantations—namely, what height should a tree of a given species be at a given age? My answer is, that under equal circumstances of soil, management, and situation, trees of any species will, at a given age, be pretty nearly a given height, but may, under different circumstances of soil, &c., greatly vary in height. Thus, if we suppose that an oak tree at forty years of age should be as many feet in height, when growing on a level and moderately sheltered part of the country, it is quite likely that another oak of the same age, if planted on a high and exposed situation, will not be much more than twenty feet high; and again, another oak of equal age, planted in a sheltered glen, may attain the height of sixty feet in the same number of years; thus showing us that, in this respect, as in the diameter of trees, a very great deal depends upon soil, management, and situation; consequently, no definite rule as to this point can be stated.

SECTION V.—HOW TO FIND THE VALUE OF GROWING PLANTATIONS, AND OF FULL-GROWN TIMBER TREES.

The valuing of plantations is a point in forestry which, to be done properly and justly, requires the exercise of the judgment of a man who has had long practical experience in the matter. He who gives himself out as a valuator of plantations, in the settlements and divisions of landed property, must be possessed of an accurate knowledge of the prospective value of all the plantations that can possibly come under his notice, under the age of full-grown timber. He must have an intimate knowledge of the habits of growth of the different species of forest-trees, and of the influence of soil and local climate on their periodical increase of timber; these qualifications being absolutely necessary in the valuing of young plantations while they are under the age of full-grown timber trees; and as such qualifications are only attainable by a pretty long course of experience as a practical forester, I shall here state only the general method of going to work in valuing plantations.

In taking the present transferable value of plantations, they are divided into three different and distinct classes, namely:—

1st, Plantations not thinned for the first time.

2d, Those which have been thinned, but are under full-timber size.

3d, Those of full-timber size.

As each of these classes is valued in a manner different from the others, I shall here treat of the manner of valuing in each case separately. With regard to the first, then—were I called upon to give the transferable value of any young plantation which had not been thinned for the first time when I saw it, I would in the first place calculate the original expense of fencing and planting; and having ascertained this point, I would next measure the extent of the plantation in acres, and put upon it a rent per acre, corresponding with the land in the immediate neighbourhood, but in all cases making an allowance for inaccessible heights and hollows. Then, the rule for finding the valuation is—to the cost of fencing and planting, and the rent of the land occupied for the time, add the amount of compound interest on these, and the result will be a fair transferable value between two parties.

With regard to the second class of plantations mentioned above, namely, those which have been thinned, but are under full-timber size:—

When trees attain a size when it is necessary to thin them for the first time, they will then afford certain evidences on which to found calculations of their ultimate produce and value. Therefore, at the time when young trees show evidence of their future health, and until they have attained a full timber size, the valuation of such plantations ought to proceed on the principle of prospective value, and the rule for doing so is this:—First, determine the number of years the trees will require to arrive at maturity; second, calculate the value of all thinnings that are likely to be taken from the plantation before it arrives at maturity, and that in periodical thinnings of five years from the time that the valuation is taken; and third, estimate the value of all the trees which will arrive at perfection of growth: from the total amount of these sums, deduct compound interest for the period the trees require to attain maturity, and the result will be the present transferable value of the plantation.

With regard to the third class of plantations as above stated—namely, those which have arrived at full-timber size:—

As this is a class of plantations which every forester ought to be able to value at sight, I shall be more particular in pointing out the method of going to work in the valuation of such. Few foresters are ever called upon to value the two first-named classes of plantations, but the case is altogether different with regard to full-grown trees: these are the harvest of their labours, and they are almost every day called upon to cut down and value trees of full-grown dimensions. In this case it is not the transferable value of the unripe crop as found upon the land that we have to do with: it is the simple value of wood itself—the value of each tree in its perfect state, in so far as the ground is qualified to produce it. It is often necessary that full-grown timber trees should be valued previous to their being cut down; and particularly in the case of a transfer of property, it is absolutely necessary to have this done, inasmuch as the trees are a part of the property to be sold. In taking the value of timber in its growing state, two methods are in practice among wood-valuators; the one is to measure the height of each tree by means of a measuring pole with a ladder, and by actually girthing the tree in the middle with a cord, and finding the contents in the usual manner of measuring round timber: the other method is, that of judging by the eye the number of feet that each tree may contain.

With regard to the first method—namely, that of measuring the trees by means of a pole with a ladder—some suppose that this is the most correct way of going to work in the valuation of growing timber; and in consequence of this opinion having for some time past prevailed among the older class of valuators, much precious time has been lost by them, as well as useless expense entailed upon the proprietors who have employed them. I have myself seen three men, apparently busily employed for the space of ten days, in the measurement of four hundred trees, by the method in question; and even after all their labour, their valuation was disputed. A friend of mine being called in to make a second valuation, he did so by estimating the size of each tree by sight, and did the whole work in about half a day; and when those trees actually were cut down and measured, his report of the valuation corresponded to within five per cent of the truth, while the report given by the other party was thirty per cent beyond the truth;—this instance at once pointing out the possibility of being very incorrect in the valuation of trees measured with a pole and cord. From the many obstacles that are apt to come in the way, it is almost impossible to measure correctly any large tree in its growing state; and by a short sketch of the manner of proceeding in this kind of work, the difficulty of correctness will at once appear. In measuring trees thus, the valuator has with him two men—the one carrying with him a pretty long ladder, in order to get upon the trees from the ground; while the other bears with him a measuring pole, generally about ten feet in length, divided into feet and inches for measuring the height of the tree, and a tape line marked with feet and inches for taking its girth. With these assistants thus furnished, the valuator proceeds by causing the man with the ladder to hold it to a tree, while the other goes upon it, and with his rod measures the height of the tree as he proceeds upwards. Having ascertained the entire height, as far as may be considered measurable timber, he again measures downwards, one half of the height of the tree, in order to take the girth at that part, for calculating the side of the square; and in this manner the valuator proceeds from one tree to another, noting down the dimensions as he proceeds. Now, as to correctness, this method would do very well, provided that there were no branches upon the trees; and, no doubt, the operators always choose that side of a tree which is most free from branches; but, notwithstanding, there are few trees which, in taking a straight line from top to bottom, have not several branches to intercept the object. This is what makes their measurement so very incorrect; for when the man with the pole has his line of measurement intercepted by one or two branches, he generally has to change his position upon the tree, and this often many times in the ascent of one tree ; — often causing, consequently, an error of several feet in the value of one tree, less or more. Mr Monteith, the well-known author of the *Forester's Guide*, invented an instrument, which wrought with a wheel in taking the height of a tree, and this instrument he himself used in the valuation of forest trees. But for the same reason that I have already mentioned—from the wheel being interrupted by the branches of the trees—it soon fell into disrepute, and is now scarcely or ever used; besides, the time and labour required are very much against its being used by active valuators of the present day. Such men, in almost all cases, accustom themselves to estimate any standing tree simply by sight—which is, indeed, when done by an experienced man, the method most to be depended upon. The eye is not easily deceived in the comparative magnitude of any two or more objects; and more particularly, if it has been long accustomed to compare the relative sizes of different objects of the same form, its judgment, if I may so speak, becomes almost indisputable; at least, a man is very seldom deceived by his eyes in the viewing of an object, if he have but accustomed them to act in accordance with his judgment; and this is all that is required in order to give a correct idea of the size of any tree. It merely requires that the eye should be accustomed to the work, and that judgment should never be passed on the size of a tree until the mind is actually satisfied of the truth of the impression produced.

Every forester ought at once to be able to estimate the size of any tree on first sight of it. But a course of training is necessary before being able to do this ; and as I myself, in all cases of valuing growing timber, pass judgment of the size simply by sight, I shall here point out the course of training necessary to those who may wish to excel in this most useful point in forestry.

Those who never have accustomed their eyes to compare the relative sizes of different objects, may at first be led to think that it is impossible for any man to give a correct judgment of the exact bulk of one tree as compared with another. This opinion, at first sight, is natural; but the power of habit is well known to be incredible; and those who entertain the idea of there being great difficulty to overcome, may be assured that a few weeks of persevering practice will overcome all the difficulty. When I first commenced training myself to value trees by sight, I was engaged in the thinning of plantations from twenty to forty years old. For a few weeks I, in every case of cutting down a tree, first eyed it from bottom to top, and from top to bottom, and passed my judgment as to the number of cubic feet it contained before I cut it down; and as soon as I had the tree cut down and pruned, I measured the length with my rule, and took the girth in the middle, and, on casting up the contents, I compared the result with my previous judgment of the matter; and at the end of three weeks, which time I was employed in the thinning of the plantations mentioned, I could have told, to within a mere trifle, the actual number of feet and inches in any individual tree before I cut it down. In the same manner I practised myself when cutting down large trees, embracing every opportunity of improving my judgment upon the point, until I came to have perfect confidence as to the correctness of my decision.

But there is one remark which may be useful to mention here, relative to the correctness or incorrectness of the judgment of the eye in taking the size of a tree—namely, the mind must be perfectly at ease. A valuator, with his mind uneasy upon any point foreign from his present purpose, is certain to commit errors; and this I mention, in order that any young beginner, who may read this, and may commence his training in the way I did, may be upon his guard at all times when valuing.

Having thus pointed out the way by which any forester may acquire the useful habit of valuing trees by sight, I shall now give a statement of the manner in which I generally go to work in the actual valuation of the trees in a plantation.

When called upon to take the valuation of a plantation of full-grown trees, or, as it may be, a thinning of trees from a plantation, I provide myself with a pretty large pass-book, containing, as usual, money columns on the right-hand side of each page, and the spaces upon the left-hand side of the money columns I divide into four equal parts, parallel with them; the first space upon the left-hand side is for entering the numbers to correspond with those intended to be marked upon the trees; the second for entering the species of each tree as it is numbered; the third for entering the number of cubic feet contained in the tree as marked; and the fourth contains the price, per cubic foot, of each tree as numbered. The following sketch of this form of book will more readily assist the learner:—

Number of each Tree.	Species of each Tree.	Cubic feet in each Tree.	Price per foot of each Tree.		£	s.	d.
			s.	d.			
1	Oak,	90	3	6	15	15	0
2	Ditto,	30	2	6	3	15	0
3	Ash,	82	2	0	8	4	0
4	Ditto,	20	1	6	1	10	0
5	Elm,	73	2	0	7	6	0
6	Ditto,	30	1	8	2	10	0
7	Beech,	75	1	6	5	12	6
8	Ditto,	25	0	10	1	0	10
9	Plane,	87	3	0	13	I	0
10	Ditto,	26	1	6	1	19	0
11	Larch,	64	2	0	6	8	0
12	Ditto,	32	1	4	2	2	8
13	Scots Fir,	58	1	6	4	7	0
14	Ditto,	18	1	0	0	18	0

In the act of valuing trees in the forest, I do not, of course, take time to sum up the value of each tree, but leave the money-columns blank until I have the work finished, or at least until the evenings when I get home, when I have leisure to do so correctly. Having provided myself with a book of the description mentioned above, all ready and ruled, with the numbers filled in, and the uses of the columns written along the top of each page, I next engage three, or perhaps, if the trees are hard in the bark and difficult to mark, four men of active habit, each provided with an *iron* adapted for the marking of figures upon the bark of trees: one of the men begins by marking No. 1 upon the first tree to be valued, a second man marks No. 2, a third No. 3, and the fourth No. 4; and in this manner the four men follow one another, each of them marking his own number next in succession upon another new tree; that is, if the first man mark No. 1, his next in succession will be No. 5, if the second mark No. 2, his next in succession will be No. 6, and so on with the rest. When the men are properly arranged at their work of marking the trees, I next commence myself with the tree having the mark No. 1 upon it, and write opposite the same number in my book the species of the tree, next the number of cubic feet that I think it contains, and lastly, the price per cubic foot of each tree, such as I think it would really bring in the market at the time of valuation. In the same manner I go on with every tree to be valued.

I may remark here that every valuator of growing timber, previous to entering upon the valuation of it in any locality with which he is not well acquainted, should in all cases make himself properly aware of the general prices of wood in that district; for if he do not, he will unquestionably commit gross errors in his work. If, for instance, a valuator were to be called from Edinburgh to value wood in the county of Peebles, or any other inland district, and he proceeded to value the same according to the rate of wood-sales in the neighbourhood of Edinburgh, his valuation would, of course, be about one-half too high; because in the county of Peebles, or indeed any other inland district, there is little or no demand for wood: consequently, before the wood could be sold, it would require to be carted by the purchaser a great distance to reach a market; and seeing this, the valuator should always regulate his prices per foot according to the prices that he knows will be given at the nearest sea-port, deducting the expenses which will be necessary to carry the timber between the place where it is growing and the sea-port where it is to be sold.

CHAPTER VII.

Effects of Transplanting upon the Constitution of Trees, as that has hitherto been practised—Method of Preparing large Trees for Transplanting—Method of Transplanting large Trees, and description of Machine for performing that operation—Method of Renewing old or decaying Trees—Fencing of Park Trees so as to protect them from Deer, Cattle, &c.—Effects of Underwood upon the Health of Trees in a Plantation—Kinds of Plants best fitted for growing as Underwood in a Plantation—Rules and Regulations necessary to be observed in the cutting down and selling of Trees—Hints to young Foresters relative to the nature and amount of Education necessary for them.

SECTION I.—EFFECTS OF TRANSPLANTING ON THE CONSTITUTION OF TREES, AS THAT HAS HITHERTO BEEN PRACTISED.

For many years past, the transplanting of large trees from the forest ground to the park, with the view of producing an immediate effect where these were wanting upon the home grounds of proprietors, has been practised with more or less success, and that in proportion as the operation of removing the trees had been done in the manner least tending to check the healthy flow of vegetable life in the trees so removed.

It appears very evident to me, that any tree, however large it may be, if only in a healthy and growing state, may, under certain circumstances, be as safely removed from one position to another, as the merest sapling from the nursery bed. If we can, in our every-day practice, calculate on the certainty of a small oak tree growing when it has been removed from the nursery-row to the open forest land, may we not, with equal certainty, calculate upon a large oak tree growing, when merely removed from one part of a landed property to another, provided the operation, in the case of the large tree, be performed with that amount of care and skill which is necessary to preserve in healthy action all its life principles?

I am aware that many entertain opinions, relative to the transplanting of large trees, very different from mine as expressed above; and those who differ from me as to the propriety and practicability of safely transplanting large forest trees, say that the constitution of a young tree is more pliable and not so easily injured as that of a large one, and consequently is not so easily affected by sudden change or removal. This, no doubt, is true; but if we, in the removal of a large tree, can but adjust the operation to the natural wants and requirements of the subject handled in the same proportion as we can do to the smaller one, are we not, according to the usual laws of nature as found to exist in all plants, equally entitled to say that the one will continue in health as well as the other? There can, I think, be no dispute as to that; therefore, in the transplanting of all trees, whether young or old, large or small, all that is required in the operator is, *to adjust that operation to the natural wants and requirements of the subject*, when the success will be as complete in any one case as in another.

Those who maintain that success in the transplanting of large trees cannot be obtained in equal proportion as in the case of young ones, point to the many failures that have taken place in that department of arboriculture, on, undoubtedly, very many landed properties in Britain,—saying at the same time that a great deal of money has been uselessly expended by proprietors upon that operation, who have had nothing but disappointment as their reward in the end. This I must also admit. But the grand question is, Were those trees which failed to grow according to the expectations of the proprietors who so laudably endeavoured to ornament their estates, and which cost them so much labour to little purpose, transplanted in such a manner as to fulfil the conditions we have specified? I fear not. Wherever this rule has not been attended to in times past, disappointment has been the result; and wherever it shall not be attended to in future, disappointment will also follow as the natural consequence. Having premised the above, I shall now endeavour to point out the cause of disappointment where that has taken place in the transplanting of large trees.

It is not to be wondered at that many of the cases of transplanting large trees, hitherto performed, have failed of that degree of success which was expected as the result, seeing that not one out of ten of them has been conducted upon principles consistent with the ordinary laws which are known to maintain a healthy state of vegetable life. Every tree of any considerable size has its principal feeding roots situated, for the most part, at the greater distance from its stem; consequently, in the case of removing a large tree from its original site, those must necessarily be cut off, and cannot act as absorbents of nourishment for the parent stem afterwards. Keeping this in view, then, is it anything remarkable that we find a tree dying after it has been separated from its means of deriving nourishment from the earth? Such a result is quite in accordance with the laws of nature as found to act upon vegetable life; and this has exactly been the state of things relative to those large trees which, after having been transplanted, either died suddenly or lived a few years in a languid and sickly state, and that just in proportion as they might have had less or more healthy fibrous roots left upon them at the time of removal.

I have not unfrequently seen trees of a considerable size lifted from their original site and transplanted into another, where they were expected to succeed well; and yet they had been, as it were, torn from the soil and all their roots left in it, little or no precaution having been used to retain them. In such cases, the soil was removed from all the roots to a considerable distance round the stem, leaving only those roots attached which were large and bare, and without any supply of small fibres, those having been separated in the act of removing the earth; and, with as much soil attached to the part where the roots issue from the stem as the nature of the means of conveyance would admit of, the trees were again put into the earth, but in nine instances out of ten the trees so dealt with never again recover so far as to assume a tolerably healthy or respectable appearance.

This has indeed been the most primitive system of transplanting large trees; and as an improvement upon it, a system of previously preparing the roots for removal has been adopted, which, indeed, considering all the circumstances, has been a decided improvement upon the old style, but has not yet been attended with that amount of success which the nature of the case demands, and which it seems quite possible to attain. The system of preparing trees for transplanting, as practised for a number of years past, is this: Any large tree, the transplantation of which was anticipated, had a trench dug round it, at such a distance from the stem of the tree as was considered expedient for the purpose of removal, according to the size of the subject to be handled. This trench was dug so deep into the earth as to cut all the side roots as far down as those were found, with the exception of perhaps two or three, which were left uncut to act as stays in the earth, both for the time being and after the tree was removed. It was then again filled up; but if the soil was naturally bad, a quantity of better was substituted, with the view of the more readily encouraging the cut roots attached to the tree to push out fresh ones to act as feeders when the tree was removed to its new site. In this state it was again left for a period, generally of two years, when all the cut parts of the roots had pushed out afresh into the new soil. The tree was now considered fit for removal, which was performed in the following manner:—

In taking away the earth from its roots, the workmen began first by opening a new trench all round, and exactly upon the outside of the one which had been formerly made, making the level of its bottom a few inches under that of the latter, with the view of the more readily getting under the level of the supply of young roots, now supposed to be made within the compass of the first trench. This being done, the workmen, with small picks made for the purpose, loosened very carefully the body of the soil, as contained in the previously made trench, beginning upon the outside of the circle, and gradually working in among the young roots made, so as to separate them from the soil; and as these progressed, others were employed in throwing out the soil thus loosened, taking care to disturb or injure any of the small tender roots, now hanging loose, as little as possible. In this manner the men followed each other regularly, till they had the ball of earth contained within the compass of the first trench well reduced, and all the young fibrous and other roots, as those appeared, preserved as well as the nature of the work would admit of. When all these had been separated from the soil on the outer part of the ball, the remaining part, immediately round the bottom of the stem, was preserved entire, and taken along with the tree; and as soon as this part had been undermined, or freed of any hold it had perpendicularly in the earth, a pole, which was fixed upon an axle with a pair of wheels, was applied to the stem of the tree, and tied firmly to it, by which means it was pulled down, with the ball and all its appendant roots, resting upon the axle, and hanging between the wheels. In this state the tree was drawn by horses to the place where it was to be replanted. In the act of replanting, the bottom of the pit, which had been previously made for the reception of the roots, had a quantity of good soil put over it: the tree was then put in, and the roots spread out, and replanted in as careful a manner as possible, new soil being used when that was considered necessary for the health of the plant. In all cases where the situation was an exposed one, and the ball of earth light in proportion to the top weight of the tree, large sticks or ropes had to be used, in order to keep the newly-planted tree firm in its position, until the roots had become properly established in the new soil. And where the newly-planted tree was found to shake much from the action of the wind on the heavy top branches, some were in the habit of putting heavy stones all round on the ball, in order to counterbalance the top weight; others adopted the plan of laying large beams of wood across the ball, sinking their ends into the firm soil on each side, and nailing them to stobs driven in at the ends; while various other means were had recourse to, according as the ideas of the parties interested in the work might suggest: all this pointing out that the art of properly and securely transplanting forest trees of a large size was but imperfectly understood; and all this I have myself witnessed in actual practice, performed by men of first-rate standing in the country as practical planters of their time.

Having thus given a very brief outline of the manner in which the transplanting of large forest trees has been conducted by many hitherto, it now remains for us to examine a little as to how far that system of operations fulfils the conditions required, and how far it is commendable or not. First, then, we are aware that no tree can form a healthy development of leaves and branches unless it be supplied with a corresponding healthy development of roots, by which to draw food in the form of solution from the surrounding soil; and yet no healthy tree, although deprived of a portion of its roots, will sustain any permanent injury, provided it be allowed to remain undisturbed in the soil till it has again replaced those roots, if, after new roots have been made, they be preserved from further injury. Secondly, that the merely hardwoody portions of the roots of a tree are not of themselves capable of drawing nourishment to any considerable extent from the earth, unless they be well furnished with the small terminal rootlets, which are of a soft, spongy texture, and which are considered as the mouths by which the sap is sucked from the earth into the plant; and, thirdly, that those very rootlets, which are so essential to the preserving in a healthy state any tree or plant, are very susceptible of injury, either by being unduly exposed to the action of the atmosphere, or by their fine outer coats or skin coming roughly in contact with any body harder than themselves. Applying those facts, as they are known to affect vegetable life, to the operation of transplanting large trees, as already stated in the foregoing, we must conclude thus: The plan of digging a trench round the trees to be transplanted, if not overdone, has no permanent bad effects upon the constitution of a tree; it gives, no doubt, a temporary check to the system of the ascent of the sap, but as soon as the roots have again renewed themselves, the strength of the sap will gradually resume its former tone; therefore, as regards this part of the operation, no important evil can arise; and the first head, as laid down, is thus dismissed. But in applying the second and third heads laid down, the system of transplanting formerly stated is much at fault; for, in removing the soil from the very soft and tender rootlets, which were so recently produced by nature for the support of the tree, their functions are so much damaged and impaired, in consequence of coming in contact not only with the strong atmosphere, but with the hands and implements of the workmen, that they are almost all rendered unfit for any further healthy action. It is in this respect alone that the operation is *not* adjusted to the natural wants and requirements of the subject handled, but is diametrically opposed to sound natural principles; and though the very system of transplanting, which I here consider as insufficient, is yet very frequently practised, I am not aware that its advocates can point out many trees of considerable dimensions, which have been lifted and transplanted by them in this way, without their having received so much injury, that they are yet stunted in their appearance, and do not indicate full health and vigour of constitution as compared with trees not removed. On examining trees transplanted on this system, they may sometimes indeed have a fair outside appearance, like the hectic flush of a delicate person; but, on close examination by an experienced eye, the reality is at once evident: external indications are at once discerned that the inward constitution of the subject is gone, and, consequently, that its duration will be comparatively short. Besides this, the machine which has been in general use for the purpose of removing large trees by the method above detailed, is so very imperfect, that no tree of any considerable dimensions can, with any degree of safety, be conveyed by it. When an assistant under-forester, I was employed, along with others, in transplanting pretty extensively upon an estate in Fifeshire, where we lifted from the forest ground a number of pretty large trees, some of them being above fourteen inches diameter near the bottom of the stem, and about forty feet high, and had them planted on the parks where necessary. These trees had been all previously prepared in the manner already detailed. When we took out our trench, and commenced separating the soil from the recently formed young roots, we found them in the most healthy state possible, and at the same time very plentifully formed on all the old roots which had been cut; and although in most cases we managed to get them relieved in as good a state as the nature of the operation would admit of, yet when we came to have the tree removed from its original stance, we had great difficulty in getting all the roots taken away, without more or less of damage in some way or other. Sometimes a valuable root was unavoidably torn away by coming in contact with the ground, or with the wheels of the janker, as the machine is called; and sometimes another was broken by the men having occasion to handle them when any unforeseen accident occurred; and all this in consequence of the nature of the machine not being adapted or powerful enough for its work: while I have very often, too, seen a principal limb torn away by coming in contact with the road as the horses pulled the tree along. All this plainly showed me that there was great room for improvement in the process of removing large trees; and from that time I began to consider the operation as practised altogether imperfect, and having a great tendency to hurt the constitution of any large tree so dealt with. As soon, therefore, as I had the management of woods on my own account, I began to experiment and follow a different system, which I shall now detail in the following section.

SECTION II.—METHOD OF PREPARING LARGE TREES FOR TRANSPLANTING.

Having thus had my attention directed to the transplanting of large forest trees for park scenery, at an early stage of my practice as a forester, and being convinced that the systems in general practice were not of a nature calculated to insure the healthy establishment of trees so dealt with, I began to think for myself as to how the operation in all its branches might be improved.

As improvements of the first importance in the process, it appeared to me that some successful method should be adopted, whereby every recently made root adhering to the plant at the period when it was to be taken out of its original site should be preserved entire and undisturbed through all the operation of transplanting; and second, that a machine of great power should be constructed, by means of which a whole tree, of whatever dimensions, with its ball of earth and roots, should be lifted and conveyed in an upright and natural position, and laid down in its new bed as entire as when taken up. Those two points forming, as it were, the whole art of transplanting, I thought that, could they be attained, any other minor points would be easily managed. In order, therefore, to accomplish them, I set about, in the first place, a system of reasoning in my own mind, and of trying experiments relative thereto. The first question which I put to myself was this :—Is it possible to have any given tree in a forest removed, with all its natural roots entire and undisturbed, and placed in the ground again as it was taken up? I did not require to think long for an answer to this question, as it appeared at once very evident that, in order to do this, a quantity of soil would require to be removed, and that all in one piece, which would be quite impracticable, seeing that the roots of one single tree, growing among others, came in contact with those of its neighbours in every direction all around; and thus I at once saw that, to remove any large tree with all its natural extent of roots entire, and soil attached, must remain an impracticable operation —at least for the present. Secondly, seeing, or at least admitting for the present, that this is impracticable, can no system of raising forest trees be adopted, by means of which, at any given time or period of their existence, they might be removed from their site, with all their roots and soil attached, without those parts being in the least disturbed? The case of a plant in a pot or box suggested itself to my mind, and the inference that I drew from this was, that if we can grow a plant in a pot or box to a pretty large size in a healthy state upon the stage of a greenhouse, with all its roots enclosed, we may as well grow forest trees in boxes of a larger size sunk in the open ground; and, from the circumstance of their roots being all collected there, they might be removed at any convenient time to any required place. This at once appeared quite a practicable case; and trees in this state could be reared upon any gentleman's property, when they could be transferred in a healthy state from one place to another, with impunity to their roots; provided they were not, in the first place, too long confined within a narrow compass, and that they were removed by a machine powerful enough to do the work safely. This, I say, appeared to me to be a branch of arboriculture quite attainable; but as no trees had as yet been cultivated upon that principle, such could not be obtained for a considerable number of years; so that, however practicable this might be in future generations, in the mean time it was out of the question; for the point wished was, not so much that of rearing trees to a large size for the purpose of being ultimately transplanted, as to have in the mean time any given tree, growing in the usual way in the forest, transplanted safely, with all its roots, &c., to any other part. Notwithstanding that, for the present purpose, the system of rearing forest trees in boxes was thus unavailable, the case of a plant growing in a pot still presented itself to my mind, and no other method I could think of appeared so feasible; and reasoning from this, it appeared to me, that if a large tree growing in the forest could not be removed with all its roots entire as those were found in the natural state, they might at least be all shortened in to a given practicable extent round the tree, without doing the subject any material injury, and this in the way which has been practised hitherto; but instead of allowing the young roots issuing from the cut part of the old, &c., to extend themselves unduly, as generally done, let them be confined and collected within a given practicable space; the tree could then be removed and transplanted, as we usually see gardeners transplant a flower from a pot to the open ground of the garden. This appeared to be the only reasonable and practicable method of preparing trees of a large size for transplanting that I could devise; consequently, I set to work to have a few experiments made upon it.

Preparative to actual experiments relative to the point referred to above, I began to examine the state of the roots of trees of different kinds, as they were found to exist naturally in different plantations, growing upon various descriptions of soil, and under different systems of management, at all the ages I could conveniently find or come at. As the result of those examinations, I arrived at the following conclusions:—First, a tree of any given species is better supplied with small fibrous roots when growing upon a light porous soil, than on a soil of an opposite character. Second, the roots of trees growing in a heavy or clay soil, extend themselves to a greater distance from the main stem in search of food, than they do in a light and open soil. Third, the small fibrous roots of trees are most plentifully formed near the surface of the ground; and the deeper in the earth the large roots of trees are found, the fewer fibrous roots are upon them. Fourth, the more confined any tree is among others in a wood, the fewer and the weaker are its roots; and the more exposed it is to the free influence of the air, the more abundant and healthy these are. Fifth, the more a tree becomes clothed with branches, the better is it supplied with small fibrous roots. Sixth, in soils of a naturally cold and damp character, the roots of trees are few, weakly and unhealthy; and in those naturally dry, the opposite is the case. Seventh, the principal masses of the fibrous roots of trees are generally found to coincide with the extension of their branches; and they are also generally found most numerous upon that side of a tree which has been most freely exposed to the influence of light and heat.

Having arrived at this stage of my examination as to the natural disposition and character of the roots, and having arrived at the seven foregoing conclusions as sign-posts for my further guidance, the next step which appeared necessary, in order to arrive at anything like a decided improvement in the art of transplanting large forest trees, was that of putting to practical use the knowledge thus attained. And I may mention here, that, in this preliminary investigation, I spent no less than the leisure time of three years successively. I did not content myself with examining the trees growing upon one property alone; my researches included several estates, and that, too, in several counties both in the middle and northern parts of Scotland; and not till I was thoroughly satisfied as to the truth of the conclusions I had formed, did I begin to set about the experiments now to be described. In giving a detailed account of the different experiments for determining the best mode of procedure best adapted to secure the end in view, I shall begin with the first conclusion in order — namely, a tree of any given species is better supplied with small fibrous roots when growing on a light porous soil, than on a soil of an opposite character. Being, then, aware of this fact, I commenced my experiments with an oak about thirty-five years old, which grew in a light sandy loam on an open situation, and quite free from the interference of any other tree. It was then nearly thirty feet high, with a diameter of trunk at bottom of about fifteen inches. The tree was of a fine spreading habit, with branches fully corresponding to its size and age. I first took a cord and tied it loosely about the bottom of the trunk of the tree; and after considering a little as to what distance I ought to cut in the roots all round, I fixed upon four feet as the half of the diameter of the circle I should make for that purpose, exclusive of the diameter of the bole itself. Then with the cord in my hand, held at four feet from the bole as a centre, I described a circle all round, making the diameter of the ball of earth fully nine feet. This being done, I had a trench dug all round on the outside of the inscribed circle about eighteen inches wide, and so deep as completely to go under all the side roots: that depth was in this case nearly two feet and a half, the subsoil being a sort of earthy sand. In digging the trench, I found the main roots very plentiful, and pretty regularly dispersed all round, but more abundant on the south and west sides, which were most exposed to the influence of light and heat. As the digging of the trench progressed, I had all the roots carefully and smoothly cut, as those appeared upon the inner side of the trench, so as to leave no roughness on the wounded parts for the lodgment of water about them. Under the depth of two feet from the surface, I found the roots scarce, and with few or no fibres; therefore I determined, at this stage of the operation, to have these more closely cut in, so as to cause them to produce a more plentiful supply of small roots for the future health and establishment of the tree when removed. Accordingly, I had the ball of earth situated between the trench and the stem of the tree undermined all round, leaving it only about twenty inches deep upon the outside, and gradually sloping it downwards as I approached the centre of the ball under the tree, where it might be fully thirty inches deep. This undermining, however, was not carried to such an extent as to come in contact with any of the tap roots situated immediately under the stem of the tree. Had this been done, it would have given too severe a check to the tree, as I considered that the tap roots were essentially necessary for its support, at least until the roots, which were now shortened, had pushed out fresh young ones for drawing in a supply of nourishment. I merely undermined the ball of earth, formed about the roots, to the extent of about two feet inwards from the perpendicular of the same all round. Having this part of the work, as detailed, all finished, I next, with a small pick, took away all loose pieces of soil from the sides of the ball all round. In doing this, wherever I found it deficient in roots, I applied the pick, and had the soil taken away till I came in contact with roots; and wherever I found them, I at once left off without disturbing them further. At this stage of my operations, the ball about the roots of the tree presented rather a rough appearance. On some parts the cut points of pretty large roots protruded, and on others the earth was hollowed out, showing that many fibrous roots were lying there; but my meaning for this will be better understood after I have explained how I finished the work.

Before commencing with the work of preparing the ball of earth around the tree as above detailed, I had ready prepared a quantity of half-rotten vegetable mould, consisting principally of leaves and small twigs of woody matter as collected from cleanings of the lawn. To this I added an equal quantity of light peat-mould, mixing the two well together; and of this compost I put in about nine inches thick all round the ball. In doing this, I began at the bottom or lowest point of the excavated ground, replacing the soil which was thrown out gradually with the compost; putting it in next the roots of the tree to the thickness already stated, and giving it a slight tramp with the foot in order to compress it a little. The soil which had been removed was then returned behind the compost, and to this also a firm tramping was given, making it as solid as possible, and keeping all the worst of the soil thrown out next the compost. In putting in the compost about the roots, wherever I came to a hollow part, as made where there had been few roots upon the ball, I filled them completely up with it, extending it, at the same time, to the ordinary thickness round the outside area of the ball; thus, in places where any of those hollow parts occurred, the compost was sometimes fully two feet in thickness—this being with the intention of encouraging an extra supply of roots to grow at such parts. In this manner I went on with the work till I had the whole extent of the ball equally done; and when I came to the surface level of the ground, I spread about six inches of the compost over on the ball; in which state I considered the preparation of the roots of that tree completed. To another tree of the same kind, upon the same soil, and of the same age and general character, I performed the like operation at the same time; but in this case I had the principal large branches shortened in to the extent of about one-third of their length; that is, I took off about one-third of the length of each of the larger branches, and put them into a regularly balanced state. In this case I did not attempt anything like a regular pruning of the tree, by taking off any branches from the trunk: I merely shortened in, and that without producing any bad effect as to the natural outline of the tree, any large overgrown limbs which appeared to have an undue ascendency upon it, and to require an undue proportion of the sap of the tree to support them.

Having thus detailed my first experiment in preparing trees, growing upon a light soil, for future transplantation, I shall next give a similar statement relative to others growing upon a heavy clay soil, exemplifying the practical bearing of the second conclusion formerly mentioned—namely, the roots of trees growing in a heavy or clay soil extend themselves to a greater distance from the main stem in search of food, than they do when growing in a light and open soil. Keeping this fact in view, I sought for two trees growing upon a clay soil, and found such as I desired; the one an ash about thirty-eight years old, and the other an elm of the same age; both good healthy specimens, but both had been a little drawn up in the bole at an early stage of their growth, and, consequently, were what might be termed rather bare of top branches. However, they were both perfectly healthy and stout in the bole, (about the same diameter as the oak,) and promised to become good ornamental trees if judiciously exposed, for they were growing in a plantation among others of the same kind. I determined, therefore, upon having their roots prepared; and, with this view, I had two or three trees cut away from about them, in order that they might in future have more free air for the spread of their branches. This being done, I next caused a trench to be opened about the ash, in the same manner and to the same extent as formerly described in the case of the oak. I was absent on other business while the men were employed in casting out the trench of the first tree operated upon, which was the ash. On my return, I found that they had thrown out very few small fibrous portions of roots; but what they had come in contact with were principally bare roots, of from one to three inches in diameter; and, following out the lead of a few of those roots upon the outside of the trench, I found that the principal masses of the fibrous roots extended outside to the distance of about other three feet. But having the trench made, I determined to have the operation completed, and judge afterwards of its effects. When the trench was all thrown out, and the ball of earth surrounding the tree undermined as with the oaks, I next took the pick in hand myself, and commenced taking off a rather large quantity of the stiff clay soil forming the ball, in places where there appeared to be no roots existing. In this instance I had to reduce the ball very much; in several parts right through to the bottom of the trench; but wherever I came upon roots of any size, however small, I at once left off there; and in this way I reduced the ball all round till roots of some size or other appeared. This part of the operation being concluded, I next had a quantity of vegetable mould, as before described, and an equal quantity or bulk of well-rotted turf mould, well mixed together, and had all the openings in the ball properly filled up with it, making it rather compact in among the roots by pressing with the hands. When the openings which I had made with the pick were all completely filled up on the flat of the ball, I next commenced and put the compost all round on the outside, keeping it fully nine inches in thickness between the clay soil put in behind, and the nearest of any one of the points of the roots projecting from the ball. This I did in exactly the same manner as in the former case of the oaks; always observing to pack the clay very solidly behind the compost put in, and the compost itself more slightly; and when the whole was levelled to the surface, I covered the top of the ball with the compost to the thickness of about six inches. The elm tree I operated upon in exactly the same manner; with only this difference, that I made the trench round it one foot farther from the tree, by which means I found more fibrous roots within the ball of earth than in the case of the ash. I may also mention that, after I had both trees finished, I had an open drain made from each, down to the level of the bottom of the trenches made; for, from the stiff nature of the soil, I anticipated that water might lodge in the trenches and destroy the health of the young roots which might be made. This I strongly recommend as being absolutely necessary in such work, wherever the soil is heavy; as, by the simple process of making an open drain from the bottom of the trench, no water can remain there, and the tree must altogether be preserved in better health, as well as have the advantage of a more healthy and sweet state of soil in which to form new roots.

With regard to the third conclusion arrived at, namely—The small fibrous roots of trees are most plentifully formed near the surface of the ground; and the deeper in the earth the large roots are found, the fewer fibrous roots are upon them—it will at once appear, in referring to the operations of preparing the roots of the different trees, as already detailed, that there were few fibrous roots, comparatively speaking, found under twenty inches from the surface; and to encourage the growth of these under that depth was my object in undermining the ball of earth, and putting a quantity of soil favourable for the production of roots under that part. We now come to the fourth conclusion, namely—The more confined any tree is among others in a wood, the fewer and the weaker are its roots; and the more exposed it is to the free influence of the surrounding air, the more abundant and healthy these are. Under this head I may remark, that trees of any kind, which have been injudiciously drawn up in a plantation, are the most unfit subjects that can be chosen for transplanting; therefore, in choosing trees for the purpose of transplanting, they should always be taken from the outside of a wood, where they will have had plenty of pure air to develop their branches, and, which is the natural accompaniment of this, a large supply of fibrous roots. It may not be out of place here to give a few hints as to the manner in which I have gone to work on Arniston estate in getting brought into proper state for transplanting a considerable number of trees, which, when I came to the place, were in rather a drawn-up condition.

On the north lawn at Arniston, there are three clumps of trees, extending altogether to about four acres, and which may be from twenty-five to forty years' standing, consisting principally of oak, ash, elm, beech, and lime trees. These clumps, when I came to the place to act as forester, were in a very close state, in consequence of many firs having been left too long among the hardwood trees which had been intended to form the principal ultimate crop. As I had no convenient selection of subjects for transplanting—without, indeed, going to an inconvenient distance on other parts of the estate for them—and as Mr Dundas wished to transplant large trees pretty extensively at a period not far distant, he gave me permission to have the clumps of trees, above referred to, thinned out to my own mind, with the view of making the trees, left there after thinning, form a future nursery for supplying him with subjects for his intended improvements upon the home grounds. With this view, I commenced and had all the firs taken out, as also all the hardwood trees which I considered would come to little ultimate value; and, altogether, I think I took out about two-thirds of the whole number of the trees as originally standing before I began to them. Those left have now stood about six years since I thinned them, and they are vastly improved in their health, having now, in general, fine branchy tops, and being clean in the stems, with healthy thick bark; and, by the way, I ought to observe, that any tree which is to be transplanted, of any size, should be possessed of a good, sound, thick, and fleshy bark. If a tree has bark in that condition, it is never easily affected by sudden change of exposure, whereas one with thin bark is easily hurt. In short, those trees are now such good specimens, that I intend this year to have a number of them prepared for being transplanted in two or three years hence. Having, I think, now shown how trees in a drawn-up state, which are always comparatively destitute of fibrous roots, and in that state unfit for being transplanted, may be recovered and made fit subjects, provided they are in a healthy state, I may also further remark, that, in choosing large trees as subjects for transplanting from any part of a plantation where the trees may have been formerly much confined, it should be carefully seen that the bark of the tree to be removed is in a good healthy state. When, therefore, it is desirable to have any part of a plantation thinned out as a nursery to supply large trees for the purpose, if the trees have formerly stood very close, they should be thinned out gradually, and not to the distance of the desired number of specimens all at once; for in this case, as well as in the case of other thinning of plantations generally, if the work be overdone, disappointment may follow: the trees, if too suddenly exposed, will become unhealthy in their bark; and if so, their future progress will be slow and uncertain.

We now come to say a little relative to the fifth conclusion mentioned, namely—The more that a tree becomes clothed with branches, the better is it supplied with small fibrous roots. In the choosing of large trees for the purpose of transplanting, this is a point which should never be lost sight of; therefore, the planter, in looking out for specimens which he would have with good roots, has only to observe the natural state of the tops: if they are spreading and branchy, he may rely upon plenty of good roots; and if they are tall, with few top branches, he may depend upon few roots existing upon them; consequently, such would make the very worst trees to transplant with any hope of success.

I may merely observe, relative to the sixth conclusion, which is —In soils of a naturally cold and damp character, the roots of trees are few, weakly, and unhealthy, and in soil of a naturally dry character, the opposite is the case—that in all cold damp soils, the growth of trees is invariably slow, as compared with others upon a dry soil; this arising from the weak and unhealthy state of the roots in the one case, and their more vigorous state in the other. He, therefore, who would wish to remove trees from a naturally cold and damp soil, must first, if he desires to be successful in the operation, have the ground well drained about the specimens to be removed; and either at the time of draining, or after the trees show more vigorous signs of health from its effects, the trees may be prepared in the roots, and afterwards removed with safety. I now come to relate an experiment which I made upon a tree which

I wished to have removed, and which grew upon a soil of cold damp clay. My reason for not relating it before is, that I considered it most proper to come under this head, as illustrating what may be done in improving the health of trees growing upon a cold damp soil.

On the estate of Craigston, in Aberdeenshire, where I prepared the oaks, the ash, and the elm, formerly referred to in this section, there grew a very fine-shaped Scotch elm, upon a flat piece of ground, which was of a stiff clay nature, and was, besides, naturally damp, and the subsoil of a cold clay till. The tree might be about fifty years old, and was, in consequence of the cold nature of the subsoil, showing symptoms of prematurity, which was indicated by the annual growths of young wood becoming small and weakly, and the leaves falling off very early in the autumn. As this tree was of a very spreading, fine, ornamental habit, I determined to attempt having it, if possible, put into a better state of health; and if I succeeded, to have it afterwards transplanted to a better and more interesting situation. With this view I had a trench, fully three feet deep, cast about it, at a distance of about six feet from the stem, all round. This trench I dug about two feet broad; and in the act of making it, the water stood plentifully when two feet under the surface, at which stage we were obliged to make a drain from it to a water-run close by. The drain being made, we got the water in the trench let off, and proceeded with the same to the desired depth. In the act of cutting the roots as we made the trench, we found them in a very bad state indeed: many of the larger roots had become entirely rotten, and upon the healthier parts the fibres were delicate and small. This was especially the case with the roots as found lower than about sixteen inches from the surface: above that depth, the roots were, in general, in a healthier state, and seemed not to have suffered so much from dampness; but over the whole extent of the ball they were weakly and unhealthy as compared with trees growing upon a drier soil. Having the trench finished, and the ball undermined as in former cases, the most earthy part of it well reduced, and all bad roots cut clean away, I had a drain made with stones all round the bottom of the trench, and conducted out to the burn. This being done, the ball was prepared and made up with compost, in the same manner as already detailed with regard to the ash and elm.

Before making any remarks as to the effects produced upon this tree by the operation performed upon it, I shall say something relative to the seventh conclusion, namely—The principal masses of the fibrous roots of trees are generally found to coincide with the extension of their branches; and they are generally found most numerous upon that side of a tree which has been most freely exposed to the influence of light and heat.

In reading the above conclusion, as laid down, it must not be understood to signify that masses of fibrous roots, growing from any tree, never extend beyond the spread of its branches. On the contrary, the principal masses of the fibrous roots of a tree may sometimes be found to extend very much beyond this; but in such a case there must exist an extraordinary cause; that is, in all cases where a tree is found growing in a soil of equal fertility throughout, the principal masses of fibrous roots will be found generally to coincide with the extension of its branches; while, on the other hand, if any extraordinary nourishing property exist not far distant from the roots of a tree, such as a water-course, a stratum of soil of a superior nature to that in which the tree may be standing, or heaps of manure, &c., they will far outgrow their usual pace in order to reach such extraordinary nourishment; and when they have, as it were, attained their desired possession, the principal masses of fibres will grow out and congregate there, although at a considerable distance beyond the extension of the branches. This may often be observed in the case of trees growing on the side of a wood where a well-cultivated piece of land may happen to be; then the roots will be found in tufted profusion in the land, and at a great distance from the trees themselves; and the same thing may be observed in the case of the roots getting into drains. All these cases, however, are extraordinary, and are not to be taken into account in speaking of the nature of trees as found under ordinary natural circumstances.

Admitting, then, as a truth founded on practical observation, that, under existing circumstances, the principal masses of fibrous roots of trees are generally found to coincide with the extension of their branches, an important question naturally arises—Should we not, in the removal of a large tree, carry along with it a ball of earth equal to the ordinary spread of its roots in the earth; or, if not to the extent of the spread of the roots in the earth or the branches in the air, by what rule are we to be guided in the operation?

Relative to this, as well as to many other matters of forest operations, different opinions are held. Some maintain that, in the act of transplanting a large tree, all its roots should be bared and traced out to their full extent *as nearly as possible*, and removed entire, along with the tree, without any respect being paid to a ball of earth; while others hold that no previous preparation is necessary for the removal of any tree, but that lifting a ball of earth, varying from eight to twelve feet in diameter, according to the size of the tree, is quite sufficient for its safety, without any attention to the natural spread of the roots in the earth. Such opinions are so contradictory in themselves, and so void of sound natural principles, that we shall at once dismiss them as unworthy of attention. We live in an age in which mere assertion has little weight; therefore, in answering the question as above laid down, we must attend to the effects of experience, as that is based upon sound natural principles relative to the laws of vegetable life.

I have already said, in the section immediately preceding this, that no tree can form a healthy development of leaves and branches unless it be supplied with a corresponding healthy development of roots by which to draw food, in the form of solution, from the surrounding soil; and yet no healthy tree, although deprived of a portion of its roots, will sustain any permanent injury, provided it is allowed to remain undisturbed in the soil till it has replaced those roots.

Now, admitting the above assertion to be true, as I have found it to be in my own experience, the reader will at once see that, to deprive a tree of its roots, and to remove it to another soil at the same time, is the very means to prevent its making healthy progress in future; and, at the same time, he will readily see, that, although any tree should lose a portion of its roots, if it be allowed time to replace them without being further disturbed till it has done so, no permanent injury will follow. Keeping in view, then, that a tree cannot make a healthy development of leaves and branches unless it be supplied with a corresponding healthy development of roots, and that it will not sustain any permanent injury though it lose a portion of its roots, if it be allowed to remain undisturbed till it replace them, I have laid down as a rule, for my own guidance in the transplanting of large trees, to have their roots previously prepared by cutting them in by means of a trench dug all round, at a distance from the tree equal to *two-thirds of the diameter of the spread of the branches;* that is to say, if the diameter of the spread of the branches be twelve feet, (not including the extreme points of large branches,) the diameter of the ball of earth inside the trench should be eight feet; and so on in proportion.

To the inquiring reader, another question will naturally arise here, namely—What object is gained by the cutting of the roots by means of a trench; and why define two-thirds of the diameter of the spread of the branches in preference to any other distance? My answer, which is entirely based upon the result of my own experience, is this:—With regard to the object gained by the cutting in of the roots previous to the removal, let any one who may have two rows of oaks or any other kind of hardwood trees in the nursery of a pretty large size, say five or six feet high, have all the side roots of the one row cut in with the spade upon each side, say about six inches from the trees in the line, but not so deep as to cut any of the *tap roots*, which are meant to supply the tree with food till new ones are made upon the sides, and leave the other row uncut in their usual natural state. In twelve months after the trees in the one row have been cut in, have them lifted, and the side roots will be found very plentiful in small fibres, and in an excellent state for being safely removed to the forest ground; whereas, on lifting the row of the same age, the trees of which were left uncut, the side roots will be found extremely spare, and the fibres, for the most part, left in the ground; and on planting the trees as contained in the two rows out into the forest, under equal circumstances of soil, situation, and management, the observing forester will very soon have occasion to decide, without the least hesitation, that those which had their side roots cut in twelve months previous to their being removed are far more healthy, and making more rapid progress, than those which were not cut till the time of their removal. It is exactly on this same natural principle that I advise to have the side roots of all large trees cut in previous to their being lifted; and I may further state, regarding this point, that I have so often practised this method of cutting in the side roots of pretty large trees in nursery-rows previous to having them transplanted to the forest-ground, and have found the effects of the operation so beneficial, that my mind is now quite decided as to the improvement that takes place in trees so managed, compared with others which may be lifted and planted out in the usual manner. The object, therefore, gained by cutting in the side roots of a tree previous to having it transplanted is, a great supply of young fibres, all in readiness to draw in nourishment as soon as it is put into its new site, which is never the case when a tree is removed without any previous preparation.

My reason for defining two-thirds of the diameter of the natural spread of the branches in preference to any other distance is, that at that distance from the bole or stem of a tree, all the large and hard or matured portion of the root is inclosed within the circumference of the ball, while on the circumference of the ball itself, at that distance from the bole, the roots are found pretty regularly ramified, and of a character and consistency of wood the most likely to send out numerous healthy fibres for the future support of the tree.

Having now, I think, pretty fully explained the basis upon which I have formed the plan of preparing large trees for transplanting, I shall, before summing up the general statement of that plan, say something as to the result of my operations on the oaks, elms, and ash trees, as already detailed in this section.

These operations were all performed upon the trees just when I went to the place in the month of November; and my intention then was to have the trees removed to other situations. But as I had occasion to leave the place (Craigston) exactly two years after the trees had been prepared by me, and finding that it was not convenient to have them transplanted before I left the place, I determined upon having them examined as to the effect produced on the roots by the cutting in they had received, which would have a tendency so far to confirm my experience in future operations of the like nature. With this view, I had openings made at four parts, at equal distances, upon the outside of each of the trenches formerly made round the trees, taking care to make the openings immediately on the outside of the good soil as formerly put in, and in such a manner as not to disturb the young roots made in it; and upon examination I found, to my great satisfaction, exactly as I had previously anticipated, that the whole of the body of new soil which was put round the roots upon the ball of earth, was actually filled with the masses of young fibrous roots that had grown from the old ones which had been cut; and these had not, at this period, begun to grow out into the natural soil beyond; but the mass of new soil which had been put in, with its roots pervading it, very much resembled the roots and ball of a plant which had been long confined in a pot, as may be often witnessed by gardeners in the act of shifting plants from one pot to another. In this state I considered the trees could be removed with all safety, provided that the whole ball of earth, with its young roots inclosed, could be removed without being materially disturbed. I may remark here also, that, in my examination of the roots of those trees, I found those upon the light soil most plentifully supplied; upon the heavy soil the roots were indeed good, but not so plentiful, nor so much ramified through the good soil, as in the case of the others; and this, of course, would be occasioned by the original quantity of the roots in the tree growing in the light soil being greater than that of those in the heavy soil. The former, therefore, which were the oaks, I would then have transplanted at once; but the latter, which were the ash and elms, I would have allowed to remain for a year longer, with the view of giving them a longer time to form a greater supply of roots before having them transplanted: a point which requires to be kept in view by the planter.

I said that I pruned one of those trees of part of the heavy branches at the time that I had them prepared in their roots: this pruning had a very beneficial effect on its after health. In all cases of cutting-in the roots of trees in the manner above described, it is observable that they receive a slight check in their growth; but in the case of the tree which I had pruned in a slight degree, there was not nearly so much apparent check as in that of the one which received no pruning. This at once gives evidence that, when trees are prepared in their roots with a view to transplanting, they should have a judicious course of pruning, which tends to secure, as it were, a balance between roots and branches; that is to say, when the side roots are checked and made incapable of supplying nourishment for a time, the health of the tree is much improved under the operation by having a proportion of the top branches shortened in also; for by this the roots are relieved of a burden they would otherwise have had to support; this tending, as I have already said, to throw a better balance between roots and branches, and consequently to retain the tree in better health under the operation.

Having been disappointed in getting my transplanting operations put into execution upon the estate of Craigston, although I did not, at the same time, find myself disappointed as to the results attendant on the plan I had adopted in preparing trees for that purpose there, and having had no convenient opportunity of extending my experience further upon that point of arboriculture till I came to Arniston, as soon as I came here, I had some trees prepared in the same manner for transplanting as I had already done at Craigston.

Since I came to Arniston, I have had my attention too much engaged with other general forest improvements upon the outer parts of the estate, to allow me to have much time devoted to the transplanting of large trees upon the home grounds; but, as I have mentioned, Mr Dundas intends soon to transplant pretty extensively, and I have been getting a nursery of good subjects prepared for that purpose, and this very year (1850) I am about to begin preparing them in the roots for after removal. Having, however, transplanted a few on the side of one of the approaches leading to the mansion-house, it may not be out of place here to give a short statement as to the manner in which this was done.

Mr Dundas wishing to have a few large trees put upon an open part of the east lawn, requested me to have that done at a convenient time. Accordingly, I fixed upon seven lime trees about twenty feet high for the purpose, and had them prepared in their roots exactly as I have already detailed in the case of the trees at Craigston; but as the trees in this case were much smaller than those I operated upon in the last-mentioned place, on the principle already laid down, I had the roots cut in by a trench at three feet distance from the stem all round, making the ball of earth, including the stem, nearly seven feet diameter. Having remained in their preparative state for two years, I was about to have them transplanted, when, in the course of other improvements of an agricultural nature upon the lawn where they were to have been planted, it was considered proper to defer putting trees there till these improvements were finished. As, however, a continuation of a line of trees was necessary upon the side of one of the approaches, Mr Dundas wished them put in there, which I did by means of the pair of wheels with a pole, termed a janker, not having any other machine for the purpose.

When I lifted these trees from their original site, I kept all the young fibrous roots formed upon the circumference of the ball as whole and undisturbed as possible; not even removing any particle of earth from among the young roots, except what could not be avoided, in consequence of the nature of the machine being imperfect, and not adapted for raising out of the ground any heavy body of earth. Even with this machine, imperfect as it was, I managed, by great care, and the assistance of a few active stout men, to have the balls attached to the trees pretty safely removed, and with the young roots comparatively uninjured.

As the seven trees, the number which I had previously prepared for transplanting, were only about a fourth of the number required for finishing the continuation of this line, and as Mr Dundas wished the line finished in order to have the full effect desired, I determined upon having that part done with trees which had got no previous preparation of their roots. This was done in as careful a manner as possible, removing all the earth with the roots as far as the nature of the machine was capable of doing; but, notwithstanding, these last are to this day decidedly inferior to their neighbours which had their roots previously prepared. It is now three years since these trees were removed, and the seven which were previously prepared in the roots have not shown the least symptoms of anything like a check, whereas the others which received no previous preparation received a great check; their appearance even yet indicates a want of vigour, and it may still be a considerable time before they thoroughly recover. This at once points out that, in order to remove large trees safely, and with the hope of future success, they must first be prepared in their roots, or if not, the subjects acted upon will receive so violent a check, that they will never after resume that healthy character which is so desirable in park trees.

Having now said so much regarding the nature of removing large trees, I shall conclude the present section by laying down a kind of abstract of the manner of proceeding with the preparing of large trees for transplanting, which, let it be understood, is the system I have laid down for my own guidance, and is entirely based upon the results of my own experience.

First, In choosing a tree of a large size for removing to another place, I first see if it will be well clothed with branches; for if the branches be few, the roots will be correspondingly few.

Second, If one or more of the branches forming the top appear to bear an undue proportion to the main stem, I have such shortened in by at least one third of their whole length, but never in such a way, or to such an extent, as to give the tree a formal or artificial outline. This I do with the view of reducing, as far as consistent with good management, the demand for food upon the roots after they have been cut in.

Third, Taking the perpendicular *drip* of the general mass of the points of the branches, as the circumference of a circle round the stem of the tree, after the strong limbs have been shortened in, I next take two-thirds of that as the diameter of the ball of earth to be left inside the trench to be formed.

Fourth, The circle being inscribed round the stem of the tree, I next take out a trench, on the outside of that circle, from eighteen to thirty-six inches broad, according to the size of the tree, keeping the earth to the outside, and have all roots as they appear upon the inside of the trench smoothly and carefully cut, and that to such a depth as the roots of the tree may be found, which is generally from two to three feet under the surface.

Fifth, The trench being made, I next pare off with the spade all loose soil from the surface of the ball of earth now formed on the roots of the tree ; and, at the same time, with a pick take away all earthy parts of the ball in which no roots exist, with the intention of putting in soil of a nature congenial to the growth of roots; and in order to encourage the more readily that growth on the under part of the ball, I have it undermined to the extent of two to three feet within the perpendicular, and the earth thrown out to be replaced by better soil.

Sixth, All the parts of the work as above stated being finished, I next bring forward, which is understood to have been previously prepared, a quantity of any light vegetable mould, such as has been already described, and have it put about the roots of the tree to the extent and in the manner already detailed.

Seventh, If the trees be originally growing on a soil of a light nature, which is naturally congenial to the production of numerous roots, they may be safely removed in two years after the roots have been cutin ; but if upon a soil of a heavy or clayey nature, which is not so congenial to the growth of these small roots, the trees so situated will be the better of remaining three years in their preparative state ; for, as the original quantity of roots was comparatively small, the more time will be required to make good that deficiency in the good soil put in for that purpose.

Some will probably consider the system of preparing large trees for transplanting, as herein laid down, an expensive operation; but those who may, at the first glance, and without due consideration, think so, may be assured that it is the cheapest and most satisfactory plan in the end. There is no doubt but that trees may be removed at a cheap rate from one place to another without any such preparation as has been advised ; but the grand question is, can they be otherwise more cheaply removed with an equal hope of success as to the object in view ? I am not aware that they can; and this has been shown from the case of others, as well as from the results of my own experience; for it is most reasonable to suppose, even by those who may have had no practical experience of their own, that a tree removed from its original site, having numerous small fibres formed at all the extremities of its roots, must have a much greater assurance of future health than one removed without any of these. No proprietor of judgment and taste would hesitate one moment as to the outlay of a few extra pounds upon such a work as the transplanting of large trees, when he is aware that by the system of preparing their roots he is likely to have the greatest amount of ultimate satisfaction. The expense of preparing a tree of thirty feet high, for transplanting in the manner advised, may stand thus:—

	s.	*d.*
Two men one day throwing out soil from the trench, at 2s.,	4	0
Cartage of three loads of light soil, which need not be valued, being the proprietor's own, . . .	2	0
Two men one day putting in soil, &c., at 2s., . .	4	0
	10	0

The above valuation of the work is amply sufficient; and where men are accustomed to it for a time, it may be done for a much smaller sum; but even allowing that each tree, of thirty feet in height, to be transplanted, should cost 10s. in order to secure its future health, it is infinitely better spent upon that operation than if no preparation had taken place; and as the work of transplanting large trees must in all cases be an expensive one, it is but right that it should be done in a proper manner.

The next thing to be considered is the work of removing large trees after they have been thus prepared: and this will constitute the subject of the following section.

SECTION III.—METHOD OF TRANSPLANTING LARGE TREES, AND DESCRIPTION OF MACHINE FOR PERFORMING THAT OPERATION.

At the beginning of the preceding section, I remarked that, as improvements of the first importance in the removal of large trees, it appeared to me that some successful method should be adopted whereby every recently made root adhering to the plant at the period when it was to be taken out of its original site, should be preserved entire and undisturbed through all the operation of transplanting; and second, that a machine of great power should be constructed, by means of which a whole tree, of whatever dimensions, with its ball of earth and roots, should be lifted and conveyed in an upright and natural position, and laid down in its new bed as entire as when taken up. Now, keeping this in view, and having already pointed out the nature of preparation that appears to me necessary for the safe removal of all large trees—without which preparation every recently made root adhering to the plant when it has to be taken out of the ground for transplantation, cannot be preserved entire and undisturbed through all the operation—I next come to point out how trees thus prepared may be safely removed by means of a powerful machine very recently invented.

For some years past I had been attempting to make a model of a machine powerful enough for the safe removal of large trees, upon the principle above stated—that of removing them with all their roots entire and undisturbed as they were found after the preparation had been effected. But not being able to produce from my own hands anything at the same time simple and effective enough for the purpose, I had just given up the attempt, when I happily read, in the *Gardeners' and Farmers' Journal* of the 15th December 1849, the following, being part of an article by the editor:—

"There are few things more desirable, and perhaps none which it is usually found more difficult to accomplish, than that of building a mansion on a bare knoll, and in the space of four or five years giving to it the character and effect which, by the ordinary process of nature in the growth of timber, requires a period of thirty years or more. Desirable as this undoubtedly is—difficult, impracticable, and wonderful as it may seem, it can be done.

"Our readers are aware that within the last few weeks we have passed through some of the northern counties, and visited such gardens on our way as appeared to claim our attention. As one of those, we called at Kingston Hall, the seat of Edward Strutt, Esq., Kegworth, near Derby. Here, then, we were delighted to find the all but impossible thing to which we have referred above, realised to an extent very much exceeding what we had anticipated. In the early part of 1843 Mr Strutt commenced the erection of Kingston Hall, selecting for its site the slightly elevated ground in the midst of the estate, where no house or tree existed before. In due time the mansion was reared, forming a structure, in the Elizabethan style, of very considerable extent, designed by the well-known and eminent architect Mr Blower. Nothing was done in the way of planting until the house began to show its bulk and general outline; and at this juncture, doubtless, not a few persons would gravely suspect that Mr Strutt had committed a serious mistake in building a magnificent residence where he could not reasonably expect to see trees much taller than himself during his own lifetime. How far Mr Strutt, or those about him, foresaw the means of meeting this objection, we are not prepared to say; but in October 1844, a pair of large wheels was provided, in accordance with the well-known plan of Sir Henry Stewart, recommended by him in his celebrated work on the improvement of estates and the transplanting of large trees. By means of this machine, about twenty trees of various sizes, from fifty feet downwards, were brought from St Helen's, one of Mr Strutt's estates, near Derby, and that upon which he then resided, and planted at Kingston. It was found, in the course of drawing these trees so great a distance (thirteen miles) along the public highway, with many of the branches frequently trailing upon the ground, that the latter got seriously injured and broken; nor did the trees themselves, when replanted, succeed sufficiently to warrant any very extended operation upon this plan. A new machine was therefore constructed, upon a principle somewhat similar to one invented by Mr Barron, who has conducted the works at Elveston with so much success. This new machine, which was built by Mr Mackay, Mr Strutt's gardener, for the future operations of tree-lifting at Kingston, is that represented in the accompanying engravings, and has been employed at Kingston Hall, where, in the short period of four or five years, a bare knoll has been transformed into a grove."

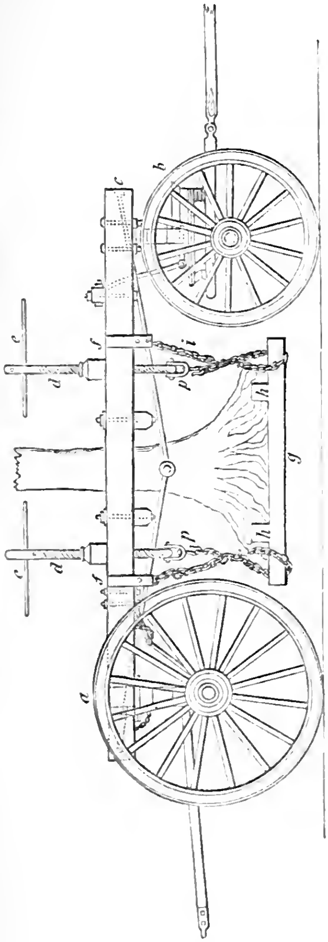


Fig. 102.

SIDE ELEVATION.

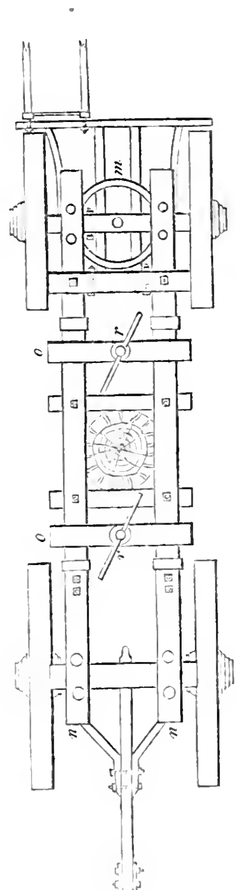
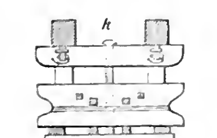


Fig. 103.

GROUND-PLAN.

Fig. 104.



END SECTION.

Fig. 105.

END SECTION.

Upon reading the article in the journal relative to the nature of the machine used for transplanting trees at Kingston Hall, part of which I have quoted above, my attention was at once called to its great value to other proprietors who might have work of the same kind to perform in future; and I took the first convenient opportunity of going to Kingston Hall to examine for myself as to how far the machine referred to was likely to answer the end in view—namely, that of its being in all respects adapted for safely lifting trees of any size in the work of transplanting. With this view, therefore, I went to Kingston Hall, and saw Mr Mackay, the very intelligent gardener there, under whose able directions all the work of transplanting with the machine had been performed. He very kindly caused his men to have the machine brought out and put into working order in my presence; and, on a thorough examination of its structure and working capabilities, I am now led to say, from my own observations, that it is exactly such a machine as I have long wished to see constructed; and I must also state, that it is in every respect adapted for the purpose of lifting and transplanting large trees in the most safe and efficient manner.

Mr Mackay has two machines which he has used in the transplanting of his large trees at Kingston Hall, both of the same construction, but different in power; the one used for transplanting trees of twenty-five feet in height and under, and which may be capable of safely removing a weight of about five tons; the other he has used for transplanting trees from thirty to forty feet in height, which is capable of safely removing a weight of from ten to fifteen tons—that is, including the tree and its ball of earth attached. Trees of the latter weight Mr Mackay told me he had removed; and having examined these, I estimated that some of them would weigh about fifteen tons, including the ball of earth.

Before entering into detail as to the manner of working the machine, I shall first give a statement as to the nature of its construction.

It consists of two pairs of wheels, each pair working upon a strong axle of superior quality. In the largest machine as referred to above, each pair of wheels is about nine inches broad in the rings.

The pair situated on the front part (see engraving at *b*) are about five and a half feet in diameter, and the pair situated on the hinder part (see engraving at *a*) are about seven feet in diameter, and distant from each other about fifteen feet; thus making the length of the machine, from the one axle to the other, fifteen feet. On each of the axles is placed a strong frame, in order to raise the horizontal bearers to a convenient height, and at the same time with the view of making the whole machine move in a workable manner. (See section of front frame *k*, and section of back frame *l*.) The front frame, I may also state, is made to turn upon a horizontal wheel, in the same manner as in the case of a carriage, for the easy turning about of the machine in any required direction, as is represented in the ground-plan of the tree-lifter at *m*. Resting upon the frames, as is shown in the front and back sections, and parallel to each other at a distance of about two feet apart, are two strong beams of wood, about ten inches deep by six broad. (See side elevation of the tree-lifter at *c*, and also on the ground-plan at *n n*.) Those beams are fastened to the frames placed above the fore and aft axles, by means of strong iron bolts, which can be unscrewed as occasion may require; and, placed across upon those horizontal beams, again, are two others, (see ground-plan at *o o*,) into which the jack-screws are placed. The screws are also shown in their working state in side elevation *d d*, with their cross-handles for turning, *c c*. On the under part of those jack-screws, as passed through the cross beams, are attached the strong chains by means of which the tree is principally taken out of its place, (see *p p*;) and, as an assistant to them, there are side chains attached to strong iron rings fixed upon the beams, (see *f f*.) Those side chains are made to act along with the others attached to the screws, and are also found necessary to retain the weight of the tree and its ball of earth during the reversing of the screws for a new hold. The horizontal planks upon which the ball of earth rests, supported by the chains, are shown on side elevation at *g*; and the two cross planks, which are placed upon the horizontal ones for the better support of the ball, are also shown at *h h*. Those planks require to be made of the best oak wood, not less than four inches thick.

Having now given a brief description of the construction of the machine as I examined it upon the spot, it remains to be stated how the operation of transplanting a large tree is accomplished by it.

The work of transplanting a tree with the machine above referred to, is perfectly simple and easily understood; but as I have not as yet myself had an opportunity of seeing the work actually performed by that machine, I could not do better than lay before my readers the manner of proceeding with the work as detailed by Mr Marnock, the able and enterprising editor of the journal formerly referred to, who visited Kingston Hall, and saw the work performed. In the journal of the 22d December 1849, he writes thus:—"In our last week's number we stated that we had seen some elm-trees at Kingston Hall, the seat of Edward Strutt, Esq., carried by the machine then represented, and replanted in another situation about three-quarters of a mile from the place where they had stood and grown for upwards of thirty years. We further stated that these trees were forty feet in height, and weighed each, including the ball of earth and the machine, upwards of ten tons, and that they were drawn by nine horses. We shall now, therefore, give the following details as to how this was accomplished. The trees to which we now allude were growing on the outskirt of a wood. The ground around the tree was cleared, and at four and a half feet from the stem of the tree a circular cutting was made to the depth of about three and a half or four feet, and about two and a half feet in width. This done, then on the most open side of the tree a sloped cutting was made, from the surface of the ground to the bottom of what may now be called the ball of earth, and a similar sloped opening was made on the opposite side of the tree. The first of these sloped cuttings was made for the purpose of drawing out the tree up this slight incline to the surface of the surrounding ground. The circular opening in the earth around the tree, and the two sloping roads on each side, being now prepared, the workmen commenced to undermine the ball of earth; this being done all around, four stout oak planks, long enough, were placed under this ball of earth in front and behind—that is, crossways to the direction of the machine; and under these two others were placed lengthways, with their ends in the direction to back and front of the machine. It will now be understood that these four oak planks under the ball of earth cross each other at their four extremities; and around their extremities, at each of the four corners, four sets of strong iron chains are fastened. A reference to the diagrams given last week will assist in explaining this. The first set of chains brought into play were those attached to the bottom of the jack-screws. Being made as tight as possible over the ball of earth, they were then hooked on the end of the jack. The two jacks were then turned by two or four men each, as the case may require, until the tree and the ball of earth were raised from the ground about six or ten inches. The jacks were then permitted to rest, and what is called the side chains were then put in requisition. These, as we have already stated, are fastened to the planks under the ball of earth, at the same point as the others, the opposite ends being made fast to the side beams, as shown in the engraving. This being done at the four corners, the jacks are then reversed, and the first set of chains slackened: the weight of the earth and tree is then sustained by the side chains. The first set of chains are again adjusted, and made as tight over the ball of earth as manual power can effect. The jack is again run down, and again attached to the chain at the lowest point it will reach. The jacks are once more applied, and run up till the end of the screw has been completely worked up to the underside of the cross-beam on which it rests. By this second lift the jacks have probably gained upon the six or ten inches which they made at the first lifting, and the bottom of the ball is now fifteen or twenty inches from the ground. The side chains, which are now quite slackened by the second lift of the jacks, are again made as tight as possible; this accomplished, and all securely and equally fastened to the side beams again, the jacks are gently reversed, till the weight is equally divided betwixt the side chains and the jack chains. The tree is now in a condition to be drawn out, unless it should be necessary to give it a third lift with the jacks, so as to raise it still higher from the ground; and if so, the side chains must always be attended to, as already described. They may be properly called the guard-chains, as they prevent accidents in the event of breakage of any of the jack chains, when the former would take the weight of the tree, and prevent its falling. About ten or fifteen feet up the stem of the tree, four ropes extend from this point to the two front and two back corners of the machine; and this is all that experience has found necessary to preserve the tree in its perpendicular position during its transport on the machine to its future place of growth. The perpendicular position of the tree is, however, very greatly secured by the four side or guard chains. We have now to describe the mode of introducing the stem of the tree within the machine. This is effected in the following manner: The machine is drawn as near to the tree as circumstances will allow; it is then taken to pieces by unscrewing the different bolts—that is, the main horizontal beams are unfastened, and thrown over the wheels on either side. The larger hind-wheels are then placed in their proper position on the sloped cutting behind the tree, and the smaller fore-wheels on the sloped cutting before the tree; the large beams are then lifted on to their places, one on either side of the tree, and made secure with the iron bolts and the requisite fastenings. The tree then stands with its stem betwixt the side beams, and with a pair of wheels behind and another before. The chains and jacks are then applied as already described, and thus the process is complete. The next and only point deserving further allusion, is that of planting or placing the tree where it is ultimately to grow; and this is effected in the following way: The hole, sufficiently large to receive the ball of earth, is dug the necessary depth; then, on the opposite sides of the hole, a sloped cutting, wide enough to admit the machine to be drawn down and through it, is also provided. Into this cutting, therefore, the machine and tree are drawn, and through which the team of horses first pass. When the tree has reached the proper point, the machine is permitted to rest; props of brick or stones are then raised at the four corners immediately under the ends of the cross planks. These props may be three or five bricks in height; and when all is prepared in this way, the jacks are reversed, and the ball of earth gradually lowered down, till the ends of the cross planks rest upon the corner props, and the tree has taken its proper perpendicular position; and this is effected by the raising or lowering of these corner props. All being adjusted, any opening that may remain, betwixt the bottom of the ball of earth and the bottom of the hole provided for the tree, is filled up with earth; the whole being made firm around and under the roots of the tree. The brick or stone props are then struck out, and the planks removed—a process easily effected, as the tree now rests upon the earth which has been placed under and about it. These planks are, however, well ironed at each end, that, in case of any difficulty in their removal, a horse or horses may be readily yoked, and the planks withdrawn."

Having now, I think, fully explained the nature and working capabilities of the machine, which I now beg to recommend for the safe transplanting of large trees, I may further state, that I am so thoroughly convinced of its proper adaptation for the purpose, after having myself examined it minutely, that I am about to have one made for our future transplanting operations upon the estate of Arniston. Mr Mackay, at Kingston Hall, told me that the larger machine, which is capable of removing a tree with its ball of earth, of a weight varying from ten to fifteen tons, cost about £60, and the smaller one, which is capable of removing a weight of about five tons, cost about £25; and it is evident that, by increasing the strength and power of the machine, it may be made to remove a tree of any given weight and dimensions. We are thus now in possession of a machine vastly superior to any other thing of the kind that has ever been introduced to the notice of landed proprietors for the speedy ornamenting of their home grounds; and where proprietors will take the trouble to prepare their trees in the roots, in the manner which I have recommended in the section immediately preceding this, and allow them to remain for two or three years, till the ball of earth has become one mass of fibrous root, the whole may be then lifted, by means of this machine, in one entire piece, without disturbing almost a fibre; and any tree removed in such a favourable state will never show any symptoms of want of vigorous growth, which has not been the case with most large trees hitherto planted on principles which left the young roots exposed and injured in the act of removal.

In lifting large trees which have been previously prepared in the way recommended, care should be taken to open up the earth upon the outside of the light good soil which was put in about the roots; that is, no part of that good soil should be disturbed in the act of removing the tree, but it should be retained as part of the ball; and as the young roots will have pervaded it thoroughly, it will easily adhere, and therefore can be safely removed along with the tree. In all cases of transplanting large trees, the ground should be made perfectly dry, when damp, by drainage, for their ultimate success; and where the soil into which the tree is to be planted is of a heavy clay nature, the hole should be made large in proportion to the size of the ball—say from four to five feet wider than the ball, and this space should be filled up under, around, and above the ball, with soil of a light character, which is always found more congenial to the growth and spread of roots than a heavy soil. At the same time, it is of importance to observe that, in the case of planting trees upon a stiff clay soil, the roots should be kept proportionally shallower in the hole than if they were planted in a light soil. There is often an error committed by planting trees too deep; for my own part, I never put more than about six or eight inches of soil over the top roots of large trees; and even in such circumstances, I have never had any disturbed by the winds, so often complained of by planters. Yet I never have used props of any kind, the weight of the ball being sufficient to keep the tree in an upright position against the effects of the weather on the top branches: this is the object gained by always removing a ball proportioned to the top of the tree, and in such a condition trees always thrive best. In putting the soil about the roots of a large tree, when having it replanted, I have found it of immense importance to its future health not to make it as put in too compact, as is too frequently done, and which is quite inconsistent with the laws of nature. My method of procedure in this case is as follows: When I have first about six or eight inches of the soil put in about the roots in the bottom of the pit, I have it given a good watering all over, making the whole, as it were, a thick mortar. This being done, I put in another layer of the same thickness, and again another watering alternately, until the whole is filled to the surface, when I give the whole a complete beating with a heavy mallet. By this plan the water causes the particles of soil to mix intimately among the roots, which has far more effect than any tramping. When the whole is finished, I turf the surface of the opening all over at once, and give a good watering over it: the turf thus soon begins to grow, and, consequently, excludes the drought better than any other plan which can be adopted. Indeed, it is of first-rate importance for the better securing of the speedy growth of large trees when transplanted, to give repeated waterings over the surface of the ground above and about their roots, during the first four months after removal, and that more especially during very dry weather. As to the time of the year most favourable for transplanting operations, my opinion is, that any time between the 1st of November and the middle of April, while the weather is fresh, is alike favourable; observing, however, to transplant those kinds of trees first which come earliest into leaf in the spring.

As to the kinds of trees best adapted for safe transplanting, I conceive that any kind whatever, if previously properly prepared in the roots in the way I have recommended, may be with equal success removed. The Turkey oak and the holly, when of large size, have been considered uncertain subjects for safe removal; but by judicious preparation they may be transplanted with as much hope of success as the lime-tree or the elm.

It sometimes happens, in the case of large trees that have been transplanted, that they send out shoots from the crown of the roots, and from the surface of the stem—thus at once indicating that the constitution of the subject has received a violent check; and in all such instances, it will be at once observable, that the top branches are not making healthy progress. In order to check this tendency, all such young shoots should be at once removed, in order to force the sap upwards; for if they are allowed to grow on undisturbed, they will appropriate a great proportion of sap to their own use as it ascends, and consequently deprive the top branches of due nourishment.

SECTION IV.—METHOD OF RENEWING THE HEALTH OF OLD OR DECAYING TREES.

As it is sometimes a matter of very great importance to those who have the management of gentlemen's home-grounds, to know what can best be done for the preservation and improvement of favourite ornamental old trees, it may be useful for some into whose hands this book may fall, to be made acquainted with the method of adding new vigour to the impaired health of very old or decaying trees. In the present section, therefore, I shall lay down my own manner of procedure in such work.

Wherever it is desirable to have a tree that may be in a declining state resuscitated, or renewed in health, the first point in the operation is, to have all dead branches cut clean away, and that as far back upon each branch as to remove entirely all decidedly dead and decaying portions, till the healthy wood appears at the cut parts. Next, the bole of the tree, as well as all the larger branches, should be scraped clean from all moss that may be growing upon their surface; and all the parts scraped should be well washed down, beginning at the highest part, with a brush and cold water, observing to make the bark perfectly clean. That being done, a trench should in the next place be opened all round, cutting the roots in the same manner, and at the proportionate distance from the stem, already described in treating of preparing trees for transplantation. Supposing, then, that the roots have been cut in, say six feet from the stem all round, making the diameter of the ball of earth about the bottom of the tree twelve feet, exclusive of the bole itself, the trench immediately upon the outer circle of the ball should be made from five to six feet broad, and as deep as to cut every root attached to the tree down even under the subsoil, and as far as they may be found to exist, without having any respect to rule in this point. In throwing the soil out of the trench, the workmen should be instructed to lay all the good portion (which may be the upper stratum) immediately upon the outer edge of the trench opened, which will, in such a position, be ready for mixing among any better soil that is afterwards to be put in. Beyond the good soil thrown out, all bad portions should be thrown, and immediately carted off, before commencing to fill in the trench about the roots again. The trench being made of the proportions above stated, and all bad quality of soil removed, the next thing is to have a mixture of the following kinds and proportions of soils brought forward, and which, it is presumed, has been previously in readiness for the purpose :—One part well-rotted cow-dug, two parts half decomposed leaf-mould, and one half part powdered lime ; or, in other words, to one barrow-load of well rotted cow-dung, and two of half-decomposed leaf-mould, add one-half barrow-load of lime in its powdered state, and in the same proportion whatever quantity may be required. A compound of the above description being previously prepared, and a sufficient quantity of it brought forward, have it mixed up with an equal quantity of the good portion of the soil which was thrown out of the trench, and have the opening or trench entirely filled up with this mixture ; observing in this case, as well as in the case of transplanting the large trees formerly referred to, to give plenty of water as the filling in of the new soil proceeds, and to give a moderate tramping with the feet also. When the trench has been filled to the level of the surface of the surrounding ground, have the turf, growing upon the surface of the ball between the trench and the stem, pared off to the depth of about four or five inches, which turf may be thrown back on the top of the new soil ; and over all this have again about eight inches of the compost spread over the whole extent from the stem of the tree to the outer circumference of the trench, making the ground upon that part eight inches higher than the level of the surrounding ground ; and after a good watering and tramping, the whole operation is finished.

In order to encourage as healthy a state of the trees as possible, it is of great advantage to syringe repeatedly, and keep clean the bark, by means of a brush and cold water, in the summer season ; and even in the event of a continued tract of dry weather, to give repeated waterings at the roots, more especially over the new soil put into the trench, where of course the young roots will be making rapid progress. By such a system of treatment I have seen old trees, which to appearance were rapidly decaying, recover, and assume quite a renewed state. This season I am about to operate in this manner upon some very fine specimens of old hollies which appear to be decaying; and from what I have seen in the case of other subjects formerly treated in the same manner, I feel confident that their health will again be established.

In all cases of resuscitating old trees in the manner above advised, it is of the greatest moment to have a drain made all round the bottom of the trench before putting in the compost; for it sometimes happens, more especially if the original soil be of a heavy character, that water will lodge in the bottom of the trench; and by simply making a drain, and leading it away by a proper outlet, any danger of this kind may be prevented. If water were allowed to lodge, the tree would, instead of improving, decay more rapidly than if it had never been interfered with.

From my frequently visiting gentlemen's landed properties, I have seen many old and ornamental trees which could be much improved by dealing with them in the manner above detailed; and it is on this account I have given these few hints for the improvement of such. Still, in order that proprietors may not be too sanguine on the point under consideration, I may state that there is a stage of unhealthiness and old age at which trees may arrive, which will render them quite unfit for being recovered, whatever means may be used for that purpose, discrimination being necessary on the spot.

SECTION V.—FENCING OF PARK TREES, SO AS TO PROTECT THEM FROM DEER, HORSES, CATTLE, &C.

There are few landed proprietors' seats in Britain so perfectly adorned with all the known ornamental and useful sorts of trees, that they may not now and then receive an additional embellishment in the form of some new and highly interesting foreign species. Indeed, however complete any proprietor's home parks may be as to its collection of useful and ornamental trees, if he is of a highly refined taste, he will frequently take pleasure in transferring good specimens from the enclosures of his shrubberies, &c., where they were almost hidden from view, to the open parks, where they are sure to develop themselves to advantage, and prove in no small degree ornamental, by their contrast with other larger and more common sorts, when judiciously arranged among them. In order to protect such specimens from being injured by cattle that may be grazing on the park where they are planted, it is of primary importance for their future welfare that they have a fence of some sort put about them for a time at least. It is more particularly under such circumstances that I would here recommend the fencing of trees on a park; for it must be admitted, that a tree growing without any protection whatever, is in all cases a more agreeable object than one having a fence about it. Wherever, therefore, it is found necessary to have single trees protected for a time from the effects of animals roaming about them, that should be done upon the most ornamental principle that can be devised.

There are various methods and forms practised for the protection of single trees—from the simple wooden posts with rails, to the neat and highly ornamental, and, I may say, almost invisible fence of iron. It would be altogether superfluous to enter into detail here upon all the varieties of fences, or *guards*, as they are sometimes called, in general use for protecting single trees. I shall therefore confine my observations to the description of three sorts—namely, the octagonal, the square, and the circular.

The names, as given above, merely indicate the shape of each sort; therefore, in order to illustrate their size and general construction, it will be necessary to give a Figure of each, with a few remarks subjoined, relative to how they are applied in protecting trees, the materials of which they may be made, and the expense of erecting in each case, according to strength and height.

Figure 106 is a plan of the octagonal form of tree-guard, as we have them made for protecting very young specimens in the lawn at Arniston; and it is an exceedingly ornamental form when well made. We make them of small larch thinnings, in the following manner:—

The tree is planted in the centre of the octagon, as shown at *a*, in Figure 106, and also at *a* in Figure 107, which last is a section of the side elevation of the plan. The open circle about the tree is marked off upon the ground about two feet in diameter, around which small stobs are driven in so as to form an octagon in that part, as at *b*, in each Figure. These stobs may be from two to

Fig. 106.

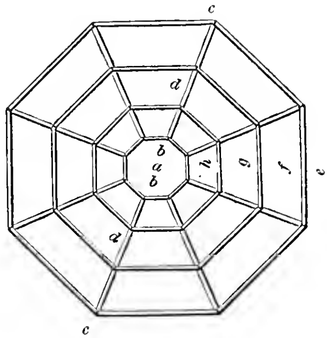
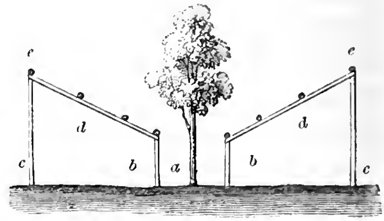


Fig. 107.



three inches diameter, according to the strength required, and from twelve to eighteen inches high above ground. The eight small stobs being driven into the ground so as to form an octagon of about two feet diameter, corresponding ones will next require to be driven in upon the outer circle, as shown in each of the two Figures at *c c:* these may also be from two to three inches diameter, and from two to three feet high above ground, according to strength required; that is, according as there may be sheep only to guard against, or deer, &c. The octagon being formed by the stobs being driven in both upon the inner and outer circles, and the diameter of the Figure made, measuring from any two of the extreme points, say ten feet, the next part of the work is, to have bearers nailed on between each corresponding pair of stobs, as shown in each of the Figures at *d*, *d*. These may be of the same strength of wood as the stobs upon which they rest their ends. Next, a top rail is to be nailed on the outer stobs, as at *e*, *e*, in each of the figures, all round, so as to bind the whole together, which top rail we shall suppose to be two and a half inches diameter. The other three courses of rails, as shown at *f*, *g*, and *h*, should be made proportionally of a smaller size as they recede downwards to the centre, which gives the work a neater and lighter appearance than if the whole were made of one dimension. In the Figure above, there are only four horizontal courses of rails shown; but in this matter the taste of the proprietor may be consulted; at the same time keeping in view, that if the eight spaces forming the outer boundary of the octagon are not made proof against the encroachment of sheep, the horizontal spars upon the inside slope must be made so; and also that, if it be found necessary to make the octagonal guard proof against the encroachment of rabbits, hares, &c., that is very simply attained by driving in a few extra small stobs on the inner circle forming the octagon immediately about the tree. The eight squares forming the outer boundary of the octagon may be made of an ornamental character, and of any design the taste of the proprietor or his forester may suggest. As to the merits of this description of tree-protector, besides being very ornamental, it is of all others the best adapted for the admitting of free and unconfined space about a young plant; the whole body receding from the plant as, it were, and yet producing perfect protection at the same time. I would, therefore, recommend it before all other forms for young specimens requiring free and open and unconfined space for the development of their branches. In parks where large cattle are grazing, the diameter of the octagon should be increased, so as to prevent them from reaching the branches of the plant; and in such a case, in order that the grass growing upon the ground occupied by the octagon may be made serviceable to sheep, it is only necessary to leave open the spaces between the stobs forming the outer boundary of the Figure. The expense of erecting octagonal tree-protectors is but trifling; for the wood being laid down, a man will easily make one in a day.

Fig. 108.

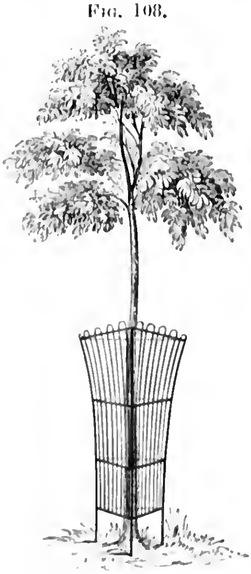


Fig. 108 represents the square, or four-sided form of tree-protector, which is not adapted for very young trees, but for trees of a considerable size only, and such as have a stem free of branches. They may be constructed of small larch thinnings, as in the former case, and of any convenient strength according to the kinds of cattle to be kept back; say of wood two inches diameter, and three feet high above ground for sheep, and of two and a half inches diameter, and from four to five feet high for deer, horses, or oxen. The spars may be put in all vertically, or with four uprights, one at each corner, and having others nailed on at convenient and proper distances, horizontally, according as taste may suggest.

In erecting these, care should be had to keep them at least six inches from the stem of the tree at any given part; for if put too close on, animals will sometimes gnaw the bark through between the spars, or peel it off with their horns.

Fig. 109 represents the circular form of tree-protector, and is adapted for trees of a considerable size only, as in the case of the square form, already referred to. They are sometimes made with spars altogether vertical, having a hoop to bind them together on the top, and sometimes with four or more upright stobs driven into the ground, bound by hoops at regular intervals between top and bottom, as in the case of the Figure here given—this, of course, being altogether a matter of taste. Both the four-sided and the circular forms of tree-protectors are of very simple construction, and may be made by any forester by means of small larch thinnings from the young plantations; and any active man will make at least six in a day. In what has been stated above relative to tree-guards, I have considered them to be made of wood only; but where a superior style is an object, they should be made of iron, painted green, so as to make them almost invisible at any considerable distance. Made of iron, they could not, of course, be so neatly done and fitted up by any forester; therefore those proprietors

FIG. 109.

who wish to have tree-guards of an elegant, light, and airy appearance, I would recommend to apply to Messrs Charles D. Young and Company, iron manufacturers, 128 High Street, Edinburgh, and 22 Parliament Street, Westminster, London, who keep on hand, for the purpose, a great variety of beautifully fitted-up articles of the kind, at various prices, according to strength and height, &c. I have at present one of the catalogues of the above-named firm before me, in which the price of the tree-guards of the square and circular forms are stated at from 10s. to 15s. The octagonal form is not, however, mentioned in their list now before me; but I should suppose that, to make it of iron, it would cost at least 60s.

SECTION VI.—EFFECTS OF UNDERWOOD ON THE HEALTH OF TREES IN A PLANTATION.

By the term *underwood*, is implied bushes of a woody habit growing under timber trees. It may consist of two kinds—namely, perfect plants of a naturally low and branchy character, as the privet, rhododendron, holly, &c.; or shoots issuing from the stoles of trees which may have been cut down in thinning, as in the case of neglected coppice. In whichever of the above forms underwood may be found in a plantation among growing timber trees, it is capable, under certain circumstances of management, of becoming of much ultimate good or harm to the health of the trees under which it may be growing. In a plantation of considerable extent, if underwood be allowed to grow up in such a profusion as to impede a free passage of air through the trees, its effects must be of the very worst description, and must ultimately be productive of many premature deaths among them; and even those that may grow up healthily, must afterwards be found inferior in the quality of their timber, from the want of a proper amount of air by which perfectly to mature the wood. On the other hand, a plantation of trees of rather small extent, more particularly if upon an exposed and high-lying situation, is much improved in health by having a well-regulated quantity of underwood growing among the trees, more especially if that is planted upon such points as are most exposed to cutting winds. But even in such situations, an injudicious quantity of underwood would certainly prove injurious to the health of the trees; for let it be understood, that most plants of the character of underwood naturally emit a great quantity of fibrous matted roots, which have the effect of impoverishing the soil to a great extent, and also of excluding a due portion of air from the roots of the trees under which they grow. In the introducing, therefore, of underwood into a plantation among trees which are wished to be kept in a healthy state, judicious management is required. A due proportion of well-chosen plants as underwood, is in all cases both ornamental and useful in a plantation, and may be attended with the very best effects; but an over-quantity is in all cases void of ornament, indicates confusion, and, instead of being useful, becomes a nuisance both to the proprietor in seeking after recreation, and to the forester while in the act of removing his trees. Having now merely adverted to the effects of underwood upon the health of trees in a plantation, which was all I aimed at in the present section, I shall in the next point out how underwood may be managed for the health of trees, and at the same time point out the plants best fitted for the object in view.

SECTION VII.—KINDS OF PLANTS BEST FITTED FOR UNDERWOOD, AND HOW THEY MAY BE PLANTED IN A WOOD SO AS TO PRODUCE USEFUL AND ORNAMENTAL EFFECT.

Having in the foregoing section made a few remarks as to the effects of underwood in plantations, and shown that it may be made to produce either good or bad effects, it still remains to be indicated how the plants generally termed underwood may be disposed of among trees so as to prove both useful and ornamental. But before doing so, I shall give a list of the different kinds of plants which are known to thrive under the shade of trees, and are therefore termed underwood.

Names of Species.	Nature of Soil in which they thrive best.
AUCUBA JAPONICA,	Any loamy soil, if dry.
LAUREL BAY,	Ditto.
BOX TREE,	Ditto.
DOGWOOD,	Ditto.
IVY,	Bare rocky parts.
HOLLY,	Rich loam.
PORTUGAL LAUREL,	Ditto.
EVERGREEN PRIVET,	Ditto.
LAURUSTINUS,	Ditto.
RHODODENDRON,	Peat soil.
JUNIPER,	Very light sandy soil.
YEW TREE,	Sandy loam.
ARBORVITÆ,	Ditto.
BUTCHER'S BROOM,	Ditto.
ALDER,	Ditto.
SCOTCH ROSE,	Rich loam.
MAHONIA AQUIFOLIUM,	Ditto.

The above-named are the most important of the class of shrubs generally called underwood; and these are, with the exception of the dog-wood, alder, and Scotch rose, all evergreens. In planting any of these shrubs with a view to produce shelter upon any given point, the holly or alder should be chosen, because they are the most hardy for that purpose. Where it is wished to cover any bare rocky part in a plantation with the view of forming cover for game, and of producing an ornamental effect at the same time, the ivy, juniper, yew tree, and Scotch rose should be planted, all these thriving well on such parts; and where general groups of underwood are wanted anywhere along the sides of forest rides, the other sorts may be used.

The common system of planting underwood is that of scattering promiscuously among the trees individual specimens, without any regard to order. To this system I object, because it is neither of an ornamental nor a useful character. I am aware that this is done with the view of producing a general cover throughout for the protection of game, but it is seldom that the plants so dealt with grow so well as either to form a respectable cover, or to be ornamental as specimens; and, besides, where underwood is found thus generally scattered over a plantation, it has more the effect of retarding and interrupting the progress of the proprietor and his friends while going through, than of adding to their recreation. I would therefore advise, as an improvement on this point of forestry, the following method, which is decidedly both ornamental and useful:—First, Upon any exposed point, where it may be advantageous to have underwood grown for the purpose of producing shelter, have hollies planted, say at eight feet apart, and made up between with firs to four feet over all. The firs will have the effect of producing shelter to the hollies for a few years, and thereby cause them to grow up more quickly than they would do otherwise; and as the nurses advance upon the others, they can be thinned out and gradually dispensed with altogether. If the situation happen to be one too much exposed to allow of hollies attaining a useful and ornamental size, and yet one where it is particularly desirable that underwood should be, plant birch, which will be certain to grow well and form underwood, while upon more favourable parts the holly may be planted as above stated. Second, where underwood is wanted in the interior of a plantation, either for the purpose of cover for game or for ornament, plant clumps of laurel bays, hollies, Portugal laurels, and evergreen privets; keeping each kind separately in a mass by itself, to the extent of from one-sixteenth to one-eighth of an acre. Where such masses are planted, the trees should be almost altogether dispensed with, leaving perhaps only one tree in the centre of each mass of evergreens; for let it be understood, that although the plants above named will generally grow under the shade of trees, they are more apt to live long and become bushy healthy plants when the trees are kept well off them. Third, at convenient intervals along the sides of the forest-rides, have groups of various sizes planted, giving these various bendings of a natural character, like plots in a flower-garden; and at well-chosen points of view from the roads, have slight openings made, so that masses of evergreens in the interior of the wood may be brought into sight. In thus disposing the underwood plants into masses, care should be had to keep all the low-growing sorts next to the rides—that is, such as the rhododendrons, mahonias, roses, laurustinus, and aucubas; and in order that a natural variety may be produced by the plants of each species being congregated in a mass, two or three arborvitæs may be put in as prominent plants in a group now and then, which would produce a pleasing and graceful effect; while, in some cases, a tree growing in the centre of such a group might be clothed with ivy, which has also a graceful effect in a wood.

Having thus briefly stated my views as to the disposition of underwood in plantations, it yet remains for me to show the advantages of such a system over the usual way of planting them without any regard to order. Where bushes of any kind are found growing as it were at random, in a plantation among trees, they have in all cases the effect of retarding arboricultural operations, and that to a very great extent, as I have myself often experienced; and, besides, they have a great tendency to prevent a free current of air passing through among the trees, causing, as it were, a stagnated state of air. Now, by the system of growing underwood in small masses as I have recommended above, these bad effects are prevented; for, as it is understood that these masses are to be grown at pretty wide intervals, the air will have free access to all the trees growing in the spaces between them, and wood operations can at the same time be carried on without interruption. Again, the proprietor and his friends, when in pursuit of game, can have no straggling thickets of bushes to annoy them; but when any of the covers are beat, they have open and uninterrupted spaces between each group; while the underwood, in consequence of being planted in masses, with few trees in their immediate vicinity to injure their growth, will be much more bushy, and will form a better cover than bushes scattered singly over the ground. In an ornamental point of view, the system which I here recommend is infinitely superior. By having shrubs planted singly and at random over the ground in a plantation among trees, there is a continued sameness and confusion presented to the eye; but when planted in well-defined masses, each species by itself, there may be made a continual and never-ending variety in the scene; for the eye, instead of resting upon a confused sameness, at once alights upon a beautiful and compact mass of foliage, having its outline perfectly portrayed on the space beyond among the tall trees, beyond which another mass may appear in the distance. This part of forestry is generally too little attended to, and that for no other reason than that taste is required to bring it out; but it is to be hoped that this state of things will improve.

SECTION VIII.—RULES AND REGULATIONS NECESSARY TO BE OBSERVED IN THE CUTTING DOWN AND SELLING OF TIMBER.

The cutting down and disposing of timber forming, as it were, the harvest of forest operations, and much of the value of that harvest depending upon the manner in which it is done, it is of very great importance that the principles upon which it ought to be conducted should be well understood.

Since publishing the first edition of this book in 1847, I have been very much called out by landed proprietors for the purpose of giving them advice relative to the manner in which the sales of their timber should be conducted; and as I have not in the first edition entered into any minute practical details relative thereto, I consider it highly important that I should do so now, seeing that information upon that point is sought after by landed proprietors in general.

There are two ways of disposing of timber—viz., by PUBLIC ROUP and by PRIVATE BARGAIN, both of which ways may be put into practice, upon any given place, according to local circumstances, to profitable account; but, generally speaking, where there is a large quantity of timber to dispose of at once, and more especially when it is of a mixed character, the greatest amount of money will be realised by the proprietor when he disposes of it by public roup. At public roups, there are in all cases people collected who are in quest of various sorts of wood, from the smallest size to the largest, consequently a competition takes place among them, which generally brings each lot to its value before being sold. As to the manner of conducting public and private sales of wood, I shall here give my own method of procedure, beginning first with the selling of wood by public roup.

We shall presume then, in the first place, that the timber to be disposed of consists of thinnings of various sizes, as to be taken from plantations of several different ages, and of different kinds of wood; and also presuming that the work of cutting is to be LET by contract, the trees, of course, having been previously marked by an experienced forester. I beg it to be understood here, that I do not mean to say that the cutting of all trees should be let by contract, for where there is an experienced forester upon an estate it is not necessary to do so; but where there does not happen to be such, I often find it necessary to have the cutting of wood let; and in such cases I find it necessary to bind the contracting party to do the work in the manner and according to the rules laid down in the following form of specification:—

SPECIFICATION of Work to be done in the cutting down and preparing Timber for Public Sale, on the Estate of D——e, November 1850.

Article 1. The trees to be cut for public sale are marked with white paint, and will be pointed out to the contractor by A B, residing at the East Lodge, D——e.

Art. 2. All the trees marked in the park must be cut down with the cross-cut saw. In the young plantations the trees marked may be cut down with the axe, excepting those that are *at and above* six inches diameter at the ground, all which must also be cut down with the cross-cut saw.

Art. 3. Each tree, previous to being cut over with the saw, must be *laid in* with the axe to the level of the surface of the ground, and then cross-cut to that level.

Art. 4. Any damage done to the standing trees by the falling of the others, or otherwise, shall be charged against the contractor at the rate of double the market value of each tree injured; and any damage done to the trees taken down by the careless work of the people employed, shall also be charged against the contractor at a rate equal to the deterioration in value caused by such damage.

Art. 5. Each tree, as it is cut down, must be neatly pruned from all side branches, and the bole laid entire along the side of the road, in order for sale—no cross-cutting of the bole being allowed.

Art. 6. The side branches, as they are taken from the trees, must be arranged into lots in order for sale, to the satisfaction of the above-named A B, or any person named by the proprietor.

Art. 7. All implements, as well as horses, &c., that may be required for the performing of the work, to be furnished by the contractor.

Art. 8. The oak trees marked are not to be cut down till the usual time of peeling in the summer, nor under the present agreement.

Art. 9. All the trees marked, excepting the oak, to be cut down and arranged into lots for sale, in the manner as detailed above, for the sum of three shillings per pound sterling, of the amount of roup-roll, and to be finished and in readiness for sale on or before the 26th day of December next.

Art. 10. All disputes or differences that may arise as to the due execution and fulfilment of the foregoing articles, shall be referred to the determination of Mr J. O., forester at M———h, whose decision thereon shall be final.

The above form requires to be signed by the contractor and witnesses in the usual manner.

By going to work in the way above specified, I have had many plantations thinned and the wood prepared for sale, and that in a very efficient manner; of course, always employing a person who could do the work well, and who had been accustomed to work of the same kind before.

The person having the oversight should see that each sort is arranged into separate lots by itself; and no individual lot should contain less timber than twenty-five cubic feet, in order that there may be a cartload for the purchaser; and each individual tree should be pruned out to the full length.

I have often had occasion to observe at sales of timber, that where large trees had been cross-cut to a particular length for the sake of convenience in having them removed from the interior of the wood to the side of the nearest road, they never sold nearly so well as others of the same dimensions and quality which had been left entire. The reason is, that purchasers of timber, when they have it in long lengths, can always apply it to many more purposes than they can do short lengths; therefore this is a point that should be strictly attended to in the preparing of wood for sale, because the value of trees may be much deteriorated by injudicious shortening of their boles.

All timber of good quality should be lotted separately from that of indifferent quality. Let good timber be sold in lots by itself, and inferior timber in the same manner; and if possible, whatever number of cut trees may be put into a lot, let them be nearly of an equal size. The great advantages arising from such a system of arranging the wood into equal sizes and qualities, will appear evident when I say, that if a purchaser come to a sale of wood with the view of buying, say one lot of good small ash for handle-wood, and found the kind he wished to purchase mixed up with other inferior trees in the same lot, he might of course buy the lot in which he saw a few trees suitable for his purpose, but he would reckon nothing upon the value of the inferior trees sold along with them, he having of course no use for such; and the same may be said of any other sorts mixed up in an unscientific manner. But where each sort is arranged according to its particular use and quality, the full value of each may be readily got from different people who may have a use for the different sorts.

When trees are laid together in the way of lotting out for sale, the bottoms and tops should all be laid one way, and that in a regular manner, so that the purchasers may see at a glance the size and quality of the wood they may wish to purchase.

All lots of wood prepared for public sale should be carried out of the plantations, and put upon the sides of the nearest roads, for the convenience of purchasers getting to them with their carts; which arrangement is always in favour of the wood bringing a high price.

After the wood has been all lotted in the manner advised above, each lot should be numbered and entered to a corresponding number in a book made out for the purpose; at the same time stating the kind of wood that each lot consists of, with the number of trees in each, and the medium value of the same. In order to illustrate this sort of book, as used by me, I shall here give a statement from my own, as taken from a sale of wood which we had at Arniston the other day. Such a statement, I am aware, will prove interesting and useful both to proprietors and young foresters who may wish to have information on the point.

Wood Lotted and Numbered for Sale at Arniston, 15th November 1850.

Number on each Lot.	Number of Trees in each Lot.	Kinds of Timber in each Lot.	Names of Purchasers.	Forester's Valuation.			Value as sold at Sale.		
				£	s.	d.	£	s.	d.
1	5	Oak	John Philip, Bonnyrigg,	0	15	0	0	14	0
2	3	Do.	Do.	0	18	0	0	16	0
3	3	Do.	Do.	1	0	0	1	4	0
4	6	Do.	Do.	1	0	0	0	17	0
5	2	Do.	Robert Grindlay, Roseberry	1	6	0	1	10	0
6	11	Ash	Do.	0	12	0	0	13	0
7	7	Elm	Mr Coldwells, Gorebridge	0	13	0	0	13	6
8	1	Larch	John Philip	0	18	0	1	2	0
9	1	Ash	Mr Galbraith, Edinburgh	1	1	0	1	4	0
10	1	Do.	Do.	2	10	0	3	0	0
11	0	Firewood	Mr Dalgleish, Gilmerton	0	3	0	0	3	6
12	0	Do.	Do.	0	4	0	0	3	9
13	1	Elm	Thomas Johnson, Temple	1	8	0	1	15	0
14	1	Plane	John Philip	2	10	0	2	15	0
15	1	Do.	John Carrick, Glasgow	7	10	0	8	12	6
16	1	Larch	John Philip	2	15	0	3	0	0
17	1	Do.	Do.	3	15	0	4	5	0
18	1	Ash	Mr Galbreath	8	15	0	12	0	0
19	1	Beech	Mr Easton	2	0	0	1	15	0
20	8	Spruce fir	John Philip	1	4	0	1	0	0
21	7	Beech	Mr Coldwells	0	10	0	0	6	0
				41	7	0	47	9	3

The foregoing statement, taken from my note-book, will at once point out how I am in the habit of arranging and conducting sales of wood made by public roup.

The first three columns of the statement given, with my own valuation, are all filled up previous to the day of sale; and upon the day of sale I follow the auctioneer, and fill up the other two columns which were left blank; that is, I then enter the purchasers' names opposite each lot, and the price given; and as the clerk of the sale keeps also an account of the same, my book forms a check upon him in case of any mistake occurring; and, besides, such a book kept by the forester becomes a guide both to himself and the proprietor, for the purpose of ascertaining if the wood sell at a fair price or not.

Relative to public sales of wood, it yet remains for me to state how they should be advertised and made known to the public; and this should be always done about ten days previous to the day of sale, so that time may be given for its being properly made known. The following is the form of intimation which I made regarding the sale which we had at Arniston the other day. Its insertion may prove useful here to other foresters who may have occasion to give intimation of the same kind for their wood sales:—

SALE OF WOOD.

There will be sold by Public Roup,

ON THE ESTATE OF ARNISTON,

Near Fushie Bridge,

On Friday the 15th November,

A large quantity of Timber, consisting of Sycamore, Ash, Larch, and Beech, of large dimensions; a considerable quantity of Oak adapted for trams, spokes, and other country purposes; Ash for handle-wood; Larch, Scotch, and spruce Fir, fit for deals, roofing, &c.

The above will be exposed in lots to suit purchasers. The Sale will begin at Braidwood Bridge, under Temple Village, exactly at ten o'clock forenoon.

T. D., *Auctioneer.*

Arniston, 31*st October* 1850.

In order that such an intimation may be made properly public, it should be inserted in one or two of the local newspapers, and printed forms put up along the public thoroughfares, and sent to people who are known to be in the habit of buying wood.

We shall now suppose that all the wood intended for a sale has been cut and arranged in the manner advised above, and that due intimation has been given relative to the same; particularly observing to make a fair statement of the kinds of wood to be sold. The next important point the forester will have to attend to is, the articles and conditions of sale. The following is the form by which, upon the estate of Arniston, we are in the habit of exposing our wood to public sale.

ARTICLES and CONDITIONS of Sale of Wood on the Estate of Arniston, to be exposed for Sale on this 15th day of November 1850.

Art. 1. The wood to be put up in lots, and at such upset prices, as the company may think fit, and sold to the highest bidder, who shall be bound to implement the following conditions:—

Art. 2. Each lot to be at the entire risk of the purchaser thereof as soon as called down by the auctioneer; but none of the lots to be interfered with until a settlement for the same be made to the satisfaction of the exposer, his agent, and judge of the roup.

Art. 3. The exposer reserves one bode on each lot for his own behoof, and also power to adjourn the sale if he shall see cause.

Art. 4. Any damage done to the plantations, gates, or fences, in the removal of the wood from the ground or otherwise, shall be paid for by the purchaser against whom such loss or damage can be qualified, the master being always accountable for his servant.

Art. 5. Purchasers shall be allowed six weeks from the day of sale to remove their purchases from the ground; and should any purchaser fail in having his purchases removed by the time above specified, he shall forfeit his offer of purchase, and be liable to the exposer in one-fifth part of his offer of purchase in name of penalty; and the exposer shall have it in his power to do with each lot or lots as he may think proper for his own benefit. The first offerer, notwithstanding, shall remain bound for the original price.

Art. 6. Purchasers, if required, shall pay to the clerk of sale one-fifth of the price of each lot as a deposit.

Art. 7. All sums at and below ten pounds sterling to be paid ready money; and for all sums above ten pounds, three months' credit will be allowed on bill and caution being granted to the satisfaction of the exposer, his agent, and judge of the roup. Purchasers paying ready money shall be allowed sixpence per pound on all sums above five pounds.

Art. 8. A person duly authorised to point out the lots and receive payment of the same shall be in attendance every lawful day between the hours of seven o'clock morning and five o'clock evening during the time before specified.

Art. 9. Purchasers to meet with the exposer's agent and judge of the roup on Wednesday the 20th next, between the hours of twelve and two o'clock, in the White Hart Inn, Grassmarket, Edinburgh, and the Cross Keys Inn, Dalkeith, on Thursday following, at the same hours, to settle for their purchases. Those, however, wishing to settle immediately after the sale will be accommodated.

Art. 10. Purchasers to pay the bill stamps their respective sums may require.

Art. 11. T. D. is hereby appointed judge of the roup, with full power to settle all differences that may arise between the purchasers and exposer, or between the purchasers themselves; and his decision shall be binding, without the power of appeal to any court of law.

In witness whereof,

(Signed) ______________

What I have stated in the foregoing part of this section is only applicable, properly speaking, to the sale of wood which has been cut; but it is frequently found convenient and necessary to expose wood in a growing or standing state also. In such a case, the only difference is, in the selling of it, to publish a form, stating the kinds and number of each kind to be sold, and what purposes they may be most applicable for; and, at the same time, it is necessary to give in such a case intimation, stating who will point out the trees upon the ground to intending purchasers before the day of sale. For the information of young beginners, it may not be out of place for me here to give another form of advertisement applicable to the selling of growing or standing timber.

SALE OF WOOD

ON THE ESTATE OF D———.

There will be exposed to sale by public roup, on Friday the 27th current,

Within the White Hart Inn, Edinburgh,

At One o'clock afternoon,

3000 Standing Trees of Larch and Scotch Fir, fit for railway sleepers, roofing, joisting, boards, &c.

The above wood will be exposed in twelve lots to suit purchasers.

W. H., forester upon the estate, will point out the lots previous to the day of sale; and further particulars may be learned on application to J. N., 20, ——— Street, Edinburgh.

D———, *10th September* 1850.

In the same manner, any sorts of trees may be given intimation of for sale, always observing particularly to state for what purposes the trees to be sold are applicable. Oak and other coppice woods are generally sold by the acre, or they may be sold in lots to any certain or convenient extent, mentioning about the number of acres in each lot, which should be all valued previous to the day of sale: such sales of coppice may be made in the month of April or May. Having said thus much relative to public sales of wood, it yet remains for me to make a few remarks as to the conducting of wood sales by private bargain upon gentlemen's estates.

In the selling of timber by private bargain, it is generally done at a certain rate per cubic foot, according to kind and quality; or it may be done at so much per tree, or so much for a certain number of trees; and in this case the trees are, of course, valued by the forester previous to making bargain with the purchaser. In some cases where I have had a quantity of timber to dispose of, and which was to sell by private bargain, I have taken private offers for the same from different parties who were inclined to have it, and, of course, sold to the person who gave the highest price for the whole.

The above remarks are applicable only to wood as it is sold in the round or rough state; but the selling of wood by private bargain, when cut up into various scantlings at saw-mills, is very different, and sometimes a matter of considerable difficulty to young foresters. Therefore, for their assistance, I shall here give a few statements, showing how they may be able to calculate the fair value of timber, of any scantling, as they may have occasion to sell it from saw-mills under their charge.

We shall suppose that a forester is in the habit of getting 1s. 2d. per cubic foot for his larch timber, as sold lying in the plantations in the round state, and that he has charge of a saw-mill, at which he wishes to cut up his larch for sale to various sorts of scantlings as may be required. We shall further suppose that he wishes to learn at what rate he should sell the cubic foot of sawn timber, so as to have at least the same profit to the proprietor off the cut timber that he is in the habit of realising from the round. In order to illustrate this point in as clear a manner as possible, we shall suppose that the forester has lying cut, in one of the plantations under his charge, say one mile distant from the saw-mill, one hundred and fifty cubic feet of larch timber, which he values at 1s. 2d. per cubic foot, or at £8, 15s. for the lot, being the sum he could realise for it in the forest, independent of any further trouble. The question now is—At what rate per cubic foot should this larch be sold, after being carted from the woods and cut up at the mill, so as to realise the original price, and cover all necessary expenses? The following statement will form an answer to the question:—

To two horses and carts, drawing one hundred and fifty feet of larch from the woods, one mile distant from the saw-mill, at 5s. per day for each horse, ...	£0	10	0
To one man assisting in loading carts, at 2s., ...	0	2	0
To four men in saw-mill one day, cutting up the same into scantling 6 × 2 inches, at 2s. 6d. per day each, . . .	0	10	0
To keeping up machinery of mill, files for saws, oil, &c., &c., &c.,	0	15	0
	£1	17	0

Here, now, we have the outlay necessary for converting the one hundred and fifty feet of rough wood into scantling at the saw-mill—namely, £1, 17s.—being 3d. additional upon the cubic foot nearly; therefore, in order to realise the original sum of 1s. 2d. per foot for the proprietor, the forester will require to lay on 3d. extra on each foot of the sawn wood, making it 1s. 5d. per foot to the buyer of the wood from the mill.

In order to illustrate this case still farther, we shall suppose that a house carpenter comes to the forester, and inquires at what rate *per lineal foot* he could supply the above larch scantling—namely, six inches by two inches, for roofing purposes, and to be laid down at a distance of four miles from the saw-mill. Here, again, the forester will require to consider how much extra per cubic foot it will take to lay the wood down at a distance of four miles from the saw-mill. I reckon that thirty feet of sawn timber is a fair load for a horse; and, at four miles distant, a horse will take two loads in a day—that is, a horse will draw from the mill sixty feet in one day to a distance of four miles. Therefore, calculating 5s. a-day for a man with a horse, we have sixty feet of timber laid down for 5s., making 1d. extra on the foot—that is to say, the forester could lay the scantling down, at four miles distance from the saw-mill, at 1s. 6d. per cubic foot, and still have the 1s. 2d. clear for the proprietor. The forester having now, we shall suppose, ascertained the price per cubic foot at which he could lay down the sawn timber to the carpenter, his next point of inquiry is, and which the carpenter desires to be made aware of, at what rate per lineal foot he could give the scantling. My method of calculation, in a case of this nature, is as follows:—

	in. in.	
The square of the end of the scantling,	6 × 2 = 12)	144
Number of lineal feet required to make one foot cube,		12

Here we have the square of the scantling, which is 12, exactly 12 times out of 144; thus showing that, of a scantling 6 × 2 inches, 12 feet in length are required to make one cubic foot of timber, therefore these 12 lineal feet can be sold at 1s. 6d., or at 1½d. per lineal foot, which is the answer required.

As every forester should be well acquainted with the sort of calculations now under notice, I will here give another statement of a different scantling from the last.

We shall suppose that a forester gets an order from a party for a quantity of paling rails, say 4 × 1 inch, to be Scotch fir. We will say that the forester sells his Scotch fir, of the size adapted for paling, at 8d. per cubic foot in the rough state; and that he reckons that, to bring the wood in to the mill and saw it up, will cost him 4d. extra per foot, as in the former case. Here, then, the price of the sawn wood will be 1s. per cubic foot; and the forester wishes to ascertain at what rate he can sell the paling rails, per yard of three feet lineal measure. In order to ascertain this, he has to calculate thus:—

	in. in.
The square of the end of the scantling,	4 × 1 = 4) 144
Number of lineal feet required to make one foot cube,	36

That is, it requires 36 feet in length of a scantling, 4 × 1, to make a cubic foot of wood; and in 36 feet in length there are, of course, 12 yards; therefore, if 12 yards in length cost 1s., the forester is enabled to sell the paling rails at 1d. per yard, and still have 8d. per foot cube for the proprietor as the value of his timber.

Knowing that calculations of this nature are extremely useful to all denominations of foresters, I shall, before concluding this section, give yet another example, showing how to calculate the value of deals per square foot, according to the rule formerly given. Suppose that a forester is requested to supply deals of one inch in thickness to a party from his saw-mill—say from old Scotch fir timber, and that the deals must be at least twelve inches broad. In this case, we shall suppose that the forester values his Scotch fir at 1s. 2d. per foot lying in the woods in the rough state; then he must add to this the expense of mill-work and cartage, as in the former cases, at 4d. per foot; and say that he can supply the sawn wood at 1s. 6d. per foot cube, his next point of inquiry will be, at what rate can I sell this wood per square foot when sawn into deals of one inch thickness?

It was said that the deals were to be twelve inches in breadth; therefore the calculation will again be thus:—

	in. in.	
Square of thickness and breadth, .	12 × 1 = 12)	144
Number of lineal feet required to make one foot cube,		12

Here again, we find that it takes twelve superficial feet of boards to make one cubic foot of timber; which, again, is reckoned in value at 1s. 6d.; therefore, the forester can supply the boards one inch thick at 1½d. per square foot. Having given the above statements, it would be superfluous to give any more upon a matter so very simple, as the rule is the same in all cases, whatever be the size of the scantling, and whatever may be the price of the wood per cubic foot.

In conclusion, I may here add, that unless a forester be well acquainted with the above rule for calculating the value of cut wood, he cannot be able to sell it by private bargain to parties who may be inquiring after it. Where wood is cut up at saw-mills, people will come inquiring after scantlings of every size and kind of timber; and if the man who has the charge be not able to give a clear and definite answer to builders and others about the value of wood, who may wish to deal with him, they will at once consider him a person of inferior capabilities; and, in such a case, many will be ready to take the advantage, and try to secure a bargain for themselves at the cost of the forester's character.

SECTION IX. — HINTS TO YOUNG FORESTERS RELATIVE TO THE NATURE AND AMOUNT OF EDUCATION NECESSARY FOR THEM.

I believe that I am justified in here stating, that, compared with any other of the branches of rural economy, forestry is the least in advance towards the perfect state which we may suppose attainable; and whether this state of forestry may be attributed to the slow growth of trees as compared with other rural crops, or to the want of competent knowledge in those who have been in the habit of rearing timber as a crop, is by many considered questionable. Still, we may safely say, that forestry's not having hitherto kept pace with the other branches of rural economy in our country, may with justice be attributed in part to each of these causes. That the slow growth of trees is one reason why forestry has been making so little progress as compared with gardening and farming, cannot be denied; for, under the most favourable circumstances, a period of not less than thirty years is required before woodlands come to pay the proprietor; whereas, in the case of farming and gardening, the results are evident in the course of one or two years at most; consequently proprietors have, as is very natural to suppose, given more attention to that kind of culture which they saw was likely to produce a quick return for the capital expended, and left the other to linger on behind in the march of improvement, seeing they were not likely to be immediately benefited by it. Proprietors, seeing that the operations of high farming upon their estates was a means of quickly enhancing the real value of their property, employed men to superintend such improvements who were of the highest standing in their profession, and of course paid them liberally for their services; while, on the other hand, seeing that their woods were in the first place a burden upon them for a considerable time, and, in the second place, considering that their ever coming to pay them as well as their agricultural operations was doubtful, they were not inclined to give a high salary to a man to act as forester, since they were not likely to receive an immediate return for his services. It is, in a great measure, in consequence of this state of things that we generally see so many plantations in a neglected state, and that we so often find foresters mere men of hand and axe, rather than of mind and knowledge. In making these assertions, I by no means wish it to be understood that there are not men in the capacity of foresters who are as efficient in their profession as land-stewards and gardeners; on the contrary, I could point out many men, employed in the former capacity, whose woods attest their abilities; but, generally speaking, foresters, as a body, are not so able to improve in their profession as many other servants upon landed property. On this account it will not here be out of place to make a few remarks as to the amount of education which I conceive necessary for young men who would wish to excel as foresters, and who have a desire to advance upon those of the old school.

First, then, as the ground-work of every other acquirement, it is indispensably necessary that young men who would be first-rate foresters, should be ready penmen and arithmeticians. It is not enough that they be able to write only so far as to keep their men's time, and calculate the amount of wages that may fall due to each at the end of a given period; but they should be well acquainted with the construction of their native language, or what we may term good grammarians; and that in order that they may be able to hold written communication with their employers upon the general business of their charge, and also that they may be enabled, in a plain, clear, and intelligent manner, to write for the benefit of the public when necessary. Not only so, but they should also be able to enter minutely into all kinds of calculations with figures; and, above all, they should be well acquainted with mensuration and geometry; for, being in possession of such knowledge, they will be able to sketch out upon paper a plan of any projected improvement that may be necessary, whether in the way of new plantations or of laying down to a scale all the different woodlands that may be under their charge; which, by the bye, every forester ought to be able to do. The amount of education above referred to is necessary for every common forester in the daily routine of his profession; but in order that he may be enabled to excel in the rearing of plantations, he must also be well acquainted with botany, vegetable physiology, chemistry as applied to agriculture, geology, and entomology. Without a knowledge of these sciences, it is impossible for any man to excel as an improving and intelligent forester. By having a knowledge of botany, the forester will be enabled to examine into the nature and kinds of trees and other plants he may cultivate, as well as to write, describe, and give his opinion intelligently relative thereto. By being acquainted with vegetable physiology, he will still further be enabled to examine into the nature of plants, in the case of disease or any other extraordinary occurrence; and will seldom be found at a loss to assign a sound reason for any unusual phenomena that may take place among the trees he cultivates; in short, vegetable physiology is to the forester what anatomy is to the medical practitioner—absolutely necessary, and not to be dispensed with, where success in business is desired. Though this science is thus indispensable to success in the rearing of trees, it is, I may say, wonderful that not one forester among twenty thinks of studying it. Agricultural chemistry and geology are two other sciences which every forester ought to be acquainted with. By having a knowledge of these, they will be enabled to examine reasonably and intelligently into the nature of soils, and their adaptation to the different kinds of trees to be reared in a given district. Many say that entomology is by no means a necessary part of a forester's education; stating that the natural history of insects is more useful to farmers and gardeners. To this, however, I answer, that insects attack trees as well as plants of a smaller and more delicate nature; therefore it is a most necessary part of a forester's education, seeing that, when insects do attack trees, if the forester is ignorant of their natural habits, he must either be indebted to others for advice, or allow his plants perhaps to be destroyed under their ravages.

I have very recently spoken to several foresters as to the necessity of young men being well acquainted with the above-named sciences, and found them averse to it upon the score of want of means. This objection can no longer hold good, as there are so many cheap books to be had upon every one of the useful sciences, by which any person of tolerable capacity, and a moderate share of perseverance, may attain a very correct knowledge of the same. I have frequently heard another objection raised on the same point—namely, that although foresters were to be well acquainted with the sciences named, and could apply them to their every-day employment, they would not in all probability ever be rewarded for their knowledge and labour, seeing that foresters' wages are in general small. This objection is scarcely worthy of being refuted. However, as I am well aware that it is entertained by many, I may here state, that every experienced forester, having the amount of knowledge which I have stated to be necessary, will have no difficulty in realising a competent salary for his abilities. Those who will be ignorant, will of course be paid accordingly; and those who, by perseverance and praiseworthy industry, have gained a proper amount of knowledge to render them superior in their profession, will also be paid accordingly. No proprietor, who had extensive woods to manage, would hesitate one moment in deciding whether he would be most benefited ultimately by employing an indifferent forester at L.40 a-year, or a first-rate one at L.150 a-year. I would therefore urge every young man who wishes to fill a respectable situation as forester, to gain first a sufficient amount of necessary education and practical experience, and he will soon be picked up by observing landed proprietors. I may remark here, that it is by no means necessary that a forester should be a profound professor of all the different sciences named: such an amount of knowledge is not, I believe, to be attained by any single individual during a lifetime: all I urge is, that he should be well acquainted with those sciences, and be able to reason upon the different branches of his daily employment, according to the rules laid down by the professors of them. Relative to this point I may also state, that I have induced a few of my young foresters at Arniston to begin to study the sciences above referred to. I spend with them, now and then as I have leisure, an hour or two for the purpose; and by this mode I not only have the minds of my young men instructed, and make them superior workmen, but I have at the same time an opportunity of improving my own mind: and I think that every experienced forester should do the same with his young men; for by adopting such a system, there would be very soon brought forward a race of foresters in every way superior to what has yet been; and thus their profession would be made of higher standing as a branch of rural economy.

However necessary the above-mentioned amount of education is to foresters, it is also of equal importance that they cultivate to a very great extent, habits of observation and perseverance in every department of their profession. In fact, without the cultivation of these, no experience can be gained in any department of rural economy. It is quite possible that a man may be well acquainted with the theoretical parts of all the above-named sciences, and yet be very ignorant as to the profitable rearing of timber; and it is also quite as possible that a man may be engaged for a period of fifty years in the planting and cutting down of trees, and be at the same time ignorant of the proper way of managing plantations. All this I would earnestly impress upon the minds of young men who attempt forestry. At the present time I am acquainted with some young men who have not been more than seven years at the business of forestry, who are far superior in their profession to others who have been not less than thirty years working among woods; all this difference being occasioned by the one being of a persevering and observing character, while the other is of the contrary. I would, then, particularly advise young foresters not to allow any part of the work they may be engaged in to slip through their hands, as it were, but to make themselves perfectly aware of why and wherefore such a piece of work should be done this way, and not that. In all cases where young men of observing habits have reason to think that the system of operations adopted by their masters could be improved upon to advantage, I would advise them to do a small part in the manner they may think would be an improvement, and afterwards observe the results for their own future guidance and experience.

In conclusion, theory in forestry, as well as in any other profession, is valuable as a suggestion, but it cannot be laid down as a practical rule until proved by observation and experience.

APPENDIX

[The following notes, from a Report actually drawn up by the Author, on the state of plantations, &c., and fitness of land for planting in high-lying districts, have been added, in order to illustrate, to those employed in similar examinations, the way in which such surveys may be conducted.—J. B.]

The principal object in surveying and reporting on lands which admit of being planted, is to ascertain and describe whether the climate, soil, and other local circumstances, present favourable inducements to undertake the extensive planting of forest trees, with a view to a profitable return—regard being also had to the local demand for timber, especially if mines are situated either close to, or within a moderate distance of, the proposed plantations. The first important step in such cases is, to examine and report separately upon the present state and prospective condition of existing plantations; and the following are examples of such examinations and reports, omitting such portions as are exclusively of a local bearing.

No. I.

PLANTATION 1500 FEET ABOVE THE SEA, 30 YEARS OLD.—DETAILED DIRECTIONS FOR THINNING AND PARTIAL REPLANTING.

This plantation consists principally of larch, with a proportion of Scotch and spruce firs intermixed, and may be about thirty years old. It occupies both sides of a ravine, to the extent of forty-one acres, and is situated at an elevation of fifteen hundred feet above the level of the sea.

Upon the sloping sides of the ravine, the upper soil is chiefly of a light and sandy nature, somewhat approaching to a light loam, which lies partly upon a subsoil of limestone rock, and partly upon beds of sand mixed up with large stones. The *flat upper* portions of the ground under this plantation, situated upon the east side of the ravine behind the wall by the roadside, consist of about twelve inches of moss resting upon a sandy clay, which is generally damp, with trees going back upon it, and requiring draining. In the bottom of the ravine some flat ground occurs, the soil of which, being clay, is in a very damp state also, and requires draining.

The soil here is excellently adapted for the rearing of larch to healthy and valuable dimensions; but notwithstanding this fitness of the soil, one half of the present crop of trees are in a weakly and unprofitable state. At thirty years of age, fir trees ought to stand in a plantation at distances varying from ten to twelve feet one from another; whereas, in the plantation now under notice, the greater part of the trees stand at distances varying from four to seven feet; and in consequence of their having for some years past existed in such a state of confinement, one half of them are now in a weakly and irrecoverable condition; but wherever any of the trees have got head-room, they are of excellent and healthy character, and will yet become timber of first-rate dimensions. Generally speaking, there are yet enough of healthy trees in this plantation to form an ultimate valuable crop under good management; and seeing this, I would advise, for the recovery of the most valuable part of the trees, to proceed as follows:—*1st,* Have all weakly trees, of whatever kinds, cut down and removed, wherever they may be lying upon, or too close to, any valuable healthy larches. *2d,* All the healthy larch being relieved from encumberers throughout the whole extent of the plantation, the next thing will be to have the Scotch and spruce firs relieved among themselves; observing in this not to leave any one tree with its branches lying upon those of its neighbour, excepting upon the outskirts of the plantation: there it will be necessary to leave the trees rather close, in order to protect the interior from storms of wind; for if the outskirts were made as thin as the interior, the wind would get in and blow down many trees. *3d,* The flat damp parts, formerly referred to, should be cleared from all unhealthy trees, the ground properly drained by open cuts at thirty feet apart, and about two feet deep; and after lying for a few months, in order that the drains may have the effect of cleansing the soil, they should be replanted with larch alone, as that tree will decidedly become of good value upon the soil now under our notice. *4th,* All beech and alder growing in this plantation are worthless as timber; therefore I would advise to have these cut down and removed, and the ground occupied by those trees drained where necessary, and replanted with ash at twelve feet apart, made up between with larch to four feet over all, where the soil is of a clayey nature, and with larch alone where it is of a light nature.

All the work, as above detailed, should be done as soon as possible; and I recommend the spring as the best time for having it performed. In the case of plantations under regular good management, a particular season of the year is not of importance for thinning; but where the trees have suffered much from confinement, it is absolutely necessary that they be thinned, say during the months of April, May, and June; for, by attending to this point, the trees do not suffer any check from winter storms, as would be the case were they thinned in the winter months The advantage, therefore, gained by thinning during spring is, that the trees become established and firm at the roots before winter sets in upon them.

No. II.

PLANTATION, 1550 FEET ELEVATION, 25 YEARS OLD.—DRAINING, SHELTER FROM WINDS, &c.

This plantation consists of Scotch fir chiefly, with a few larch intermixed, and may be about twenty-five years old. It extends to about three acres, and is situated at an elevation of 1550 feet above the level of the sea. The soil is of the same nature as No. 1, and is excellently adapted for the growing of larch timber to valuable dimensions. In consequence of the land not having been drained when the trees were planted here, the present crop is for the greater part diseased and worthless, and will not now attain to any considerable value. Seeing this, I would advise to have the land cleared of all the present crop; have drains formed at forty feet apart; and after it has been allowed to lie one year under the action of the drains, to have the whole replanted with larch at from three to three and a half feet apart. I said above that I would advise to have the land cleared of all the present crop of trees; but I should observe here that it will be necessary to preserve a narrow belt of the present crop all round the outer edge of the plantation, with the view of protecting from storm the young trees forming the second crop, till they arrive at the stage when they will require to be thinned for the first time.

In replanting here, it will be necessary to run a narrow belt of Scotch firs right through the centre of the ground, *from south to north*, with the view of intercepting the strong west winds, which would otherwise sweep unchecked through the whole breadth of the plantation. The larch being a deciduous tree, it is often retarded in the spring months by severe frost-winds blowing through a plantation composed of it alone; but when narrow belts of Scotch fir, which is an evergreen, are run at proper distances against the prevailing winds, the climate is much ameliorated, and the larch trees are in consequence much improved in their general health.

No. III.

PLANTATION, 1400 FEET ELEVATION, 28 YEARS OLD.—INJURIOUS EFFECTS OF DAMPNESS ON THE GROWTH OF LARCH, &c.

This plantation consists of Scotch and larch firs mixed, which may be about twenty-eight years old. It extends to nearly twenty-six acres, and is situated at an elevation of fourteen hundred feet above the level of the sea. On the higher parts, the soil in the upper stratum consists of a sandy loam; on the lower parts it is inclined to a sandy clay, all resting upon sandstone rock.

The bad effects of dampness upon the health of forest trees is very strikingly exemplified in this plantation, as well as the good effects of dry ground upon the same; and there is at once indicated the great necessity of draining the land in this district of country previous to planting trees upon it. Upon all the damp parts here, the larch has entirely died out; while the Scotch fir, on the same parts, has merely kept in a state of existence, and formed low, bushy, spreading plants, quite out of the usual character. Upon some slightly elevated parts, again, where the soil is naturally dry, both the Scotch and larch firs have done well; but in consequence of neglect in thinning, they are much drawn up and weakly.

In order to improve this plantation, and make it become of ultimate value, I would advise to have all the bad Scotch fir cleared from the damp land, have it properly drained, and after the drains have been allowed to act for a period of one year, have the drained land replanted with larch alone, say at three and a half feet apart. Upon the dry portions, where the larch and Scotch fir have thriven comparatively well, I would advise to have the trees judiciously thinned, and the best allowed to remain (for they will yet increase in value) in order to shelter the young crop for a time. It may be proper for me to remark here also, that it will be of great importance for the future benefit of the young trees to be planted here, if a narrow belt of the present crop be left all round behind the fence; and that more especially upon the west side of the plantation. The land under this plantation is well adapted to bring larch timber to durable and valuable size.

No. IV.

PLANTATION, 1400 FEET ELEVATION, 40 YEARS OLD.—IMPORTANCE OF BREADTH IN EXPOSED SITUATIONS.

The crop of trees here consists of Scotch fir principally, upon the northern division, and of larch and Scotch fir, mixed, on the southern division, and is about forty years of age. This plantation extends to sixteen acres, and is situated at an elevation of fourteen hundred feet above the level of the sea. The soil is very nearly of the same description as that of the last-mentioned plantation, but having a few inches of moss in the upper stratum upon the higher part. Upon the northern division, where Scotch fir forms the principal crop, the trees are mere bushes, and will never arrive at any ultimate value. This state of the trees may be easily accounted for; for the plantation on this part being quite narrow, the wind from the west blows easily through the whole breadth. Upon the south end the plantation is much broader, and the trees are consequently much healthier; thus pointing out that, in order to grow trees profitably in this district, it is only necessary to plant them in large masses.

In order to improve the state of this plantation, and make it valuable as woodland ultimately, I would advise to have a few of the Scotch fir trees, where they are close, taken out, with the view of replanting larch among them, (that is, upon the northern division); and that being done, the whole of the vacant ground among the old quarry rubbish, and wherever openings occur among the Scotch fir, should be replanted with larch alone; and in consequence of the Scotch fir trees being left for the greater part among the young larch trees, the latter will grow up rapidly, and very soon form a valuable plantation. Of course it is here understood, that as the young larch trees rise up, the old Scotch firs left among them as nurses might be either taken out altogether, or left, if considered necessary, for a continuance of shelter. Upon the southern division, the trees, both larch and Scotch fir, are in a fair state, but have been much neglected, and altogether they have suffered from want of thinning, being much drawn up and weakly; but as they will yet considerably improve under future good management, I would advise to thin out fully one-third of the weaker trees; after which, the healthier part left will become more strong and vigorous, and attain the size of good deal-timber.

No. V.

PLANTATION, 1480 FEET ELEVATION, 18 YEARS OLD—THINNING AND DRAINING.

Part of this plantation consists of larch, which may be about eighteen years old; and the remainder consists of Scotch and spruce firs principally, with a few larch intermixed, which appear to have been planted in the spring of the present year. The extent of the two parts put together is six acres, situated at an elevation above the sea of about fourteen hundred and eighty feet. The soil upon which the older larch trees are growing is of a heavy loamy nature, which, if dried by means of open drains, is capable of growing either larch or hardwood to valuable dimensions. The present crop of larch is excellent wherever the ground is naturally dry under them; but where the ground is damp, the plants have of course failed to grow. In order to improve the older division here, I would recommend to have the trees thinned where too close upon the dry ground, and at the same time to have all the damp parts which are vacant well drained, and afterwards replanted with oak, at from ten to twelve feet apart, and made up between with larch to about three and a half feet over all. The soil here is well adapted for growing oak, and, if dried by means of open drains, valuable trees would ultimately be produced, more especially as the present crop of larch would shelter and bring them away quickly.

No. VI.

PLANTATION, 1370 FEET ELEVATION, 16 AND 20 YEARS OLD—INJURIOUS EFFECTS OF PRUNING LIVE BRANCHES FROM FIRS, &c.

This plantation consists of oak, sycamore, and ash, with larch and spruce fir as nurses. The northern part is about sixteen years old, and the southern twenty years; and altogether the plantation may extend to about nine acres, situated at an elevation of thirteen hundred and seventy feet above the level of the sea. The soil is generally a light sandy loam, resting upon an open decayed freestone bottom.

The whole extent of this plantation is at present in a close and neglected state. The greater part of the trees being, however, healthy, and the land being well adapted for bringing either hardwood or larch to valuable dimensions, I would advise, for the future improvement of this plantation, to proceed as follows:—1st, All healthy hardwood trees should be relieved from every fir that may be lying upon or too close to them; and when relieved, they should have a judicious pruning, which pruning should be done in the months of May, June, or July, but never in the winter season.—2d, All the healthy hardwood trees being relieved, the firs should next be thinned among themselves; observing, in doing this, not to leave any individual tree with its branches lying upon those of its neighbours. In thinning here, generally, observation should be had to cut down any bad or unhealthy hardwood tree, and leave the nearest fir instead.

In looking through this part, I observed that a system of pruning live branches from the firs has lately been put into practice. Such a practice is injurious in the extreme to the health of the trees; therefore I would advise, that in future no such pruning should be allowed. It is in all cases an improvement to the health of fir trees to prune dead branches from them; but the cutting off of live branches causes a wound not easily healed.

The trees growing on the northern division of this plantation are inferior in health to those on the southern division, in consequence of the difference in the breadth of the mass. On the north, the mass is narrow and inferior in health, while on the south the mass is broader and superior; and I consider it proper to advert to this, seeing that the health of plantations in a high-lying part depends very generally upon the extent; that is, the larger that a plantation is made, the healthier will the trees be, and the greater will be the ultimate produce per acre.

No. VII.

PLANTATION, 1500 FEET ELEVATION—NEWLY PLANTED—EFFECTS OF NEGLECT OF DRAINING, AND PROPER SELECTION OF TREES.

A piece of ground extending to about eleven acres, which has very recently been enclosed as woodland. The soil is a good deep sandy loam, well adapted to the rearing of hardwood and larch to valuable dimensions, and is situated at an elevation of about fifteen hundred feet above the level of the sea.

This piece of ground, although naturally damp, has been planted with larch, Scotch, and spruce firs, without any drains having been previously put on it; and in consequence of the natural wetness of the soil, a great portion of the young plants have perished. Besides, of the kinds put in here, the Scotch and spruce firs are not adapted to the soil and situation. With the view of raising a valuable crop of timber here, I would recommend to have the ground dried by means of open drains, say at forty feet apart, and two feet deep—not draining of course any knoll naturally dry—and to plant oak and ash, with a few sycamores upon the outsides, at from ten to twelve feet apart, making up with larch to about three and a half feet over all.

No. VIII.

PLANTATION, 1200 FEET ELEVATION, 20 YEARS OLD—IMPORTANCE OF TIMELY THINNING TO HARDWOOD, &c.

A young plantation about twenty years of age, consisting of oak, ash, and sycamore, as a permanent crop, with larch and spruce fir intermixed as nurses. The soil is a good deep sandy loam, resting upon freestone. The plantation is situated at an elevation of twelve hundred feet above the level of the sea, and in extent may be about four acres. The greater part of the trees are in health, but much drawn up in consequence of neglect of thinning. This plantation requires to be judiciously thinned, and that as soon as possible. In thinning here, I would advise to proceed in the same manner as already detailed under the head No. VI. Some damp parts occur here, which should be drained and replanted with larch alone.

Under future good management, there will be produced here both hardwood and larch of large size and valuable quality.

No. IX.

PLANTATION, 1050 FEET ELEVATION, 35 YEARS OLD—THINNING, SHELTER FROM PREVALENT WINDS, AND ADVANTAGES OF TREES HAVING ROOM TO GROW, &c.

Consists of larch and Scotch fir, about thirty-five years of age, and extends to forty-eight acres. The soil is generally a good deep light loam, resting upon freestone, and is excellently adapted for the rearing of either hardwood or larch to valuable dimensions, and the situation may be about ten hundred and fifty feet above the level of the sea.

The trees in this plantation are very much crowded, but, considering the neglected state they have existed in, are good. Wherever the larch have got room and air they are first-rate specimens, and of large dimensions for their age; at once pointing out what the whole plantation would have been under good management. The Scotch firs are much inferior to the larch throughout the whole plantation; therefore, in making future thinnings here, the Scotch firs should be considered as a secondary tree only, and gradually removed in order to give place to the larch. The whole of the plantation requires to be gone carefully through, and all the weaker trees taken out, so as to give proper room and air to the stronger: at least one-third of the whole require to be thinned out. As this will ultimately, under good management, become a wood of great value, I would advise to have it thinned immediately; and in the act of thinning, care should be had to leave the west side rather close of trees, with the view of protecting the interior from storms of wind; for otherwise, after thinning, many might be blown down, seeing that they have stood so long in a confined state. On the low-lying flat part of this plantation some good ash and oak are growing, but in a very crowded state: these should be well thinned out, to such an extent that the branches of no individual tree shall interfere with those of its neighbours. Where the hardwood trees are growing, a considerable number of drains require to be cleared out, as they are at present filled up, and causing water to stagnate among the roots of the trees.

No. X.

PLANTATION, 1000 FEET ELEVATION, 18 YEARS OLD—SELECTION OF TREES FOR ULTIMATE CROP, AND IMPORTANCE OF PLANTING EACH KIND OF TREE IN A SUITABLE SOIL.

Consists of oak, ash, and sycamore, with a few Scotch elms, and also larch, as nurses. The soil is a very light sandy loam, resting on freestone, at an elevation of one thousand feet above the level of the sea. The trees are about eighteen years old. The ash and elm, in consequence of the very light nature of the soil, are not doing well; therefore, in thinning here, those sorts should be cut out, and place given to the other kinds which are more healthy. The oak, sycamore, and larch are good, and will arrive at valuable dimensions under future good management. The whole plantation is in a very crowded state, and should be immediately thinned; and in doing so, the operation should be gone about in the same manner as already advised under the head No. VI.

No. XI.

PLANTATION, 1070 FEET ELEVATION, 45 YEARS OLD—REMOVAL OF DISEASED TREES, AND CAUSE OF DISEASE, &c.

The crop of trees here consists of larch and Scotch fir, about forty-five years old. The soil is a naturally dry and light sandy loam, resting upon freestone. The extent of the plantation may be about twenty-eight acres; it is situated at an elevation of one thousand and seventy feet above the level of the sea. Many of the trees stand at distances not exceeding five feet one from another, whereas, at their age, they should not stand closer than fifteen feet. On the north end of this plantation, a part has lately been cleared of trees; and upon making inquiry as to the reason of such a premature step, I was led to believe that it had been done under the impression that the trees were diseased, and failing to increase in value. In consequence of the crowded state the greater portion of the trees have existed in for some years past, a few have become diseased; but this will be found equally the case in all plantations under like circumstances of management; and the only reasonable way of recovering such a plantation is, to thin out the diseased, in order to improve the healthier trees, but by no means to cut down the healthy and improvable portion along with the diseased. An experienced practical forester can easily detect in a plantation a tree that will improve in value from one that will not; therefore, instead of sweeping the crop entirely down, the diseased portion should have been taken out and disposed of, and the healthy trees left to improve, and become of more value as an ultimate crop.

This plantation should be improved by a judicious regular thinning. In doing this, it is only necessary to give, in the first place, ample room to all good, healthy trees, whether larch or Scotch fir, (and there are enough of good trees for an ultimate crop;) and in the second place, to cut out all trees, whether larch or Scotch fir, having a weakly or unhealthy appearance. If this be attended to, the plantation will yet increase very much in value.

The whole of the plantations described are situated more than one thousand feet above the level of the sea, and in districts of a semimountainous character, in which there are, both in England and Scotland, many hundreds of square miles of land capable of rearing timber. Taking into account the extremely neglected condition in which the trees in the plantations described in these notes have hitherto been left, I am led to conclude that they are good, and, I may even add, comparatively healthier in constitution than many others which I have examined, both in England and Scotland, which were growing under more favourable circumstances of situation—at once confirming my judgment, and giving me full confidence in here stating, that the soil upon which these plantations are growing, as well as the climate in which they exist, is well adapted to the rearing of trees to valuable dimensions and sound quality; that is to say, if attended to in a regular and thoroughly practical manner.

An opinion unfavourable to the extensive planting of forest trees has been formed by many persons residing in elevated districts, from an idea that the soil and climate present a great discouragement to trees attaining healthy and profitable maturity. Such an opinion can only be entertained by persons unacquainted with the present improved system of arboriculture, and without extended practical observation and experience relative to the point in question. In proof of this, it is only necessary to remark, that the plantations already noticed in this Appendix have been for the greater part planted without discrimination, and almost left to nature, which at once indicates that those who hold the opinion referred to above have not formed a correct judgment upon the subject.

The principal points to attend to in the rearing of timber, in a high-lying district of country, to healthy and profitable maturity, are, first, to drain the land in such a manner as to render and keep it in a sweet and dry state; second, to distribute the several kinds of trees over the ground to be planted, in such manner that each may have a soil and site congenial to its nature; third, to plant in such large masses, that only the trees forming the outer boundary of the plantation may be affected by local storms, and thus ameliorate the general climate for the good of the trees forming the interior of the plantation; fourth, to plant pretty closely at first, and afterwards thin out gradually as the trees advance in size; fifth, to thin very frequently, so as the plantations may neither receive a check from being overcrowded, nor from being suddenly thrown too open; sixth, to keep all drains in a clear running state; and, seventh, in the forming of a plantation, to throw out a bold convex bend against the prevailing local winds.

The following notes refer to proposed operations in high-lying districts, and are selected, with the omission of local descriptions and details, from professional reports by the Author.

No. XII.

PROPOSED PLANTATION AT AN EXTREME ELEVATION OF 1700 FEET—PRODUCTION OF SHELTER—DRAINING—SELECTION OF TREES, &c.

An extensive tract of comparatively waste land, which, at an altitude of seventeen hundred feet, is capable of great improvement, either as grass or woodland. The soil in this district is very variable: at an elevation above seventeen hundred feet, it consists chiefly of moss above three feet in depth, resting upon blue clay; which nature of soil, at such an elevation, is quite unfit for the rearing of any kind of tree to any profitable size. Taking a parallel range of about two hundred feet under the last-named height, the upper surface consists, generally, of from six to eighteen inches of moss resting upon a blue clay, with various indentations of good loamy soil—all well adapted, if properly drained, to the rearing of either larch or Scotch fir. Between the elevations of twelve hundred and fifteen hundred feet, the soil varies from a good light loam, generally dry, resting upon a gravelly and stony bottom, to a strong sandy loam, generally wet, resting upon a blue sandy clay—all well adapted, if properly drained, to the rearing of either hardwood trees or larch.

Taking into account the large extent of land which rises to an elevation above seventeen hundred feet in this district, and which may at present be considered incapable of growing timber to useful size; and also taking into account that a large portion could be very profitably converted into grass land, I am of opinion that about fourteen hundred acres ought to be planted with forest trees; and as the land here is well adapted for rearing trees to healthy maturity, such an extent would not only prove of great ultimate value as timber, but would, in consequence of producing shelter and ameliorating the climate, greatly enhance the value of the land in the neighbourhood, which might be kept either under the plough or in grass. In laying off the fore-mentioned quantity of land for planting, I would advise to keep all the better portions lying along each side of the water for the purpose of being improved and cultivated as *arable;* and as the greater part of the land there is good, if drained, and otherwise improved, it might, under the ameliorating influence of the rising forests, be made available for the production of agricultural crops. Keeping this in view, and supposing that a considerable portion of good land is to be retained along each side of the water, I would next advise to make, at proper intermediate and irregular distances along the back-ground of the land to be cultivated, bold masses of plantation, bending down to the waterside. By laying off the woodland in this manner, a pleasing and natural outline will be produced; and at the same time such projecting masses of plantation will have the beneficial effect of sheltering the cultivated land from winds rushing down the vale, independently of the main body of the wood producing shelter from winds coming from the hills. Again, in laying off the *outer* or higher boundary line of fence for the land to be planted, I would recommend, where the land is of good quality, and free from any considerable depth of moss, to take the fence well up, in order to include such parts within the plantation, even going in such cases a little beyond the specified elevation of seventeen hundred feet; and where the land may be of an inferior quality, and consist of rather deep moss, to bring the line of fence considerably under that height, in order to avoid such bad portions of the soil. In all those cases, it should be particularly observed to throw out a wide and bold convex bend against the most stormy point or points, which will be found capable of resisting the action of the local winds much better than a straight line of fence.

The plantation or plantations being laid off to the extent of about fourteen hundred acres, the next thing in order, after the fencing has been completed, will be to have the land drained where necessary. This forms a most important part of the work of laying down plantations, much of the future success depending upon its being well done.

In draining here, I would recommend the following rules as to depth and distance between:—Upon all hollow or flat-lying portions, where the soil may be inclined to clay, have the drains put in at about thirty-five feet apart, and make them about twenty-four inches deep. Where the soil is of a light loamy character, yet naturally damp and requiring to be drained, have them put in at about forty-five or even fifty feet apart, and make them about twenty inches deep. And upon the higher portions, where the soil may be inclined to moss on the surface, have the drains put in at about twenty-five or thirty feet apart, and about eighteen inches deep.

It will not be found necessary to drain the whole extent of the land to be planted here. I would say that fully one-third is naturally dry, and will grow trees perfectly well without being drained—all which can easily be ascertained by an experienced person; but I may add that, throughout the whole extent of the district, draining would be of great advantage.

The land being all drained where necessary, it should be allowed to lie in that state for at least three months previous to planting the trees upon it—that is to say, no particular part requiring to be drained should have plants put into it till the drains have been allowed to act for a period of three months; this being with the view of having all stagnated qualities that may be lodging in the soil *washed out* before the plants are put in.

In distributing the young trees over the different qualities of land, I would advise as follows:—Beginning upon the highest and most exposed parts of the ground, have a belt of about fifty yards in breadth planted all along behind the fence, of one-half Scotch fir and one-half birch, planting them equally over the ground at about three feet apart. This is intended to act as a *break-wind* against the prevailing storms; and if the Scotch fir should fail to make good upon any particularly exposed point, the birch will decidedly grow well, and maintain shelter for the trees in the interior. Immediately behind this *break-wind belt*, have another of about one hundred yards in breadth, planted of Scotch fir and larch, of each an equal number, to the distance of about three and a half feet over all. This second belt is intended to act as a medium protection between the break-wind outside and the more valuable trees in the interior of the plantation. With regard to this second belt, however, I may add, that it is by no means necessary that it should be made a hundred yards in breadth throughout the whole of its length: it ought, indeed, to be made of that breadth upon particularly exposed and prominent points; but where the boundary of the plantation falls into a comparatively sheltered part of the ground, it may be almost dispensed with, and gradually widened as the line of fence may fall upon a more exposed situation.

These very necessary points in the rearing of timber upon high lands being attended to, any kinds of trees adapted to the soil may afterwards be planted in the interior with every hope of success. Next, therefore, have all the good clay and loamy tracts planted with oak, ash, and elm, say at distances averaging between ten and twelve feet, and make up with larch alone to about three and a half feet over all. Next, all the best of the land in the most sheltered parts being planted with hardwood trees, as specified above, all the *sloping braes*, situated between the hardwood trees on the one hand, and the secondary belt upon the other, should be planted with larch alone, at distances varying from three and a half to four feet; and all prominent ridges of land forming the tops of the slopes, as well as any portions of the land having more than twelve inches of moss on the surface, should be planted with Scotch fir alone, at distances varying from three and a half to four feet.

By attending to these rules, each kind of tree will occupy the soil and situation most congenial to its nature, and consequently the plantation as a whole will be made to produce ultimately the greatest possible value in useful timber; and I may state, that it is the want of attention to these rules that is the cause of many plantations failing to become of value.

No. XIII.

PROPOSED PLANTATION AT AN ELEVATION OF 1350 FEET—SPECIES OF TREES FOR DIFFERENT LOCALITIES, &c.

An enclosure extending to about 500 hundred acres. The medium elevation above the level of the sea, 1350 feet. The soil for the most part consists of a good light loam, with limestone under. On some flat parts the soil is a sandy clay, which is all damp, and requires to be drained.

This land is of first-rate capabilities for the growing of timber to valuable dimensions; and as it is generally of an open bottom, draining may be easily and readily performed. After drying all naturally damp parts, by means of open drains at about forty feet apart and twenty-four inches deep, there should be a belt of Scotch fir planted immediately behind the wall forming the *south* and *west* boundaries, to the extent of about fifty yards in breadth; and as the land is of the highest elevation on those sides, such a belt will prove of great benefit in giving shelter to the interior of the plantation. Next, the land upon the west side of this allotment being of the highest elevation, I would advise to plant upon that side Scotch fir to the extent of about one hundred and fifty acres; upon the east side, along the banks of the water, oak, ash, and elm, mixed with larch, as already detailed in No. XII., to the extent of about one hundred and fifty acres; and between those two compartments, where the soil is generally of a good sandy loam, I would advise to plant larch alone, which of course would be to the extent of about two hundred acres.

Upon this land, hardwood and larch will arrive at great value, and Scotch fir will also be good.

No. XIV.

PROPOSED PLANTATION, 1100 FEET ELEVATION—IN PLANTING, DEPTH OF MOSS ON SURFACE TO BE TAKEN INTO CONSIDERATION.

Comparatively waste land, extending to about one hundred acres, situated at an elevation of about eleven hundred feet above the level of the sea.

On the hollow and flat-lying parts, the greater part of the soil consists of a good sandy loam, well adapted for the healthy growth of either oak or larch. On the higher lying portion, the upper soil consists of about twelve inches of moss resting on sandy clay, all damp; but if drained, it is well adapted to the rearing of either larch or Scotch fir; or on some parts where the moss is not more than six inches deep, of oak and ash. In planting here, I would advise the same manner of procedure as already detailed in note, No. XIII.

No. XV.

PROPOSED PLANTATION, 1500 FEET ELEVATION—SCOTCH FIR AS A BREAK-WIND, &c.

A portion of land extending to about fifty-two acres, situated at an elevation of fifteen hundred feet.

The western and highest-lying half of this tract consists of a thin light moss on the surface, with sand and gravel under, and is adapted for the growth of Scotch fir only; the slopes hanging to the south and east, being a good light loamy soil, are well adapted to the growth of larch. The greater part of the land here requires to be drained at forty feet apart, and about eighteen inches deep. In planting here, it will not be necessary to form a belt upon the storm side, seeing that one-half of the ground is to be planted with Scotch fir upon that quarter, which will form sufficient protection of themselves to the interior, as well as to the larch upon the sloping ground under them. Both the larch and Scotch fir divisions may be planted at about three and a half feet apart.

No. XVI.

PROPOSED PLANTATION, 1700 FEET ELEVATION—NOT ADVISABLE TO PLANT TREES ON MOSS LAND ABOVE THAT ELEVATION.

An extensive tract of waste land, the greater part of it rising to an elevation considerably above seventeen hundred feet. I would advise to enclose and plant of it only to the extent of about ten chains in breadth from the enclosed land on the south-east; which extent in breadth would run the outer fence along the elevation of about seventeen hundred feet above the sea-level, and consequently would include the land to be planted under that extreme.

The soil of this part consists generally of from six to eighteen inches of moss, resting upon an open subsoil of the same nature as that described in Note, No. I.,—all well adapted to the rearing of the fir tribe.

Excepting upon some naturally dry ridges, the whole of the land here requires to be drained before planting. In doing so, I would advise to lay the drains on at about forty feet apart, and make them about eighteen inches deep. In planting, I would recommend to have the upper half of the proposed breadth planted with Scotch fir alone at three and a half feet apart, and the under half with larch alone, excepting on a few partial spots where the moss is deeper than twelve inches, which should be planted with Scotch fir. Both Scotch fir and larch will grow here to a good useful size.

No. XVII.

PROPOSED PLANTATION, 1700 FEET ELEVATION—TREES WILL SUCCEED AT THAT ELEVATION IF NOT ON DEEP MOSS LAND.

A continuation of No. XVI. tract. The soil on many parts consists of a good sandy loam, but it is generally of a light moss, varying from four to thirty-six inches in depth, and all resting upon an open sandy bottom. On this district there may very properly be planted with larch and Scotch fir one hundred and thirty acres; and in laying off the land for planting, I would advise not to extend the boundary fence beyond the elevation of seventeen hundred feet. In draining, and distributing the trees over the ground on this district, I would recommend to keep in view the same remarks already made under the last head.

No. XVIII.

PROPOSED PLANTATION, 1400 FEET ELEVATION—DRAINING AND DISTRIBUTION OF TREES ACCORDING TO THE NATURE OF SOILS.

A tract of waste land extending to about seventy-five acres. The soil consists of a sandy moss, varying from three to twelve inches in depth, resting upon an open sandy bottom, sometimes approaching to sandy clay. The slopes hanging to the north have the soil generally of a good sandy loam, well adapted to the rearing of larch to a valuable size. The medium elevation of the higher ground here is about fourteen hundred feet above the sea-level. All the higher part of this allotment requires to be dried by drains laid on at about forty feet apart, and eighteen inches deep. The slopes are generally dry; but on some partial spots where the soil inclines to clay it is damp, and will require to be drained before planting upon it. I would advise to plant the higher ground with larch and Scotch fir in equal numbers to three and a half feet over all; and the sloping ground, where inclined to clay, with oak and ash, at from ten to twelve feet apart; and where light sandy loam, with larch alone to three and a half feet: of course, making up among the hardwood with larch to the same distance over all.

THE END.

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