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No. 20



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Central Inset

EDITING COMMITTEE :

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D. HEALEY

JAMES MACDONALD

R. G. BROADWOOD, *Editor*

E D I T O R I A L

AS WE FEEL we are all honoured by the distinctions that have recently been bestowed on Forestry Commission men, we start our Editorial with a recital of these honours. Lord Robinson's barony will be fresh in all our minds, and we now congratulate Sir William Ling Taylor on the knighthood he has just received. Sir William is one of the Old Brigade of the Forestry Commission ; he has been in the Commission's service since its inception in 1919 and, while he relinquished the post of Director General last year, he still serves as a whole time Forestry Commissioner. Sir William's love for the soil and everything that springs from it is well known, and bears out a dictum of his that a man may be a good silviculturist and a good forest manager, but only he who has an abiding love and care for the land in all its aspects can claim to be the true forester. Sir William also serves on the newly formed national Nature Conservancy, and his knowledge of the ways of the wild life of the countryside, and of the woods in particular, will be valuable on questions of the care and protection of the rarer animals and plants—a matter of growing importance in this already crowded country of ours.

We also record the award of the Order of the British Empire to James Fraser, Conservator of Forests for Northern Scotland ; while J. Q. Williamson, Chief Education Officer, and Harry Watson, Forest Officer Instructor, Benmore Forest School, were designated Members of the British Empire ; and H. B. Weir, Head Forester, Kielder, was awarded the British Empire Medal.

We are also happy to reproduce, on another page, a photograph of Sir William seated at the desk which was presented to him by his colleagues and the staff to mark their appreciation of his services to the Commission. The presentation was made by Lord Robinson at an informal but representative gathering at Headquarters on the 23rd March.

The Commissioners

Three Commissioners resigned during the past year, and three others were appointed to replace them. The retiring Commissioners were Lord Courthope, who had served since 1927 and who represented the Department in the House of Commons from 1928 to 1945 ; the Rt. Hon. Thomas Johnston, who continues to be a keen advocate of afforestation in the Scottish Highlands, and Colonel William Stirling of Keir.

The Commission is now constituted as follows :

Lord Robinson, O.B.E. (Chairman).
 Major Sir Samuel Strang Steel, Bart., T.D.
 Sir William Ling Taylor, C.B.E.
 Earl of Radnor, K.C.V.O.
 John MacDonald Bannerman, Esq.

Major Sir Richard Charles Geers Cotterell, Bt.
 Major Arthur Lloyd Owen Owen, Esq.
 The Rev. John Edmund Hamilton, M.C.
 Major John Stirling of Fairburn, M.B.E.
 William Hubert Vaughan, O.B.E.

The National Committees

The following changes have taken place in the membership of the three National Committees. In England, Lord Lucas has resigned and the Hon. James Best, a well-known Dorset landowner, has been appointed in his place. In Wales, Sir Cadwaladr Bryner Jones has retired, and has been succeeded by Professor Alun Roberts of the Department of Agriculture, University College of North Wales, Bangor. In Scotland the vacancies arising through the retirement of the Rt. Hon. Thomas Johnston and Colonel Stirling of Keir have been filled by the Rev. J. E. Hamilton and Major Stirling of Fairburn.

Obituary

FRASER STORY, O.B.E.

We record with regret the death in August, 1948, of one of the pioneers of scientific forestry in Britain—Fraser Story. From Edinburgh, Fraser Story went to Germany, and it was at Eberswalde under Schwappach and other famous foresters that he received his forestry training. After a period as a lecturer in the East of Scotland College of Agriculture, he went to the University College of North Wales, at Bangor, first as lecturer, and later was appointed the first Professor of Forestry at this college. During the 1914 to 1918 war he served in the Timber Supplies Department of the Board of Trade. Fraser Story joined the Forestry Commission in 1921 as Education and Publications Officer, and continued in this post until his retirement in 1941. The Forester Training Schools at Parkend and Benmore were his special charge, and his care and guidance brought these up to a very high standard. Fraser Story edited, and guided through the printers, the whole of the Department's publications for seventeen years, and of his work it can be said that he had a particularly meticulous regard for accuracy on the printed page; he was also Editor of this *Journal* from its inception in 1922 until its publication was interrupted by the war in 1939. He had a great enthusiasm for everything appertaining to forestry, and many will remember his kindly and helpful ways, and regret the passing of a good forester and a kindly mentor.

DR. M. C. RAYNER

Forest research has lost another prominent figure by the death of Dr. M. C. Rayner, on 17th December, 1948. Many knew her only as an expert on mycorrhiza in relation to the growth of conifers, but her work was by no means confined to forest problems, and Dr. Rayner had an international reputation for her work on mycorrhiza in relation to many types of crop plants. She was a pioneer in the application of composts to forest nursery soils, and the results of her experiments at Wareham opened up the way for the development of the heathland nursery technique. Her life was entirely devoted to research, and British forestry gained immeasurably from her deep knowledge of, and independent outlook on, some of the fundamental problems of tree growth under difficult conditions.

To Contributors to the Journal

The Editing Committee wishes to thank all those who have submitted articles, and to express the hope that before placing this present volume alongside its predecessors on the shelf, the reader will consider what contribution he can make to the next volume. Articles may be sent in at any time, and the Committee would like it to be known that a few articles of greater length than the longest in this *Journal* would be welcomed.

25 Savile Row,
London, W.1
May, 1949

Erratum

In the first line of H. C. Dyer's article on Strip and Group Planting, which appeared on page 73 of the 1948 *Journal*, we unfortunately printed "inches" in place of "feet." This line should read as follows:—

"*Strip Dimensions.* The strips of oak, spaced at 5 ft. by 2½ ft. apart, were made half a chain wide."

JOURNAL OF THE FORESTRY COMMISSION, No. 20, 1949

IMPORTED SEED

BY W. H. HAMILTON

Senior Executive Officer, Headquarters

TUCKED AWAY EVERY year in the Commissioners' *Annual Report* is a short and rather dry note on seed supply. The reference is normally divided into two sections—the first dealing with "Imported" seed and the second with "Home collection." In practice there is a sharp distinction between the work involved in procuring seed from the two sources. The collection of native seed necessarily falls to the lot of the Commission's field staff, but Headquarters explore the possibilities (but only by correspondence, alas !) of obtaining seed from abroad.

According to the *28th Annual Report*, 147,675 lb. of seed were sown in the Department's nurseries during the year to 30th September, 1947. Of that total 15,852 lb. were coniferous seeds and 131,823 lb. seeds of broad-leaved species. That is quite a lot of seed, and it may come as a surprise to many to learn that no less than 11,256 lb. of the coniferous seed and 62,488 lb. of the broadleaved seeds were imported from abroad. The Commission, however, not only purchases seed for its own use, but also seed of the main species required by the nursery trade and owners of private woodlands. Provision, too, must also be made, by storage, against a possible crop failure in the ensuing season ; thus the total purchase in F.Y.47 was no less than 17,052 lb. of coniferous and 70,444 lb. of broadleaved seed. The cost was just under £90,000. The Department's total "intake" of seed, "own collected" and "imported," amounted during the current year to approximately 186,750 lb.

During F.Y.48 the largest single importation was 2,586 lb. of Japanese larch direct from Japan. A consignment of 2,413 lb. of Sitka spruce seed from U.S.A., however, was nearly as large. The costs respectively were £3,397 and £4,097. Sitka spruce, with 7,506 lb. (at a cost of £12,345) headed the list of species, but both Japanese larch and Norway spruce passed the 4,500 lb. mark. Owing to the bad season oak dropped below 2,000 lb., and beech faded to a mere 210 lb. The Douglas fir crop was a complete failure and not a seed was imported.

In addition to the purchase of foreign seed, Headquarters are responsible for the distribution of seed from the Commission's seed stores, for sales of seed to the nursery trade and private owners, for the maintenance of Seed Ledgers, for the preparation and printing of the official *Register of Identification Numbers* and for a number of other allied tasks. In the aggregate this covers a wide scope, and by the very nature of the work there is usually a headache either just coming or just going. The needs of the Research Branch are frequently the cause, and I feel that that Branch at least ought by statute to be compelled to find its own seed ; for it is one thing to buy 1,000 lb. of seed of a well-known species from a reputable merchant in

the U.S.A., but when it comes to a "demand" for 4 oz. of seed from somewhere on the west coast of Southern Patagonia, it is a different prospect. It's not so easy to beard the appropriate Consul in a palatial residence off Park Lane with a request for help in securing a "pinch of seed" for experimental purposes from a place all but off the map, as it is to approach other foreign gentlemen with a £2,000 order.

During the last two years or so, requests to obtain seed from most parts of the globe have been received. American seed is in greatest demand, with enquiries going to Alaska in the far north and Southern Patagonia in the extreme south. New Zealand, Korea and Northern India are all in the picture this year. Normally, seed from most parts of Europe is not difficult to obtain, but 50 lb. of *Picea omorika* from behind the "iron curtain" will not be so easy. Within my experience no requests have been received yet for supplies from Russia, Finland, Turkey, Asia Minor, or even Australia, although seed in bulk is sent to the Forests Commission of Victoria by the Commission every year. Of the popular species *Sequoia* seed (both *gigantea* and *sempervirens*) seems the hardest to procure in quantity, and, on average, to hold the lowest potential germination of all. Only 21 lb. of the former with a germination assessment of 8 per cent. and 25 lb. of the latter with a value of 4 per cent. have been secured since 1944. Green Douglas failed entirely in F.Y.48 and there is no crop again this year. The Sitka spruce crop, a complete failure this season, was ample last year and almost a failure in 1947. The purchase of Corsican pine seed is a tricky business. The Commission desires nothing but seed genuinely grown on the island, and has reason to believe that there is quite a trade there amongst the "brigands" of importing inferior seed from the mainland and selling it as genuine "home production." Another irritating and unfortunately regular habit is for the vendors there to over-sell their crop, leaving the Commission in "thin air" late in the season, with the prospect of insufficient seed. Corsican pine seed, incidentally, is normally purchased on the basis of a guaranteed germination percentage, with an adjustment of price up or down according to the assessment determined by the Official Testing Station at Cambridge.

By arrangement with the nursery trade and owners of private woodlands, the Commission in recent years has become the sole importer into this country of Corsican pine, Japanese larch, Douglas fir and Sitka spruce seed. This arrangement is of considerable help to the trade and to the owners. It prevents competition in the overseas seed markets, and eliminates as far as the trade and owners are concerned, the troublesome difficulties of import licences and Customs formalities; it also gives to the buyer an assurance of good strains of seed.

LABORATORY GERMINATION TESTS FOR FOREST TREE SEED

BY **W. H. GUILLEBAUD**
Deputy Director General

WHEN A CONSIGNMENT of seed is imported, or when a substantial quantity of conifer seed is collected in Britain, samples are taken and sent to the Official Seed Testing Station at Cambridge for testing. The official instruction is that one two-ounce sample shall be taken for every 200 pounds of seed of a large consignment.

When the samples get to Cambridge, each is tested by three different methods known respectively as the "Jacobsen," "Hearson" and "Sand" tests. The period of test varies with the species, namely, forty days for Douglas fir, thirty days for Sitka spruce and Japanese larch, and twenty days for all other coniferous species. At the end of the test period, the number of seeds which have germinated is expressed as a percentage of the number of seeds originally placed in the receptacle.

In the case of the Jacobsen and Hearson tests, the seeds which have not germinated by the end of the test period are cut in two, and those that contain an embryo are counted and termed "fresh seed." This is not possible, however, in the case of the sand tests.

The three tests sometimes give very similar germination percentages, and an arithmetical average of the three will then not be far off the mark. Presumably this was the case in the early years of the Commission, when our seed testing procedure was laid down, and so the practice grew up of averaging the three tests.

Recently, the whole matter has been re-examined, and the seed testing data analysed. It then became apparent that quite often the three tests gave widely differing results, and that to average the data would be wholly misleading. Such a result as the following is by no means unusual:— Jacobsen, 76 per cent., Hearson, 66 per cent., Sand, 20 per cent. To add these percentages up and divide by three giving an average of 54 per cent., is obviously wrong. The true value is of course the highest figure obtained (76 per cent. in this case) because the test sets out to tell us what proportion of the seed is "viable," i.e., can germinate under optimum conditions. It is quite immaterial which method of test gives the highest result.

From F.Y.49 on, the seed testing data will be put out on the new maximum figure basis. Where large bulks of seed are concerned, involving a number of samples, the germination percentage recorded will normally be the average of the highest results irrespective of method of test.

The following hypothetical illustration will perhaps make this clearer :

<i>Method of test</i>	<i>Sample No.</i>				
	(1)	(2)	(3)	(4)	(5)
Jacobsen	65	60	70	60	59
Hearson	50	65	75	61	72
Sand	50	69	60	72	51

By the procedure followed hitherto, the Germination Percentage would be given in our records as 63 per cent., i.e., the mean of the 15 values ; but the correct figure is 71 per cent., which is the average of the highest values obtained for each of the five samples. It is on this new basis that all laboratory germination test data will be put out in future.

As a further result of the analysis of past seed testing data, it has become apparent that it is unnecessary to test all the species by each of the three methods, and these have been reduced to two, and for some species to one method. This will result in a considerable economy in the cost of testing, and may help us to get the data quicker.

The frequent complaint that seed is despatched to the nurseries without the germination test data, is a quite understandable one. Sowing densities should be related to the viability of the seed, and in the absence of any test figures the nurseryman is at a disadvantage.

The difficulty is the time factor ; species such as Japanese larch, Sitka spruce, and Douglas fir take thirty to forty days to test ; this means that the seed must be extracted, cleaned, bagged up and transported to this country, and samples sent for testing, before the end of February, if the results are to reach the nurseryman in time to be of use to him. Quite often this is not possible ; much of our imported seed does not reach these shores until March, and then seed has to go out without any data as to viability.

The Research Branch is now investigating an interesting chemical method using tetrazolium salts, which produce a colouration in the living embryos of seed steeped in the solution. The test by this method takes only about twenty-four hours, but a great deal of work remains to be done before we can use the results with any real confidence.

For the present we shall have to rely as before on the conventional methods of test.

BREEDING FOREST TREES

BY J. D. MATTHEWS

Geneticist, Research Branch

THE AIM OF this contribution is to introduce a new line of work in British forestry, small at present but of great potential value in future operations. Work on tree breeding began in the middle twenties in America and Denmark, and has greatly increased in scope and tempo since 1936, when Sweden entered the picture with very large scale breeding projects aimed at placing her forest industry on a secure foundation for the future.

The General Division of Breeding Methods

In Sweden two lines of work are followed—silvicultural breeding and experimental breeding. In the former the growing forests are treated so that the best trees are left as parents of the next generation. The higher the original number of plants available, the more rigorous the selection may be; and silvicultural breeding reaches its highest expression when applied to evenly and densely stocked areas arising from natural regeneration. It will be seen at once that in artificial regeneration the number of plants available is very much lower, often in fact the difference between 20,000 and 2,000 plants per acre. Thus for silvicultural breeding to have any appreciable effect in reafforestation work, the plants used must themselves be subjected to extremely rigorous selection prior to planting or better, be of guaranteed first-class stock having definite promise of the characters desired in the final crop. Silvicultural breeding is at best a crude form of mass selection, which can only produce a limited degree of improvement, and there is a definite need of more intensive and controlled methods of breeding.

Experimental breeding employs all the different methods which have been applied so successfully in the breeding of agricultural crops, fruits and vegetables. By the use of such methods, modified to suit the peculiar needs of forest trees, strains are developed of first-class silvicultural value guaranteed suitable for each locality and able to give the highest possible yield per unit of area and time.

Stress is often laid upon the long-term nature of tree breeding work but while long-range plans must be laid down to ensure continuity of policy, results are obtainable within relatively short periods. Modern technique will enable an estimate of the value of a tree to be made in the space of ten years (one-seventh to one-tenth of a rotation) and features such as improved rate of growth, resistance to frost, disease, etc., often become visible in even shorter periods, while timber quality takes longer to be assessed reliably.

The Possibilities in Great Britain

British forestry has a greater opportunity to profit by sound genetical research than any other country in the world. Our present problem of reafforestation is, in fact, our greatest benefit from one point of view, since we have almost complete control over the stocking of 5 million acres of land in fifty years. Even if genetics only becomes a decisive factor after the first ten years, there still remains over 3½ million acres to work on, plus an accumulation of experience and education in what is good or bad in forest trees to help us. An increase in productive capacity per acre over and above that achieved by good silvicultural practice is possible if our trees are improved in their inherent qualities.

Coupled with this control over restocking, we have the possibilities resting in the great variety of material already assembled in Great Britain. Whilst the remnants of our truly natural formations are pathetically small, the qualities they possess can be saved by prompt action. There exist also the results of over a century of steady importation of small lots of seed, now included in arboreta and policy woods throughout the country. These together with provenance trials and the very mixed nature of existing plantations, give a geneticist a vast field of variation to work on.

Progress Already Made in Great Britain

In Sweden emphasis was laid primarily upon knowing what is already in the forests. They have accordingly surveyed and classified their stands into "plus," "normal" and "minus" stands, only the "plus" stands and, for the present, "normal" stands being used for seed collection.

In Great Britain the Census now in progress includes a most important category of stands "elite for seed." A high standard has been set and accordingly these stands will in many cases provide an excellent starting point for the selection of elite material. The Census has the additional value of enabling the location of pure stands of the rarer exotics to be determined with accuracy and speed.

Finally we must draw attention to the pioneer hybridisation work in Great Britain of Professor A. Henry, which is valued highly in Denmark.

Progress in other Countries

Sweden is now engaged in tree breeding on a very large scale. Seed collection is rigidly controlled; the search for elite material is well advanced; and five main and two sub-stations are going ahead on all branches of intensive experimental breeding work. Denmark, through Dr. C. Syrach Larsen and other workers, has developed the idea of seed orchards. Valuable studies have been made on the basic problem of sorting out good trees from bad, and lately an intensive study of the rooting of cuttings to make possible standardisation of material has been carried out. Also from Denmark comes the modern approach to arboreta—not as mere collections of unusual species but as valuable "banks" preserving the best material in our forests.

The United States of America was early in the field at the Placerville Breeding Station, where the emphasis has been on hybridization and breeding among pines. One outstanding example of the value of hybridization has been the production of a rust resistant cross between *Pinus peuce* from the Balkans and the Weymouth pine.

In Canada much has been done on vegetative propagation by cuttings to develop this as an efficient tool in breeding work. Hybridization is also well to the fore. Work proceeds also in other countries and we can reasonably expect that tree breeding will become an essential part of every Forest Service in the near future.

Tree-Breeding and the Man in the Field

The outstanding tree now has a new significance, and one is in keeping with the needs of the times when preservation and conservation of such trees are uppermost in any forest policy. The outstanding or elite tree must now be preserved in some form or other, and not sacrificed without thought for the future. Cutting good trees does not breed good trees, and we must take every advantage of the good material still left to us.

The man in the field can play a vital part in the recording and favouring of these elite stems and stands, and the bigger the known reserve of material we have to choose from the more efficient will be the subsequent breeding operations. Thus anyone can, by intelligent work and observation, contribute to the quality of future forest trees. The selection and favouring of good quality material can and should commence from the very earliest operation in plantation work.

What is an Elite Tree?

Any tree is the product of two groups of factors—those inherent in the tree and those of its environment or surroundings, which also include the forester. Trees are unique because of the great length of time any given generation is subjected to the effects of the environment.

Thus we have the way the tree desires to grow clashing with the way all the external forces desire it to grow, and the primary job in genetical work is to separate out the inherited tendencies of the tree by eliminating the effects of environment as far as possible. Within certain limits a forester may, by careful tending, produce well-formed trees from a crop with poor inherent qualities, but offspring from such a tree will still require the same nursing to make them equally valuable.

Thus we must say that all fine looking trees are not necessarily suitable for breeding purposes, but the chances are that a very fine tree among a fairly big group of good well-formed trees will usually meet our requirements. We must therefore attempt the correlation of external appearance with inherited qualities as far down the scale towards a seedling or seed as possible, so as to make our choice a more certain one.

The Geneticists Weapons and Lines of Attack

Firstly we can breed from the variations found in nature, i.e., those existing in stands at present. This is the process of selecting our phenotypically elite trees and judging them by comparison trials.

For example we might start with 800 elite beech. These are grafted onto stocks of known performance, and grown under uniform environmental conditions, and the individual trees are eliminated over a period of years. Trees with poor stem form; trees with poor branch habit; trees which are frost tender; trees susceptible to disease and so on, are rejected. Next the breeding value of the remainder is tested, and the best surviving trees, perhaps only twelve or less, are multiplied vegetatively and placed in special seed plantations isolated from other trees of the same species and treated for large scale seed production.

Secondly we can breed from new spheres of variation created artificially. This includes :—

(a) Artificial cross-pollination between races of a species or between selected closely allied species. When closely related species are crossed it is sometimes possible to obtain an F_1 product with greater growing capacity than either of the parents, e.g., the natural first generation hybrid between Japanese and European larch which combines the stem form of European larch with the canker resistance of Japanese larch, and exceeds both parents in rate of growth.

(b) Induced polyploidy—the object being to produce new and valuable species with high chromosome numbers. Entirely new forms of a species representing higher ranks in a polyploid series can arise from older

species with low chromosome multiples. This can sometimes be brought about by the colchicine treatment of germinating seeds, and it sometimes occurs in nature, e.g., trembling aspen has $2 \times 19 = 38$ chromosomes in the cell nucleus. Very rare aspens in Sweden have $3 \times 19 = 57$ chromosomes, forming a triploid race capable of producing thirty to fifty per cent. more timber per unit area than the common types. Special techniques have been used to propagate these giant aspens by breeding from these triploid trees.

Another important line of work is the use of vegetative propagation for production of trees specially suited for a given job, or possessing commercially valuable characters. The striking of "sets" of poplar is a familiar example in this country.

The final aim in genetical work is the meeting of demands for superior forest seed in the future. It is hard to think of any branch of biological science that is not of some value to forestry either directly or indirectly. Tree breeding, demanding as it does an intimate knowledge of plants, provides a new opportunity for a closer study of individual trees by everyone. Thus it cannot fail to be of permanent interest and of lasting value.

THE ELITE TREE

BY M. V. EDWARDS
District Officer, Research Branch

THE INCREASING INTEREST in the science of genetics is suggesting to foresters everywhere the possibility of raising crops containing only the best trees. More and more attention is being paid to the selection of the most suitable parents from which to reproduce our forests. So it happens that the fashionable term for a specially good parent is now the "elite tree." Indeed, the term "super-elite" has even been mentioned as a description of the ideally perfect tree that we are likely to meet only in our dreams. But "elite" is sufficient to denote those individuals whose growth is outstanding in both vigour and form, and which should be regenerated as prolifically as possible.

The Scandinavian countries have made great advances in the study of heredity in trees. The desirable characteristics of the elite tree have been classified, the trees themselves selected and reared, and woods containing many elites carefully tended so as to remove all other poorer types of tree. The trees themselves are reproduced by cuttings or grafting to multiply their progeny as quickly as possible, and to keep the line pure. The young trees so produced may even be induced to produce seed unusually early by special treatment. By all these means it is possible to produce young plantations of trees, all of whose parents are almost certainly trees of the elite class.

Although careful tests of the progeny of the elite trees are necessary to prove that they have inherited the good qualities of their parents, a considerable advance has been made when the chosen seed-bearers have been selected and collection of their seed is regularly carried out. But first the elite tree must be defined, and it may be helpful to describe the qualities preferred in the Scandinavian countries as a guide to the building-up of a similar definition in this country. Each species has its characteristics. The trees selected must be fairly mature, as young trees have not developed sufficiently for their characters to have become clearly defined and stable.

The following list has been compiled from various Scandinavian sources, and it includes a list of measurements and notes suggested for record against each tree proposed as an elite—in this case a Scots pine.

The Elite Scots Pine Tree

*Measurements and notes
to be recorded for
each elite tree*

1. *Vigour*

(a) *Size.* The elite must be both taller and larger in girth than the average, both in relation to the size of other dominants in the same stand, and in relation to the normal at the elevation and on the site and soil concerned.

Site characteristics :

Elevation :

Aspect :

Exposure :

Geology :

Soil type :

Vegetation type :

Height :

Girth :

Age (approximate if not known) :

Recent ring width by
Pressler's borer :

*Measurements and notes
to be recorded for
each elite tree*

- | | |
|--|---|
| 2. <i>Freedom from disease.</i> | Presence of any fungi or insects, etc., however insignificant. |
| 3. <i>Crown</i> | |
| (a) Amount. At least one-third total height of tree. | Height to lowest branch of crown : |
| (b) Shape. Class I : Narrow crown
,, II : Intermediate crown.
,, III : Broad crown. | Maximum width of crown in two directions at right angles, by projection on to ground* : |
| (c) Fertility. The tree must bear plenty of cones. | (The amount collected will be recorded each year). |
| 4. <i>Branches</i> | |
| (a) Quality. Fine and slender. | Yes, No or Average. |
| (b) Angle with main stem. They should be at about a right angle, and not steeply ascending. | Angle with stem : |
| (c) Number per whorl. Should be small, at most five. | Number per whorl : |
| 5. <i>Stem (below crown)</i> | |
| (a) Straightness. Only very slight bends permissible. Must be viewed twice, at right angles. | Straight or Slightly bent. |
| (b) Circularity. | Two breast height diameters at right angles : |
| (c) Taper. | Girth at various heights above breast height, if possible : |
| (d) Cleanness. Branch scars, etc., not obvious. | Yes, No or Average. |
| (e) Self-cleaning capacity. Branches not persistent. | Yes, No, and Height to lowest branch scar not healed over. |
| 6. <i>Bark</i> | |
| (a) Weakly developed at stem base. | Yes, No, and Thickness at breast height :
(Mean of two measurements). |
| (b) Colour. | Colour. |
| (c) Form. ("Plate" type desirable, as seen on Old Caledonian trees). | Yes, No. |

* Division into three classes cannot be made until there are enough samples of the elite in Britain on record. From photographs it seems likely that there are few, if any, trees as narrow-crowned as the Swedish elites.

A DEVICE FOR COLLECTING CONES

BY R. J. JENNINGS

Forester, North Wales

ONE OF THE CHIEF difficulties in seed collection has always been the gathering of cones from the extremities of branches of all species, particularly in fairly young stands where the limbs are neither long nor sturdy enough to withstand either the weight of a human being or a ladder. Cone collection from young plantations can result in considerable damage being done to the trees by ladders and climbing irons, particularly in the larches, whose brittle branches will quickly snap off without warning, resulting not only in disfigurement of the tree, but, by the stripping of bark and opening of wounds in the cambium, facilitating the entry of spores of destructive fungi.

It appears to be the general opinion of all foresters that a ladder of any length is of little use when placed against the trunk of a tree for seed collection, as the majority of cones, and usually the best ones too, are at the extremity of the branches, and more often than not quite out of reach and sight. It occurs to me that the following hint in the use of an ordinary ladder in cone collection may well prove of use to foresters undertaking this work. At Kimmel Park, St. Asaph Forest, in the late autumn of 1948, some sixty bushels of Japanese and European larch cones were collected at very short notice in the way explained below.

At the base of both feet of an ordinary wooden ladder (20—30 rungs) firmly fix two iron spikes, six inches long, fashioned by the blacksmith in the form of the point of a gate hook. The object of these spikes is to enable the ladder to be placed firmly and securely in a given position so that with the spikes dug well into the ground the ladder will not slip.

At the third or fourth rung down from the top of the ladder, tie securely one end of a twenty-foot length of good stout rope. Now place the ladder in a normal position with the spikes firmly in the ground and the ladder base three to four feet from the bottom of the tree, the ladder top resting against the tree. Ascend the ladder and pass the loose end of the rope around the tree trunk, and twist it twice on the other ladder pole at about half the rope's length.

The picker should now climb *round* the ladder, and with his back to the ladder rungs and a firm hold of the loose rope allow the ladder to lean backward at an angle of about sixty or seventy degrees, or more or less as required. All that this amounts to is that the top of the ladder leans away from the tree eight feet or so, but cannot fall backwards to the ground. With the ladder in this position, and the rope made fast, the collector can, by working with his back to the ladder rungs, secure all the cones, as he is now outside the ends of the branches. The ladder can be moved at the required angle right around any tree on the rideside or in the plantation, wherever the cones may occur.

(An ingenious method, but not without its dangers when applied to tall trees—*Editor*).

THE STORAGE OF BEECH MAST AND ACORNS

(*SILVICULTURAL CIRCULAR No. 25*)

IN THE PAST there have been cases of failure to store successfully the considerable quantities of beech and oak seed which are collected in an average seed year. This year there is a heavy crop of both species and it is most important to ensure that the seed is properly looked after.

Stored seed can go wrong in two ways : if it heats badly in course of storage it will be spoilt ; on the other hand if it is allowed to get too dry the germination may be reduced virtually to nothing. It seems probable that most of our past failures have resulted from the second of these errors, i.e., excessive drying out, possibly the result of storage in over-ventilated barns or lofts.

When the seed is freshly collected, the seed coats will be saturated with water. This excess moisture must be got rid of before the seed is actually put into store, otherwise the seed will need almost continuous turning to prevent it overheating. Freshly collected seed should be spread out in a thin layer (not more than three to four inches deep) on a dry, covered floor, and turned frequently for several weeks until the "sweating" process is completed. The seed is then fit to be put into store, where the problem is to keep it from sprouting, which it will do if it is allowed to heat ; or from drying out too much, which may easily happen if the seed is kept for a long time under cover on a dry floor.

Probably the best method of storage is in a large shallow pit excavated out of the soil, with wire netting sides and an over-hanging roof heavily thatched with straw or heather. The pit should be dug to about eighteen inches below ground level, and the sides and floor covered with mouse-proof netting. A central path about eighteen inches wide should be boarded to allow access for inspection and turning, without trampling on the seed.

The storage pit must be on a well-drained site, so that there is no risk of flooding or of seepage of water into the pit. If there is no such site available, it will be necessary to lay a cement floor and provide any drainage required.

The thickness of the seed layer in the pit must not exceed twelve inches at most. Turning about twice a week during the period of storage will still usually be necessary, but the condition of the seed must be carefully watched, and a little water applied if there is any sign of the seed getting over-dry, i.e., if the seed loses its plumpness. Watering must be done with great care to avoid excess of moisture, and consequent heating and pre-germination.

The same principles of turning and watering apply to storage in sheds or barns, but there is greater risk than in pits of the seed drying out too much ; and constant vigilance will be necessary to keep the seed in good condition.

Another method of storing beech-mast in sheds, etc., recommended by the Dutch, is to mix the seed with an equal quantity of white sand in a layer about sixteen inches deep. This should be turned over every fortnight, and when too dry sprayed with small quantities of water ; but care should be

taken not to use too much water because an excess will cause either rotting or premature germination. This method, which has not been much used in this country, may be tried when beech-mast is being stored in roofed-in buildings. In such cases, part of the seed should be mixed with sand and treated as described here, and part should be kept without sand in the usual way. A report on the results of the two methods should be provided before the end of the 1949 growing season.

W. H. GUILLEBAUD

Deputy Director General

January, 1949.

NURSERY PRACTICE

(*SILVICULTURAL CIRCULAR No. 21*)

I. Soil reaction and the raising of trees in nurseries

Investigation in both England and Scotland has shown that tree seedlings, of the spruces and pines in particular, are sensitive to the reaction of the soil. For satisfactory growth they appear to require a relatively acid soil (pH. 5.6 or below). They grow poorly on soils of neutral or alkaline reaction (pH. 7.0 and over). As regards other species, the larches seem more tolerant of basic conditions in the seed bed than the pines and spruces.

We do not yet know much about the major hardwoods, e.g., oak, beech, chestnut and birch, but the indications are that beech and chestnut at least behave in much the same way as spruces and pines, preferring acid soil conditions. Ash and sycamore on the other hand do not like extremely acid soils, and can be safely sown on soils round about the neutral point.

Recent analyses of nursery soils show that a surprising number of our nurseries have a pH. round about 7.0, while most of the Eastern Counties nurseries are definitely alkaline (7.3 to 8 pH.). It is probable that some at least of these nurseries had reasonably acid soils when they were new, but as a result of lime applied in different ways have gradually become neutral or basic in reaction. This may well be an important factor in the "running down" of established nurseries.

Methods of correcting the conditions resulting from a basic reaction of the soil are still in their infancy, but promising results have been obtained experimentally by acidifying the soil by the use of sulphuric acid and, alternatively, of sulphur; also by partially sterilizing the soil either by steam or by formalin.

Green Crops

In the past both lime and basic slag have been applied in order to raise green crops, especially crucifers such as mustard, and legumes such as clover and vetches, which do not thrive on acid soils. At present we know of only few green crops which tolerate fairly acid soils, these include yellow lupin, oats, rye, and also potatoes.

There is a new sort of yellow lupin which seems promising; details will be given later. Preliminary experiments with buckwheat on the very acid soil of Wareham are also promising.

Note.—The pH. units express the concentration of hydrogen ions in a liquid, and so form a convenient measure of acidity. In soils the usual range is from about pH. 3.5 to pH. 8.0. The following are some arbitrarily selected points on the scale :—

pH.	3.5	Extremely acid
	4.5	Very acid
	5.6	Moderately acid
	6.5	Slightly acid
	7.2	Neutral
	8.0	Alkaline

Practical Implications

We must stop any practice which will make our nursery areas more basic. Accordingly, the following are prohibited*:

- (a) The use of lime or basic slag for application to the nursery soil, whether seedbeds, lines, or green crops.
- (b) The spreading of any existing weed heaps to which lime has been added.
- (c) The covering of seed with limestone chips or with any gravel containing free lime.

(Note.—It is easy to test gravel for the presence of free lime by throwing a handful into a glass jar full of pure vinegar. If there is no effervescence, the gravel can be safely used).

We should also do our utmost to :

- (1) extend the use of heathland nurseries as much as possible for raising Sitka spruce, Corsican pine, and Norway spruce seedlings ;
- (2) restrict as far as possible the sowing of Sitka spruce, Corsican pine, and Norway spruce to nurseries with a pH. below 6.5, and preferably about pH. 5.6 ;
- (3) discontinue the sowing of seed in the basic East Anglian nurseries, using these nurseries only for lining out ;
- (4) avoid sowing beech on soil with a pH. over 6.5.

II. Other Aspects of Nursery Technique.

Date of Sowing

Sow as much as possible of the hardwood seed before the end of March at latest ; conifer seed should all be sown before the end of April. No hardwood seed is to be sown later than April 30th, and no conifer seed later than May 31st, in any year, except with the written consent of the Director.

Method of Covering

Seed of Sitka spruce and other small-seeded species (Norway spruce, tsuga, thuya, etc.), must not be covered with the local nursery soil, except with the written authority of the Director. Use instead lime-free and clean chips or gravel or, if available, Leighton Buzzard sand No. 2L. Sand from local sources must not be used for seed covering, unless there is definite evidence that it is free from silt particles.

Heathland Nurseries

If a bulldozer is used to remove the heather covering, this must be done with great care, so as to remove as little of the peaty humus as possible. It is almost certainly wrong to pare off all the peaty humus down to the mineral soil, as has been done in some cases. Where the peat is tough, intensive discing is necessary to break up the peaty layer and incorporate it thoroughly with the mineral soil. Plough as shallowly as possible to keep the surface peat in the top six inches of the soil. The peaty humus must not be deeply buried.

* This refers primarily to established nurseries on arable soils. For the special case of Heathland nurseries with very acid soils, see the first para. of Silvicultural Circular No. 26, page 27.

Watering

Experience this year suggests that water is not necessary when seeds are sown reasonably early, and when the soil is moist at the time of sowing. Water is probably valuable in periods of spring drought, to encourage germination.

Weeding

The saving in weeding costs in heathland nurseries during the first few years is so great that every effort should be made to avoid introducing stable manure, pig manure, or incompletely composted weeds, straw, etc., which are liable to bring in weeds.

W. L. TAYLOR

Director General

October, 1947

MANURING OF NURSERIES

(SILVICULTURAL CIRCULAR No. 23)

I. Introductory

(1) The shortage of plants to meet the planting programmes continues. One of the contributory factors to this shortage is the poor out-turn of seedlings from most of the established nurseries in the country, and it is necessary to make the best of all available information on the improvement and maintenance of fertility in established nurseries, and to raise seedlings in heathland nurseries, using the latest methods that have been developed as a result of research work done in recent years.

(2) This research work, which has been carried out under the general direction of Professor Brook's Sub-Committee on Nutritional Problems in Forest Nurseries, by Dr. Crowther in England and under the guidance of Dr. Stewart in Scotland, together with the results of experiments at Wareham over a number of years by Dr. Rayner, had given a number of indications of directions in which nursery practice could be improved, and these were embodied in a Research Branch circular entitled *The Production of Strong Nursery Plants of Sitka Spruce*, first issued in 1946 and revised in February, 1947.

(3) Briefly this circular gave provisional instructions regarding the treatment of heathland nursery sites either with hopwaste or with N.P.K. (Nitrogen, Phosphate, and Potash) fertilisers, and suggestions were also made for the use of fertilisers to maintain or restore fertility in established nurseries. It was emphasised that these proposals were provisional, as they were based on the preliminary indications of incomplete investigations, and that it was not known to what extent the manurial treatments prescribed would improve the growth and out-turn of plants under the widely varying conditions in different nurseries. Indeed it was quite expected that results might be negative in some cases. In order to test this, instructions were given in the circular that, wherever manurial treatments were applied, untreated control beds were to be left so as to enable us to assess the effects of the treatments given. Unfortunately this instruction was overlooked in some instances, and useful information on the value or otherwise of the treatments was lost. Some comparative experiments in a Latin square design were also prescribed in the circular to test the effects, in Heathland nurseries, of N.P.K. fertilisers, hopwaste at two levels of application, and hopwaste (at the lower level) combined with N.P.K. fertilisers. In established nurseries a prescription was given for a simple experiment on partial sterilisation of the soil, using formalin with and without applications of N.P.K. fertilisers.

II. Report on Work Done in 1947 in Accordance with the Research Branch Circular

1. Heathland Nurseries

(4) Results varied considerably from nursery to nursery. Briefly summarised—fresh hopwaste applied at the rate of 750 lb. per 100 sq. yds., or hopwaste compost applied at the rate of 400 to 500 lb. per 100 sq. yds., produced beds of Sitka spruce seedlings which had, with few exceptions, 60 per cent. to 100 per cent. usable seedlings of 1½ inches height and over. Either doubling the

amount of compost or hopwaste, or adding N.P.K. fertiliser to the single dose of compost, increased average heights by 20 to 25 per cent., and brought the out-turn of usable seedlings up to 100 per cent. The rate of application of fertiliser varied, but a typical formula was :—

13½ lb. crushed hoof per 100 sq. yds. (= 6 cwt. per acre).

7 lb. ground mineral phosphate per 100 sq. yds. (= 3 cwt. per acre approximate).

4¾ lb. per 100 sq. yds. muriate of potash (= 2 cwt. per acre).

(The low level of phosphate was deliberate on account of the high phosphatic content of the hopwaste). Application of fertilisers alone, without organics, at the above rates for N. and K., but doubling the phosphate, gave much more variable results. In more than half the trials artificials alone were as good as, or better than, the lower rate of application of hopwaste, but never as good as the higher rate, or as good as the combined hopwaste and fertiliser treatments. In a few cases results were bad, and usable seedlings were not produced in the first year.

2. Established Nurseries

(5) *Treatment of Seedbeds.* Many reports were received, but in almost all cases the results were negative. The addition of N.P.K. fertilisers either had no effect on growth, or in a few cases had a depressing effect. In the rare cases where an improvement was obtained, it was too small to justify the expense and trouble of adding the fertilisers. The effect on the total number of seedlings was generally adverse and, in some cases, an increase in weed growth was reported. Under the 1947 conditions, with late application of fertilisers followed by late sowing and a prolonged summer drought, the use of fertilisers in seed beds in established nurseries was "not worth while." In no case were seedlings of Sitka spruce usable as "1 + 0" stock produced.

(6) *Treatment of 1 + 0 rising 2 + 0 seedbeds and Transplant Lines.* Here the reports of the effects of top dressings were similar, though the percentage of reports of slightly improved growth was higher. On the whole the results were again described as "not worth while."

(7) *Partial Sterilisation Experiments with Formalin.* Only a few of these were carried out, and the results were on the whole not strikingly successful. The improvements in growth were definite but generally small, and the further improvements through the use of fertilisers after sterilisation were slight. The percentage of one-year seedlings that reached usable size was insufficient even in the best treatments, to justify lifting them, and the beds would have to be kept for a second year before lining out.

III. Summary of Latest Information

1. Heathland and Woodland Nurseries

(8) *Composts.* The excellent results obtained by Dr. Rayner at Wareham, using composts or raw hopwaste, have been confirmed in heathland nursery experiments all over the country. Applications at the rate of from 500 lb. to 1,000 lb. per 100 sq. yards (= 10¾ tons to 21½ tons per acre) have given fine beds of one-year seedlings fit for lining out or, in favourable conditions, for direct planting in the forest.

Of the various composts tried, the best results were obtained with a mixture of 75 per cent. chopped green bracken and 25 per cent. hopwaste. A good compost was also made with ride trimmings cut when fresh, before the grass and herbs started flowering, mixed with a proportion of hopwaste.

The composting of hopwaste itself is not worth while, as it has been clearly established that raw hopwaste applied when fresh is just as good as composted hopwaste. Hopwaste is, however, in very short supply. It contains sufficient nitrogen to make it an excellent composting agent, and it is recommended that it be used for that purpose as far as possible in order to make it go further.

In one instance a serious failure occurred in a Heathland nursery to which bulky organic materials had been added, and this was attributed to the surface layers of the beds drying out in a period of severe spring drought. The beds were exceedingly soft, and it is believed that had they been consolidated, they would have retained more moisture in the top layer of soil.

A separate note on the preparation of composts has been prepared by Mr. W. G. Gray, and published in the Forestry Commission Journal for 1948, pages 10 to 13. This gives details of the methods used.

(9) *Farmyard Manure.* The use of farmyard manure in Heathland nurseries has given variable results, probably owing to its very variable composition. In these days of shortage of concentrated feeding stuffs, farmyard manure often has a very low plant nutrient content. It also usually contains weed seeds, and on this account its use in Heathland nurseries, which are usually free from weeds, is not recommended.

(10) *Artificial Fertilisers.* Experiments in Heathland nurseries, with artificial fertilisers but without the application of any hopwaste or compost, have shown that, provided the fertilisers are correctly balanced in relation to the nutrient content of the soil, it has been possible to produce as large seedlings as with the use of compost. The main points that have arisen in connection with the use of fertilisers are :—

(a) That the phosphate used should be in a quick-acting form, and of all the materials tried, superphosphate has proved the best. Ground mineral phosphate was previously recommended, because there was some fear that soluble forms of phosphate such as superphosphate might damage the plants ; but this fear has turned out to be quite unfounded. Even in the excessively dry season of 1947, no damage at all was experienced from its use. In some of the less acid soils the responses to superphosphates were much better than to any other form of phosphate, including basic slag. Both mineral phosphate and basic slag gave good results on very acid soil at Wareham. Results with basic slag have been poor on all but the most acid soils, even where the best kinds of high-soluble basic slag were used. It has to be borne in mind that basic slag particles in the soil have a local alkaline reaction which may affect the absorption of phosphate and other nutrients by the seedling roots of acid-loving plants, such as Sitka spruce and other conifers. The application of basic slag has an effect on the pH. of the soil equivalent to the addition of an equal weight of limestone, and its use is, therefore, to be avoided, except possibly on very acid soils.

(b) Potash has to be applied according to the requirements of the nursery soils concerned. For instance, Wareham soil has proved to be very deficient in potash, and unless potash is supplied in sufficient quantity to balance the other fertilisers used, acute symptoms of potash deficiency appear,

and the plants grow badly. Other Heathland nurseries, however, have not shown the same acute potash deficiency, and at Inchnacardoch additions of potash actually depressed growth. Generally speaking, a moderate application of potash, in the form of either sulphate or muriate of potash, is expected to be beneficial in conjunction with adequate phosphate and nitrogen.

(c) Additions of nitrogen fertilisers are often necessary for the healthy growth of seedlings, but as they stimulate shoot growth rather than root growth, it is difficult to determine the best form, time and method of applying them. Top dressings of fertilisers such as ammonium sulphate during late June and July, had a beneficial effect, particularly if the nursery was in a moist climate or if watering was done throughout dry spells in summer. Some cases of injury to seedlings through a top dressing of nitrogen fertiliser were reported, but this was probably due to applying the fertilisers when the plants were damp, causing the grains of the fertiliser to stick to the leaves.

Work is continuing in an endeavour to find a slow-acting form of nitrogen which can be applied along with the phosphate and potash fertilisers before the beds are sown, but so far no suitable material, available in sufficient quantities, has been found. Even ground hoof or dried blood are found to be too quick acting to be satisfactory for this purpose though *small* applications before sowing may sometimes be beneficial.

(11) *Artificial Fertilisers combined with Organic Dressings.* Where fertilisers were used in combination with organic materials, the result was generally a definite improvement, provided the total nutrients supplied by both the fertiliser and the organic manure were properly balanced. Hopwaste, for instance, is generally rich in phosphate and nitrogen, but deficient in potash. Bracken, on the other hand, is deficient in phosphate but rich in potash. (Provided it has not been cut and left in the open for a long time when the potash tends to leach out).

2. Established Nurseries

(12) *Causes of Failure.* Recent experiments have not, so far, thrown a great deal of light on the manurial methods required to raise good one-year conifer seedlings in established nurseries, but certain facts have come to light which, in part, explain the negative results obtained with fertiliser trials in the past.

Firstly, it is important that the pH. of the soil should be below 6.0, and preferably below 5.5, if large healthy conifer seedlings are to be raised, the optimum being probably about pH. 4.5. (This is not so critical in the case of most hardwoods which, though they like fairly acid soils, will tolerate pH. values over 6). If beds are more alkaline than 6.0, no application of fertilisers is likely to improve growth or out-turn appreciably. Attention is drawn to Silvicultural Circular No. 21, (p. 14) in which the causes of high pH. are described and prescriptions given for avoiding this condition in future. It is of vital importance that these prescriptions be strictly followed.

Field experiments in acidifying nursery soils which were slightly alkaline and had only a moderate amount of free calcium carbonate in the soil, showed some improvement but not enough to provide good one-year plants. Unfortunately many of the established nurseries have far too high a content of calcium in the soil to be easily dealt with by acidification. Work is going on in the hope of discovering some practical method of rendering such nursery soils fit for raising conifer seedlings.

Secondly, many established nurseries appear to have developed a condition which is toxic to young conifer seedlings, but which can be remedied to some extent by partial sterilisation. We do not know the cause of this

toxicity yet—i.e., whether it is due to antibiotic fungi, bacteria or to micro-fauna, or whether it is purely chemical. All we have so far discovered is that partial sterilisation, either by means of heating the soil by passing steam through it, or by treating it with a solution of formalin, often makes it possible to grow good seedlings.

Apart from the two factors mentioned above, growth in established nurseries may be unsatisfactory owing to a number of causes such as late sowing, use of bad seed-covering material, etc. These have been detailed in Silvicultural Circular No. 21.

IV. Prescriptions for Manuring Heathland Nurseries for Raising Conifers

(13) Where Raw Hopwaste is Applied :

- Hopwaste*— 1,000 lb. of fresh raw hopwaste per 100 sq. yards of nursery bed (= 23 tons per acre).
- Nitrogen*— None at the beginning of the season, as the hopwaste will contain more than sufficient N for the use of the seedlings in the early stages. (A top dressing, as indicated below, may be given during June or early July).
- Phosphate*— 7 lb. of superphosphate per 100 sq. yds. of nursery bed (= 3 cwt. per acre).
- Potash*— 2 lb. of muriate of potash per 100 sq. yds. of nursery bed (= 1 cwt. per acre).

(14) Where Bracken and other Composts are Applied :

Where bracken compost or other composts made with dried blood, poultry manure, or up to 25 per cent. hopwaste as an activating agent are used—apply as follows :—

- Compost*— 750 lb. per 100 sq. yds. of nursery bed (= 16 tons per acre).
- Nitrogen*— None at beginning of season.
- Phosphate*— 14 lb. of superphosphate per 100 sq. yds. of nursery bed (= 6 cwt. per acre).
- Potash*— 2 lb. of muriate of potash per 100 sq. yds. of nursery bed (= 1 cwt. per acre) except in the case of bracken compost where the potash should be omitted.

(15) Where Neither Hopwaste nor Compost is Available :

If no organic manure is available, apply a " swede " type of fertiliser (containing about 4 per cent. N and 13.75 per cent. P_2O_5 , or National Compound No. 3 containing 6 per cent. N and 12 per cent. P_2O_5) at the rate of 14 lb. per 100 sq. yds. (= 6 cwt. per acre). On sandy soils likely to be deficient in potash a compound N.P.K. fertiliser should be used, as e.g., 20 lb. of a compound with 6 per cent. N, 9 per cent. P_2O_5 , 6 per cent. K_2O , per 100 sq. yds.

(16) Time of Application

All applications, i.e., the hopwaste, the compost and the fertilisers, should preferably be made about a fortnight to three weeks before the beds are sown. The fertilisers may be spread on top of the compost or hopwaste

(or on the soil in the case of (c) above) and forked, disced or rototilled into the top four inches of soil. There is no harm in doing it still earlier. The fertilisers should not be merely raked into the seedbed.

(17) Top Dressing with Nitrogenous Fertilisers

In all of the above three cases, where sowings have been done in good time and growth is normally advanced, a top dressing of a nitrogenous fertiliser should be given at the end of June or early in July. This should consist of either 4½ lb. of sulphate of ammonia per 100 sq. yds. of nursery bed (= 2 cwt. per acre), or 6 lb. of nitrochalk per 100 sq. yds. of bed (= 2¾ cwt. per acre). On acid soils nitrochalk is to be preferred. It is realised that there may be some risk of burning the plants by this top dressing. In order to minimise this, the application should be made when the plants are dry, and any fertiliser lodging on the leaves should be brushed off while the leaves are still dry. The fertiliser should then be thoroughly watered in, giving first a light watering of about half a gallon per square yard to get the chemicals into the surface, followed within an hour or two by a heavier watering of two gallons per square yard to wash it down. In nurseries where water is not available, the application should be made when rain is expected but the plants are still dry, and the soil preferably moist. If, on account of unsuitable weather, it has not been found possible to apply the top dressing before the end of July, the quantity should be halved, and no such top dressings should be made after the middle of August, as late or heavy nitrogenous dressings are liable to stimulate late Lammas growth, which may result in damage to the plants by early frosts.

(18) Treatment of Older Beds in Heathland Nurseries

The indications are that repeated applications of hopwaste or good composts build up a high degree of fertility in a few years, and that this fertility lasts several years after stopping the applications of organics. Experiments have not been going long enough to work out the best regime for maintaining fertility at a satisfactory level, but in view of the high cost of composts at present, the following is suggested as a provisional programme :—

- (i) beds that have received no compost or hopwaste in the past, should receive normal applications this year and next year, as in paragraph (13) or (14).
- (ii) beds that have received one dressing of compost or hopwaste last year should, if possible, receive a second dressing this year as in paragraphs (13) or (14), and artificials next year, as in paragraph (15).
- (iii) beds that have received compost or hopwaste two years running should only receive artificials this year and next year, as in paragraph (15).

V. Treatment of Established Nurseries

1. General

(19) **Greencropping.** Experiments are still in too early a stage to be able to prescribe the best greencropping schedules. Mustard is definitely to be avoided, because if the ground has to be made sufficiently alkaline to grow a good mustard crop, it will be much too alkaline for conifers.

In the Scottish nurseries, where the general fertility has been maintained at a higher level than in most of the southern nurseries, a regular four-year rotation is used, namely : green crops (usually oats and tares), raised

with fertilisers in the first year ; transplants lined out on the ground in the second year ; and the ground used for seed beds in the third and fourth years. There is much to be said, with our present state of knowledge, for making the main applications of phosphate and potassium fertilisers to the green crop rather than to the seedlings or transplants, though the latter practice should not be ruled out. Any acidifying operations, either by sulphur added in the autumn or applications of sulphuric acid, should also preferably be done before a green crop.

(20) Forms of Nitrogen, Phosphate and Potash

(i) *Nitrogen*. As in Heathland nurseries, nitrogen presents a special problem in established nurseries. It is not required in spring by the seedlings in quantities greater than what becomes available in any soil containing a reasonable amount of organic matter, and early additions of nitrogen as hoof and horn before sowing had an almost universally depressing effect in 1947, and in some cases did much harm. This was particularly the case after partial sterilisation. On the other hand, plants are liable to become short of nitrogen in the middle of the growing season, and we must either discover a really slow-acting form of nitrogen to include in the spring dressings, or top-dress in June or July with a readily soluble form.

Hoof and horn and dried blood as sources of nitrogen are becoming very difficult to get and are exceedingly expensive—up to nearly £60 per ton. They may, for that reason, be left out of consideration. As we have not yet found a sufficiently slow-acting form that is available in quantity (formalised casein and “flash” are suitable materials, but cannot be got in large amounts), it is necessary to use a readily soluble form as a top dressing in June or July. Ammonium sulphate is to be preferred in nurseries with a pH. over about 5.5, as it has an acidifying action, removing its own weight of calcium carbonate from the soil. In more acid nurseries nitrochalk, which has no acidifying action, may be used. The precautions to avoid burning the plants, when top-dressing, already mentioned in connection with Heathland nurseries, should be observed ; namely, apply when the plants are dry, brush any adhering particles off the plants, and water the fertiliser into the ground.

(ii) *Phosphate*. Superphosphate is to be preferred to other forms of phosphate. Ground mineral phosphate is likely to be ineffective in established nursery soils where the pH. is much over 5.5. Basic slag must not be used on established nurseries on account of its liming effect.

(iii) *Potash*. Potassium should be given according to the potassium status of the soil. Sulphate of potash is easier to handle, but usually muriate is the only form available.

(21) **Watering**. Watering may be essential in dry spells during the germination period, particularly if the seed has been treated by soaking, or in any other way, to stimulate germination. Watering later in the season, in dry periods, may be ineffective if the soil does not contain sufficient available nutrients to provide for an increased rate of growth. Watering in conjunction with top-dressings of nitrogenous fertilisers may give greatly increased growth. Watering must not, however, be continued beyond about the first or second week in September, otherwise the plants may not have time to harden off before the autumn frosts.

(22) **Leaving of Controls, and Reports on Results**. As it is important that as much information as possible should be collected regarding the effects of

fertiliser treatments when used over a wide range of conditions, it is prescribed that :—

- (i) In all manurial treatments in *established* nurseries, untreated beds will be left at regular intervals as controls, so as to be able to assess the effect of the fertiliser treatments. (This is not necessary in Heathland treatments, as it is now known that untreated Heathland beds are hopelessly poor).
- (ii) Wherever *different* manurial treatments are tried in the same nursery, alternate beds of each treatment, or regularly spaced sets of contrasting treatments (as well as controls in established nurseries), should be laid down and replicated as often as possible, and in no case less than four times. The order should be varied at random in successive replications.
- (iii) The results of the comparative trials mentioned in the above two paragraphs, should be reported to Director, Research and Education (through Director, England, Scotland or Wales, as the case may be) at the end of the growing season—i.e., from observations made in October/November. These reports should be sent in by the 15th December, and should be in the form given in Appendix I to this Circular.

2. Prescriptions for Manuring Established Nurseries for Raising Conifers

(23) **General.** Established nurseries which showed little or no improvement in growth through the application of fertilisers in 1947, are probably suffering from either too high a pH, or from toxic conditions requiring sterilisation. If high pH is suspected, samples of soil should be sent for pH, and free calcium determination. (See Appendix to Silvicultural Circular No. 26, page 32, regarding sending soil samples for analysis).

Where the general condition of the nursery appears to be reasonably satisfactory for raising conifer plants, but where there may be a doubt if there are enough available nutrients in the soil, the following manurial treatments can be applied :

(24) **For Seedbeds to be Sown.** For general purposes a fertiliser such as Fison's Compound Fertiliser No. 6, containing 6 per cent. N, 8.25 per cent. soluble P₂O₅, and 6 per cent. K₂O should be applied at the rate of 19 lb. per 100 sq. yds. (= 8 cwt. per acre). Where farmyard manure is applied in preparing the seedbeds *shortly before sowing*, the fertilisers can be spread over the farmyard manure, and the mixture forked in or worked in with a rotary hoe, keeping it in the top four or five inches of the soil. If, however, the farmyard manure is put in before March, the fertiliser should be applied separately and forked well into the soil, in preparing the beds a fortnight or so before sowing.

(25) **Existing 1-year rising 2-year seedbeds, if the seedlings are so small that it seems unlikely that they will be fit to line out as 2 + 0.** The following treatment is recommended, and occasional scattered beds should be left untreated so as to observe the effect of the application : In the middle or towards the end of April, and again in the middle of June, 10 lb. of Fison's Compound Fertiliser No. 6 per 100 sq. yds. (= 4 cwt. per acre) should be distributed, preferably in granular form, over the surface of the bed *when the plants are dry*. Any fertiliser adhering to the seedlings should be brushed off to prevent burning.

Unless rain is expected, and falls within forty-eight hours, the fertiliser must be thoroughly watered in, but the water must be carefully applied in two stages, a first light watering of half a gallon per square yard to get the chemicals into the surface, followed within an hour or two by a heavier watering of two gallons per square yard to wash it down.

(26) **Transplant Lines.** When transplant ground to be lined out during winter is prepared, a dressing of superphosphate at the rate of 10 lb. per 100 sq. yds. (= 4 cwt. per acre) is recommended.

If the plants show poor growth or a poor colour, a dressing should be given in early spring of Fison's No. 6 Compound Fertiliser at the rate of 14 lb. per 100 sq. yds. (= 6 cwt. per acre) for 1 + 0 seedlings lined out, or 7 lb. per 100 sq. yds. (= 3 cwt. per acre) for 2 + 0 seedlings lined out. The same precautions should be observed as in the case of top-dressing seedlings (vide previous paragraph).

W. L. TAYLOR

April, 1948.

Director General

Appendix I

NURSERY MANURING REPORT—F.Y. 1948

See Silvicultural Circular No. 23, paragraph (22) page 23

Conservancy.

Forest.

Name of Nursery.

Established or Heathland.

What crops did these beds bear in the last two years and what manurial treatments, if any, did they receive ?

Were the 1948 treatments applied to :—

- | | |
|--|---|
| (a) Seedbeds before sowing..... | } Density of sowing.....
Date of sowing..... |
| (b) 1 + 0 rising 2 + 0
seedlings..... | |
| (c) Transplant lines..... | } Size at beginning of
season |
| | |

Species sown or planted.

Type and quantity of manure, including composts or organics, applied per 100 sq. yds. of ground (or per acre). If more than one treatment, give details of each.

Date of application.

Were untreated controls left ? If so, how were they distributed ?

If more than one treatment was given, how were the treatments (including controls, if any) arranged ?

How many replications of the least frequent treatment ?

Were top-dressings given to any of the above treatments ? If so, give details and dates of application.

Was there rain soon after applying top-dressing, or was the dressing watered in ?

RESULTS AT END OF SEASON

1. Height of plants in each treatment including controls (give minimum, maximum, and average).
2. Yield per lb. of seed sown, for each treatment (for 1 + 0 or 2 + 0 beds at end of season).
3. Were there marked differences in survivals in the different treatments in the case of rising 2 + 0 seedlings, or transplants ?
4. Any differences in colour or health between the different treatments ?
5. In the case of seedlings, what percentage of 1 + 0 seedlings are fit for lining out (i.e., 1½ in. high or more) ?
6. In your opinion has the manuring been worth while and justified the cost ?
7. Other observations, if any.

Signed

Date.....

Note.—Estimated figures may be given where detailed assessments have not been made.

NURSERY PRACTICE

(*SILVICULTURAL CIRCULAR No. 26*)

SILVICULTURAL CIRCULARS Nos. 21 and 23, dealing with Nursery Practice and Nursery Manuring, have now been reviewed in the light of experience gained since their issue, and this Circular, which is based mainly on observations of recent practice, covers part of the ground dealt with by the earlier Circulars, and also refers to certain aspects of the work not touched by them. Where the same subject is covered, this Circular should be taken as superseding the appropriate part of the earlier instructions. Generally speaking, the instructions given in Circular No. 21, relating to soil reaction, still stand so far as established nurseries in agricultural soil are concerned ; but recent experience has shown that some of the extremely acid Heathland nurseries may benefit from a single very light application of lime, i.e., not more than five cwt. of ground limestone per acre.

1. Seedbeds

(a) **Depth of Tilth.** It appears that some nursery foresters are still cultivating their seedbeds too deeply, and so dispersing the humus which ought to be kept as much as possible in the top four inches to five inches of soil. There is no virtue in a tilth deeper than about four inches, and there is the great objection to deep tillage that it can only be done when moisture conditions are just right ; the consequence is often late sowing and small resulting seedlings.

Time and money are also sometimes wasted in working up an unnecessary fine tilth for large seeds such as acorns, chestnuts and beech nuts.

(b) **Density of Sowing.** While it is admittedly hard to hit the happy mean, the stocking of seedbeds of Douglas fir, the larches, and spruces, in the established nurseries, is often deplorably low. Unduly thin stocking leads to greatly increased costs of weeding per thousand seedlings, and greater risk of frost lift. With the seed which we have been getting during the last few years, it seems clear that the densities prescribed in *Bulletin 14 (Forestry Practice)* are too low (i.e., number of square yards per lb. of seed too high) to achieve a satisfactory stocking. Much depends, of course, on local conditions, efficiency of technique, etc., but in many nurseries a reduction of the order of 25 per cent. in the standard rate of square yards per lb. would appear desirable ; but any such reduction must only be made with the express approval of the Conservator. Pines which are to stand two years in the beds should not be sown more densely than the standard rate recommended in *Bulletin 14*, and densities in Heathland nurseries must not be increased.

Every effort is made at Headquarters to ensure that imported seed arrives in this country in time for germination test results to reach the nurseryman before he sows. But often the seed does not reach us until March or even April, and it is then impossible to get the test results out in time for sowing. In such cases the nurseryman must assume that the seed is of average quality and sow accordingly. Experiments with quick chemical test methods are in progress.

(c) **Width of Seedbeds.** In Heathland nurseries, more particularly when seedbeds are sown for the first time, little weeding is usually necessary.

A great economy in space can then be achieved by increasing the width of the seed beds to four feet six inches, with one foot alleys between the beds.

(d) **Sowing.** The low yields of one-year seedlings per pound of seed have led to the examination of possible causes. One of these, undoubtedly, is the loss of seedlings along the edges of raised seedbeds. When such seedbeds have been sown right up to the edge, the crumbling of the edges all through the season causes the loss of large numbers of seedlings in the aggregate, and this is aggravated by the hoeing and weeding of the alleys which leads to further eating into the beds.

Sowings, therefore, should not be made up to the very edge of the seedbeds ; three inches on each side should be left unsown.

(e) **Covering of Seed.** Attention must again be drawn to the importance of covering Sitka spruce seed to the correct depth, i.e., to an average of one-eighth of an inch and not over one-quarter of an inch. Particular care is necessary when using the mechanical sand distributor. With this machine the risk of over deep covering is considerable, especially at the ends of the seedbeds, and it is a question whether it is advisable to use it for covering Sitka spruce.

Trouble has been experienced in some exposed nurseries from wind storms which blow off the sand covering soon after it has been laid down. In such areas fine gravel or chips are preferable to sand.

(f) **Shelter**

(1) *Against Frost-lift.* The only real remedy against frost-lift is to grow sturdy, well-rooted seedlings. Early sowing, high humus content, and avoidance of lime-rich soils are factors contributing to this end.

Altogether, too great reliance is often placed on lath shelter, which is very expensive and often quite ineffective.

As a general rule frost-lift so rarely occurs before Christmas that it is quite time that the common practice of sheltering seedbeds in the autumn was abandoned. Shelters should not be erected before the beginning of January and then only after careful examination of the root systems of the plants (a well-rooted seedling rarely, if ever, lifts) and only if local experience has shown that shelter is both necessary and effective.

(2) *Shelter against late frosts.* Tender species such as Sitka spruce, beech and larch, may have to be sheltered against late frosts, but this is not a valid reason for erecting shelters in the autumn with all the consequent wear and tear and drip damage throughout the winter. In general, shelter only those species which require it, and keep the specially tender species out of frosty sections of the nursery.

(3) *Shelter in hot weather.* The need for shelter during the late spring and summer months is very debatable. If the weather is cool and showery, shelter is likely to do harm rather than good. Certain species, notably *Tsuga* and *Abies grandis*, may require sheltering during very hot spells in the south of England, but in general there is little need for this form of protection in our climate.

(g) **Measures to prevent Frost-lift.** Two measures employed in some nurseries deserve more general adoption, especially where the soil is on the heavy side. These are :—

- (1) Raising the level of the seedbeds above the alleys. This promotes drainage, both of water in the soil and of the cold air at ground level ;
- (2) Rough digging the seedbed alleys in the early winter. This also helps to promote drainage and so to reduce frost-lift.

2. Treatment of Seedlings

(a) **Transport and Packing.** In F.Y. 48 some heavy losses resulted from the lining out of imported seedlings in certain nurseries. On investigation it was found that in nearly all cases rail transport was involved ; some consignments spent nearly three weeks on the journey. Some of the batches of seedlings arrived heated, and others dried out. Of the two evils heating is probably the greater menace.

In transporting plants, above all seedlings, speed is the essence of the business, so the maximum possible use should be made of road transport. Where rail transport is unavoidable, and large consignments are involved, box vans attached to passenger train must be used. Special care must be taken to minimise the risk of heating ; bundles should be kept small, and dry straw used to separate the bundles in the van and provide ventilation. At the same time the roots must be covered with sufficient packing material to keep them moist for a reasonable period, and to prevent freezing.

(b) **Heeling-In.** Much damage is frequently caused to seedlings which have been lifted, or have just been imported, through lack of care in heeling-in. Even though they are heeled-in in anticipation of lining-out the following morning, just as much attention should be paid to the job, because a change in the weather overnight may prevent their use for a week or more.

If the seedlings have arrived in tied bundles, the string round each bundle must be cut and the plants spread out thinly and evenly in a trench deep enough to comfortably hold the roots. When covering the roots with soil, care must be taken to ensure that no air spaces are left, and the soil should be well firmed. If the weather is cold, or dry and windy, the tops should be protected with straw.

Attention must also be drawn to another frequent cause of loss. It is bad practice to bundle plants some time in advance of despatch and then to heel-in the bundles. Plants should not be bundled until all is ready for packing.

(c) **Lining Out.** It is unnecessary to defer until the late winter the lining out of one-year seedlings raised in heathland nurseries. Experience has shown that well rooted seedlings can safely be lined out in the late autumn, and thus the lining out season materially extended. Mid-winter, e.g., December—January, appears a particularly unfavourable time for lining out the pines. September—in Scotland even August—lining-out has been very successful with Scots pine.

Lining-out of one-year Corsican pine should be completed by March 1st.

(d) **Bedding-Out.** The problem of how to treat seed beds in Heathland nurseries, when the seedlings are too small to lift at the end of the first season, may be partially solved by thinning-out the beds by forking out the best seedlings and bedding these out. The remaining seedlings will then stand in the beds until the second year.

Practice with regard to bedding-out appears to vary greatly in different Conservancies and nurseries. As a rule very close bedding-out is wasteful of plants. The technique adopted in the North Conservancy in Scotland of bedding out the seedlings in rows across a four foot bed, with the plants one inch apart in the rows and four inches apart between the rows, appears worthy of more general adoption. There are alleys fifteen to eighteen inches wide between the beds, and all the weeding is done from the alleys. This prevents the soil being consolidated and avoids damage to the plants.

3. Manuring

In some nurseries where compost supplies were short, the available compost was spread thinly over the whole area, with indifferent to bad results. It is recommended that any compost available should be applied at the full rate prescribed.

In the following pages, the prescriptions for manuring which are now recommended are set out. Many of these are expressed in terms of compound fertilisers prepared for agriculture, because these materials are easier to obtain and apply than special mixtures prepared at the forest nurseries.

They are also much cheaper than organic fertilisers such as hoof and bone meal. For illustration, the examples given are the products of a single firm (Messrs. Fison), with depots and agencies in many parts of the country, but several other manufacturers prepare closely similar materials, some of which are "National Compound Fertilisers." Where possible, all fertilisers should be purchased in the granular form, because this is far easier to store and apply. It is important to store "Nitrochalk," super-phosphate, muriate of potash and compound fertilisers under dry conditions.

If potassic superphosphate is difficult to obtain, it may be replaced by a mixture of superphosphate and muriate of potash; instead of 12 lb. potassic superphosphate, a mixture of 10 lb. superphosphate and 2 lb. muriate of potash may be used.

The analyses of the mixtures recommended are given below for reference. Similar mixtures can be purchased from other firms.

<i>Compound Fertilisers</i>	<i>Percentage</i>		
	N.	P ₂ O ₅	K ₂ O
Potassic superphosphate (Fison's No. 7) ...	—	15	8
Fison's No. 8 Compound	5	10	5
National Growmore	7	7	7
National Compound No. 2	9	7½	4½
 <i>Straight Fertilisers</i>			
Sulphate of Ammonia	21	—	—
Nitrochalk	15½	—	—
Superphosphate	—	18	—
Muriate of Potash	—	—	60

HEATHLAND NURSERIES

Application of Fertilisers*All per 100 square yards***Seed Beds****(a) New Beds**

1. If organic manure, rich in phosphate, is available (spent hops), use at least 14 days before sowing, at the rate of 1,000 lb. per 100 sq. yds.
Apply also, at the same time :—
Potassic superphosphate : 12 lb.
and Nitrochalk : 6 lb.
2. If organic manure, rich in potash is available (straw, or farmyard), use at least 14 days before sowing, at the rate of 1,000 lb. per 100 sq. yds.
Apply also, at the same time :—
Superphosphate : 10 lb.
and Nitrochalk : 6 lb.
3. If no organic manures are available, apply at least 14 days before sowing :—
Potassic superphosphate : 18 lb.
and Nitrochalk : 6 lb.

(b) Seed Beds following Beds or Lines

Manure as above, but apply organic manure, when it is available, at the rate of not more than 500 lb. per 100 sq. yds.

Lines following Beds

Do not use hops or compost unless supplies are surplus to full seedbed requirements.

1. If organic manure, rich in phosphates, is available, use at a minimum rate of 500 lb. per 100 sq. yds.
2. If organic manure, rich in potash, is available, use at a minimum rate of 500 lb. per 100 sq. yds.
Apply also Superphosphate : 10 lb.
3. If no organic manure is available apply :—
Bessemer Basic Slag or
Superphosphate : 12 lb.
and Crushed Hoof : 6 lb.
Top dress with Nitrochalk
in April : 6 lb.

Top Dressing, Beds or Lines

In a moist or showery summer and if the plants are backward, top-dress early in July with 6 lb. Nitrochalk per 100 sq. yds.
If there is a summer drought, top dressing with Nitrochalk is likely to be ineffective.

ESTABLISHED (AGRICULTURAL SOIL) NURSERIES

Application of Fertilisers**. Seedbeds**

No manures should be applied to the soil direct before making up the beds, but the fertility of the nursery should be maintained by manuring the rotational green crop. An exception can be made when a green crop has had to be omitted, or if there is good reason to doubt the fertility of the soil.

In such cases apply :—

(a) Soils of moderate acidity —	<i>Per 100 sq. yds.</i>
Complete Fertiliser (Fison's No. 8) :	18 lb.
(b) Slightly acid, neutral or slightly calcareous soils :—	
National Growmore Fertiliser :	12 lb.

Application should be made at least 4 days before sowing.

Lines

No fertiliser should be given where growth is usually satisfactory.

If growth requires stimulating, top dress with Nitrochalk in April at the rate of 6 lb. per 100 sq. yds. and hoe it in well.

Green Crops and Rotation Crops

For green crops apply the following manures before sowing :

	<i>Per 100 sq. yds.</i>
Oats and Tares } National Compound No. 2 :	16 lb.
Rape }	
Grass mixtures :—National Compound No. 2 :	16 lb.
Sulphate of Ammonia after each cut :	6 lb.
Lupins :— Potassic Superphosphate :	16 lb.
Rye :— National Compound No. 2 :	16 lb.

W. H. GUILLEBAUD,

March, 1949.

Deputy Director General.

(APPENDIX TO SILVICULTURAL CIRCULAR No. 26)**Soil Sampling in Forest Nurseries**

- The purpose of the sampling of forest nursery soils is threefold :
 - To check the suitability of the soil reaction for certain sensitive species.
 - To detect acute nutrient deficiencies.
 - To provide material and information which, over a term of years, will cover most of the nurseries, and allow an investigation on the relation of actual performance to the results of soil analysis.
- It is impossible for the Rothamsted staff to analyse a large number of soil samples from each nursery, and it is, therefore, proposed to spread the work over several years by taking a few samples each year from different

parts of the nursery. It is suggested that each nursery should be divided into convenient units of around 5 acres. Nurseries less than 10 acres should be divided into two units. Soil samples will be taken from each of these units periodically. The units should be chosen to represent the main parts of the nursery. Thus, one might be from the original part of the nursery and another from each extension.

3. Where the nursery is divided into sections or blocks of something around one-quarter acre, a single section is to be picked for sampling in each of the 5 acre units. If the nursery is not divided into such sections, any other convenient unit of around one-quarter acre can be taken, provided it is not too long and narrow. In the selected quarter-acre section, a single line down the length of the section is to be selected for sampling. This line will often be along a seedbed or down a transplant line. The precise position of this line must be very clearly defined, by describing its position, and by marking it on an outline map of the nursery. A copy of this map should be kept for reference in the nursery, so that future sampling points could be added and, when necessary, copies supplied to Rothamsted. It has also been suggested that one end of the sampling line should be marked permanently in the nursery itself, by driving a numbered stake into a hedge or at the side of a path, out of the way of cultivation. These fixed points will help the Nursery Officer, or other visitor, to find the actual spots to which the analytical data refer.

4. Along each selected line, about 20 soil cores should be taken to a depth of six inches and mixed together. Where any marked change occurs in the character of the soil along the line, separate samples should be taken to represent the two main kinds of soil, or better still, two other lines should be taken so that each represents one of the principal kinds of soil. The most convenient soil-sampling tool is a semicylindrical borer, which can be made from an 18-inch length of gas pipe or bicycle frame, by cutting along the diameter for a distance of about nine inches. Holes can be made at the other end, and a cross handle inserted. A label should be included in each sample bag, giving the name of the conservancy, the name and address of the nursery, and the sample number, the label being folded over so that it is not dirtied too much by the soil. It is still better to enclose the label in a small pay-packet envelope. A similar label should be tied to the bag. Clean cotton bags are suitable for soil samples. If these cannot be obtained, the sample can be sent in tins.

Samples from nurseries in England and Wales should be sent to :—

Dr. E. M. Crowther,
Rothamsted Experimental Station,
Harpenden,
Herts.

At the same time a letter should be sent to Dr. Crowther giving the following information :—

- (a) Name of Conservancy.
- (b) Name and address of nursery.
- (c) Full National Grid Reference of nursery from Ordnance Survey Map.
- (d) Name and address of Forester in charge.
- (e) Age, and history of the particular part of the nursery represented by each sample, including condition of the land before it was taken over.

- (f) Elevation, aspect, drainage conditions of nursery.
 - (g) General nature of the soil and parent rock.
 - (h) Some indication of the general method of cropping and manuring, the kind of seed cover used, and the general performance of the nursery, such as average out-turn of usable seedlings of a given age for the commoner conifers grown.
-

Note :—The address to which samples from the Scottish nurseries are to be sent is :—

Dr. A. B. Stewart,
Macaulay Institute for Soil Research,
Craigiebuckler,
Aberdeen.

THE TREATMENT OF NURSERY SOILS

BY S. M. PETRIE
District Officer, West Scotland

THE MANURING OF permanent nurseries in Scotland has received a good deal of attention during the last ten years, to the apparent detriment of the condition of many of the nurseries concerned. The chemical side of manuring appears to have been so studied, and the possible deficiencies of elements in the soil so much kept in view, that tilth, fertility and the physical condition of soil are factors which have almost been forgotten. Ground "in good heart" in nurseries is a thing one never hears referred to; the condition as well as the expression has almost become obsolete. Soil analysis may show all the necessary elements present, but the soil may be in poor condition in spite of that, and the forester of experience is still able to decide by the appearance and feel of a break in working, whether it is fit for use or not.

Reference has been made elsewhere* to the present-day custom of ignoring all that earlier Scottish forestry practice has to teach us, and to the modern tendency to start from scratch, in spite of the methods used and results achieved by our predecessors; in nursery practice this tendency seems to be especially obvious. It will be agreed by most of our older foresters that plants going out from nurseries to-day are not superior, in fact they are generally inferior, to those which were despatched for planting a generation ago.

The expression "in good heart" in reference to soil means that the physical condition and plant food content in that soil are sufficiently good and abundant respectively for the production of the next crop, be it oats, turnips, or forest trees; with correct soil management it is possible to maintain this condition, and even to improve it, in spite of the fact that crops are being taken off annually or periodically. Soil in good heart has the necessary content of both humus or organic material (decayed animal and vegetable matter), and chemical (mineral) elements for proper plant growth; in addition it has the "puffiness" of a properly manured and properly cultivated soil, the physical state which makes aeration, drainage and germination possible, or, briefly, the tilth. It is the organic manuring or supply of humus, and the physical condition, which are forgotten in present day practice.

It does not seem to be sufficiently appreciated that, in exporting forest tree plants from a nursery, a quantity of the best-quality soil is removed annually and sent out with the plants, never to return. This is a loss which is not so pronounced in farm cropping, where either only the portion of the plant above ground is carried off, or root crops are cleaned of soil before being removed; more attention is, therefore, called to the need for restoring this loss in forest nurseries. The constant despatch of the finest soil particles, attached to the roots of outgoing plants, has left many nurseries with merely the skeleton of soil, the bare bones from which all the flesh has been stripped, the framework of the ground without the necessary filling of humus and fine workable particles. Such breaks are easily recognised. They have a "lean and hungry look." It is impossible to get a good tilth in working them, and within twenty-four hours of cultivation, or after an hour of rain, they settle into a solid block of the consistency of a suburban cement pavement.

* "Wight's Observations on Estate Forestry in 18th-Century Scotland" (*Scottish Forestry Journal*, Vol. 59, 1945).

To obtain good germination of seed, or healthy growth of seedlings and transplants, on such a break is obviously out of the question, and no amount of artificial fertilisers will render it productive. The annual boosting of ground with a shake of mineral manure from a bag is merely by-passing the requisite remedy, and will not procure results similar to ground in good heart. Such artificial manuring is in its place if used as a supplement to proper organic manuring and cultivation, but by itself it is of no avail. Germination of tree seed and growth of seedling trees are as much dependent on physical condition of the soil as they are on the nutrient content. This is especially the case with pines and larches.

It is well known that the time to manure is in the fallow period or the green crop period, and it is in the preparation for production of the green crop that sound organic manuring should be done. The soil should then receive as much bulk humus producing material as will grow the green crop, *and* retain the "heart" and condition of the soil during the following years when the break is occupied with plants. It is at this period that the loss of soil should be made good, and there is little doubt that as much farmyard manure, stable manure, leaf mould, composts, seaweed and other tilth-improving material as can be got should be applied. The rotting green crop itself is not sufficient to provide the humus. It is this decaying crop in conjunction with the organic manuring applied to grow it which puts body in the soil; and the more of these made use of, the bulkier will the green crop be. A weak thin green crop is worse than no crop at all.

Such procedure is not strictly adhered to in modern nursery practice. It was formerly, and the well rooted bushy plants which then resulted were the best indicators of its success. The quality of transplants to-day is not so good as it used to be, nor is the fertility and appearance of nurseries. It seems fairly safe to say that if permanent nurseries are to be maintained (and the wasteland nursery has not yet justified itself) there will have to be a reversion to previous practice—the arable farmer's practice of maintaining the ground in good heart at all costs, and then the crops will come of themselves. There is no inherent difference between forest nursery work on the one hand and gardening or farm cropping on the other, and yet no gardener or farmer would attempt to produce his yields without proper feeding of the soil, feeding mainly of bulky organic material. Any growth from the soil, when rotted, can be returned to it. This observance is even more necessary in the forest nursery, due to the annual loss of soil, and it is stressed that the green cropping manuring period should be arranged for each break each third year without fail. Two years of seedbeds or two years of lines only, and then green crop plus manure; no more following of two years of seedlings with one and sometimes two years of transplants. This is what knocks the heart out of the soil.

A word may be added on cultivation. Summer cultivation is important and should be carried out as frequently as possible. A fallow area should be regularly grubbed and cultivated. It should not be allowed to lie settled for weeks on end. The main advantage of a root or potato crop as a green crop is that it allows of summer cultivation, and if such crops are heavily manured and cleaned during the growing season they can be very beneficial. In winter, fallow ground in nurseries in damp climates should be ridged up with the drill plough for better aeration. Areas so treated generally work well when levelled off in spring.

There is no doubt that most of to-day's methods in the nursery are inferior to previous practice. Machinery seldom does the work so well as a

skilled man's hands. While it is admitted that large scale operations necessitate the use of the machine, it might be kept a little closer in mind that, where conditions allow, the machine should only be used where it does a better, not merely a cheaper, job than manual labour. This may all read as very elementary and as a first essay on nursery practice ; but it seems that reaching back a little would do no harm in this side of forestry, and would improve the type of plants which we produce. There will always be a place for the strong sturdy transplant so long as afforestation is carried on, and no long-established industry like nursery management in Scotland should be recklessly changed as a result of the experiment of a few years duration.

ACIDIFICATION AT BARCALDINE NURSERY

THIS YEAR AN acidification experiment was tried out at Barcaldine Nursery where the soil has a high pH. (6.0). The treatments were sulphuric acid (4 per cent. solution), sulphur at three different levels, and ammonium sulphate, with and without formalin sterilization, and complete N.P.K. (Nitrogen-Phosphate-Potash) fertilizer. Factorial combinations of these treatments were used making twenty-four treatments in all, and there were two replications of each treatment. Sitka spruce seedlings were grown in all units of the experiment, and at the end of the growing season an assessment of height and out-turn was made.

The most successful treatment was sulphuric acid, which very considerably increased height and out-turn, and in addition reduced weeding in the early part of the season to a minimum. The heavy and medium doses of sulphur had an even greater reducing effect upon the weeds, but had an adverse effect upon the plants as well. It will be interesting to note the effect of these two sulphur treatments in the second year. A promising effect was obtained from the light dose of sulphur (2 oz. per sq. yd.). This increased height and out-turn considerably, with no apparent weed reduction. Ammonium sulphate had a slight adverse effect on the seedlings without reducing weeds. Out-put and growth were very much increased by formalin sterilization, and to a lesser extent by the N.P.K. fertilizer.

A combination of the three best treatments, formalin, sulphuric acid, and complete N.P.K. fertilizer, produced 1,170 seedlings per square yard, or 99,450 per lb. of seed. The average size of the seedlings was 2.64 inches, and included seedlings 5 to 6 inches tall. Furthermore, it was one of the treatments comparatively weed-free in the early part of the season.

J. H. THOMSON

Forester, Research Branch

NURSERY SOWING PROGRAMMES AND YIELDS

BY W. H. GUILLEBAUD

Deputy Director General

THERE ARE MANY pitfalls in the path of one whose job it is to co-ordinate our sowing programmes so that three or four years hence the needs of a rapidly expanding planting programme can be met with a comfortable, but not excessive, margin for contingencies.

Of the various unknowns which enter into the problem the most incalculable is the weather. Local excesses—cloud bursts, cyclones which remove both soil and seed into the next parish, hail storms and the like, are seldom worse than a mischance. But every now and then a major vagary of our climate can upset the best-laid programme, and the planner can only hope that he will not run up against one of these freak years. A second unknown is seed quality. This, as we all know, can vary within very wide limits. For example, the shortage of Japanese larch plants during the last year or so is mainly due to the low quality of the seed which we have had to import. It aggravates the difficulty when, as has been the case with Douglas fir in the last two years, poor cone crops and seed of low viability have gone together. Our policy now is to import or collect large stocks of seed in bumper years, and to store against the lean years that usually follow. A third variable factor which may upset planning is technique. The level of our nursery practice is certainly high in some nurseries, but not in all. If the general level could be brought up to that of the best nurseries, we could almost cut our nursery programmes in half.

To illustrate how results can vary in a single season, I append a table which shows for the more important conifers the average yield per pound of seed sown in established and in heathland nurseries respectively. The table also gives the data for the nursery in each country which had the highest yield.

It is only fair to point out that a low average yield in one of the three countries is not necessarily a reflection on its nursery technique. Weather conditions and quality of seed are other factors which must be taken into account. But a comparison of the maximum yields with the average yields within a country does suggest that there is a wide margin for improvement. It would be tedious to comment on the data species by species, but there is one result which is so outstanding that no apology is needed for directing attention to it. This is the case of the sowing of Sitka spruce in the new heathland nursery at Devilla in the West Conservancy of Scotland. One hundred pounds of seed of Identity Number 48/10 (laboratory germination 69 + 23) were sown broadcast on land to which the full prescribed rate of compost plus artificials had been applied. This resulted in a yield of eight million one-year seedlings, averaging nearly four inches in height (80,000 per lb. of seed). If we could achieve such a result in all our nurseries there would be no need to sow, as we shall have to, over 3,000 pounds of Sitka spruce seed in F.Y. 49.

F.Y. 48 saw a big extension of heathland sowings, but in a number of cases compost supplies were inadequate, and in others the preparation of the ground was rushed and seed sown late in order to achieve the programme.

YIELDS FROM CONIFER SEED SOWN IN F.Y. 48 IN ESTABLISHED AND HEATHLAND NURSERIES

Species	Country	Average for all Nurseries in each Country						Highest Yield for each Species in each Country (Average for Nursery concerned)							
		Amount of seed sown lbs.		Thousands of 1 + 0 seedlings per lb. of seed		Percentage fit to line out		Established Nurseries			Heathland Nurseries				
		Estab-lished	Heath-land	Estab-lished	Heath-land	Estab-lished	Heath-land	Nursery	Conser-vancy	Weight sown lbs.	Yield per lb., thousands	Nursery	Conser-vancy	Weight sown lbs.	Yield per lb., thousands
Scots pine	England	597	357	27.1	21.8	81	94	Hazelborough	E.	16	39.0	Wykeham*	N.E.	2.6	40.7
	Scotland	1,485	34	15.5	15.5	26	71	South Laggan	N.	5	29.1	Durris	E.	2.5	27.1
	Wales	171	52	19.1	26.5	66	100	Tair Onen	S.	116	20.0	Goror	N.	45	33.0
Cors. pine	England	571	1,547	7.6	8.8	86	100	Wykeham*	N.E.	13	13.1	Wykeham*	N.E.	73	13.5
	Scotland	283	20	9.5	13.5	50	50	Newton	E.	200	10.6	Kilcoy	N.	17	15.0
	Wales	506	—	5.7	—	100	—	Tair Onen	S.	326	6.2	—	—	—	—
Eur. larch	England	86	5	8.3	1.6	70	100	Hazelborough	E.	20	16.9	Deerleap	New	5	1.6
	Scotland	385	31	4.0	8.0	60	65	Inchmacardoch	N.	26	7.6	Tillifeure	E.	1	10.0
	Wales	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jap. larch	England	445	167	5.8	6.2	65	53	Widehaugh	N.E.	3	20.9	Broxat	N.E.	11	11.3
	Scotland	934	20	13.4	15.0	13	67	Findon	N.	72	19.9	Teindland	E.	1	23.0
	Wales	210	330	8.0	14.9	86	70	—	—	—	—	Kerry	N.	50	21.6
Douglas fir	England	224	104	7.2	6.2	85	73	Gravetye	S.E.	29	9.5	Bramshill	S.E.	54	7.9
	Scotland	150	2	8.3	12.5	31	100	Loch Ard	W.	6	11.1	Devilla	W.	2	12.5
	Wales	20	40	12.5	5.5	100	100	Tair Onen	S.	20	12.5	Myherin	N.	40	5.5
Norway spruce	England	540	386	17.3	17.3	53	12	Widehaugh	N.E.	4	24.4	Wykeham*	N.E.	80	20.9
	Scotland	1,348	135	23.5	18.8	0	45	Strathord	E.	118	42.2	Kilcoy	N.	59	41.4
	Wales	260	216	29.0	21.2	0	35	Tair Onen	S.	160	30.0	Cynwyd	N.	70	32.8
Sitka spruce	England	338	612	20.8	18.1	11	13	Sawdon*	N.E.	10	42.1	Broxat	N.E.	284	39.5
	Scotland	1,238	352	33.2	65.3	3	43	Findon	N.	50	59.6	Devilla	W.	100	80.0
	Wales	62	806	38.5	28.2	9	4	Usk	S.	4	50.0	Gwydyr	N.	28	60.8

* Allerston Forest

† Langdale Forest

The season also was a rather unfavourable one, especially in the south, where the spring was cold and dry. As a result of all these adverse factors the yields have been disappointing, though there were shining exceptions such as Sitka spruce in Scotland. As regards size also, the F.Y. 48 heathland sowings have not come up to expectations, though reports on the root systems are generally favourable and the saving in weeding costs is universally acknowledged. Past experience, however, shows that though results in the first year of a heathland nursery are sometimes indifferent, the second year often shows a great improvement, so we can hope for better results in F.Y. 49. There is one other factor to be borne in mind when comparing yields in the heathland nurseries with those in the established nurseries. Partly as a result of improved technique and partly as a result of reducing, or stopping altogether, sowing in the less satisfactory established nurseries, the general level of the yields has been stepped up very materially. This is a welcome improvement which should continue in future.

SELECTIVE WEEDKILLERS IN CONIFER SEEDBEDS AND TRANSPLANT LINES

BY G. D. HOLMES

District Officer, Research Branch

THE DESTRUCTION of weeds by chemical means has been a subject of investigation by research workers for very many years, and a considerable number of substances have been recommended for use from time to time. It is only in comparatively recent years however, that greatly increased weeding costs have focussed serious attention on their potentially enormous economic value in weed control in forest nurseries in this country.

The term "Selective Weedkiller" refers to any chemical compound which, when sprayed or dusted on mixed populations of weeds and crop plants, kills or seriously injures the former while leaving the latter comparatively unharmed. The selective or differential action of many of these substances is due, in large part, to differences of structure and the nature of the surfaces of the plants, the susceptibility of a plant depending on its power to retain the poison spray on its surface for a sufficient length of time to ensure penetration of the tissues.

The exposed nature of the special growing points of the majority of broadleaved weeds renders them particularly vulnerable to treatment. The enclosed growing point and the smooth waxy "unwettable" nature of the needles in the majority of conifers, makes them less liable to injury by facilitating the shedding of the spray droplets, the few drops remaining being nearly spherical with only a small point of contact with the needles.

The lethal action of contact herbicides depends entirely upon the destruction of the aerial assimilating portions of the weed. In the case of annuals, due to the lack of reserve food materials, this brings about the death of the whole plant. Perennial weeds are less susceptible and usually only suffer temporary damage, due to their food reserves and more widespread root system. That class of weedkillers which, when applied to the above ground portions, penetrate into the conducting tissues and deep into the root system, can be used to combat deep rooted perennials; but unfortunately there is little or no selectivity in the action of the majority of compounds falling in this group. This class includes several arsenic and chlorate compounds.

It is now known that there are two broad types of selective toxicity: (1) selectivity due to differences of penetration, and (2) selectivity due to differences in toxicity within the plant. The mineral oils appear to be selective solely because of differences at the site of action, and may penetrate the crop plants just as rapidly as they do annual weeds, yet show toxicity only to the weed species.

It is important to note that selective action very frequently is not complete, in that some adverse influence to the crop plant is often seen in the form of slight discolouration or exaggerated or slightly abnormal growth.

Research work in several countries over the past twenty years has resulted in a greatly increased knowledge of the principles and methods of selective weed control. The greatest progress has been made in agricultural

practice, chiefly in the direction of controlling broadleaved weed species in cereal crops. With the introduction of new spreaders, and new toxins, the selectivity of contact sprays is subject to a much finer degree of control than was previously possible.

The extension of these methods to weed control in forest nurseries is not a recent development. Baumann in 1885 found small amounts of zinc sulphate killed a number of weed species without injury to coniferous seedlings. In 1920 Kitchin demonstrated the effectiveness of sulphuric acid in selectively reducing weed growth in seedbeds of *Pinus monticola*. Steven in 1928 discovered that 1 per cent. solutions of copper sulphate significantly decreased weed growth, without injury to the sensitive Sitka spruce.

In the United States, Robbins, Griggsby and Churchill (1946) tested a range of substances, including "Stanisol," a petroleum by-product which has shown very great promise. Three days after spraying 4 gallons "Stanisol" per 2,400 square feet of seedbed, 84 per cent. of the weeds in ten-day-old seedlings, and 56 per cent. of the weeds in one-year seedbeds of white pine were dead.

For purposes of convenience the known weedkillers with selective properties may be grouped under four heads as follows :—

- (1) Inorganic toxic salts and acids : Copper sulphate, zinc sulphate, sulphuric acid.
- (2) Oils and petroleum products : Stanisol, Varsol, kerosenes, etc.
- (3) Organic substances : Nitrophenol and cresol compounds, etc.
- (4) "Growth-promoting" substances, which used at certain concentrations have been found to possess properties of selective toxicity.

Current trends are in favour of oils and petroleum products and growth-promoting substances. Oil sprays applied several times during the season give promise of reducing nursery weeding costs by as much as 70—80 per cent. Stoeckeler (1947) using several oil products, including Stoddard Solvent and Sovasol No. 5 (oils used by dry cleaners), found they gave 91.2 per cent. and 90.8 per cent. weed kills respectively, with little or no injury to coniferous seedlings.

Several growth-promoting substances have been found to be unexpectedly valuable in weed control in nurseries. These substances, when applied in sufficient concentration, produce marked responses in parts of the plant considerable distances from the point of application. Stem curvature, proliferation and formation of gall-like growths are typical responses to moderate concentrations of these substances. In greater concentrations they may become lethal, and according to Egler are potentially the most important herbicides in the history of economic botany.

Experiments are being undertaken by the Forestry Commission, utilising a range of "selective" herbicides of known toxicity to the more important annual nursery weeds. This work is being done in collaboration with Professor G. E. Blackman, one of our foremost authorities. The experiments carried out in 1948 enabled the isolation of several substances having no significant detrimental effect on the growth of coniferous seedlings. To date, the compounds tested have been those which have proved of value in agricultural crops.

The effects observed are subject to very great variation, and in the majority of cases it cannot be stated categorically that such and such a weed-killer will produce a similar response each time it is applied. Even on the same weed, a treatment giving complete control under one set of conditions may be a complete failure under another. A very large number of factors may contribute to this variability in the degree of control under a given treatment, foremost among these are differences in sensitivity of weeds under various growing conditions ; generally those in favourable fertility and humidity conditions exhibit greater susceptibility than those struggling under adverse conditions. The stage of growth of the weed at the time of applying the spray also plays an important part ; the younger or seedling weeds are very much more sensitive, due to their exposure of delicate growing tissues, and thinner cuticles. Any spray application, particularly water solutions, may be rendered completely ineffectual due to droplets of spray on the foliage being washed off by rain. A minimum dry spell of at least six hours after application is necessary ; dry still weather conditions are necessary for best results.

The long-term effect of prolonged use of these methods on soil fertility cannot be assessed as yet. In the case of the very promising oil sprays, however, no ill effects have been observed to date, and it seems likely that the effect will prove to be small as they evaporate very shortly after application.

From the point of view of use in forest nurseries, most of the herbicides mentioned are still in the experimental stage, and detailed costings have not been considered, but there is little doubt that when sufficiently developed these methods will be capable of greatly reducing expenditure on nursery weeding, which, with present methods, constitutes one of the most arduous and costly operations in nursery practice.

ROBINIA PSEUDOACACIA

FROM MISCELLANEOUS TRIALS at Kennington nursery on the raising of *Robinia*, it is apparent that this rather hard-coated seed responds to being immersed in boiling water, in which it is left to cool overnight, prior to sowing on the following day. Soaking seed for thirty minutes in a fifty per cent. solution of commercial sulphuric acid, followed by continuous washing in tap water for thirty minutes, also appreciably increases the yield, but is somewhat inconvenient in practice. Soaking for seven days in tap water has given the lowest yield of these three pre-treatments.

The following figures were obtained from a trial in 1945 :—

Approximate number of seeds per pound : 25,000

	<i>Production per pound of seed, as 1 + 0 seedlings</i>
Boiling water treatment :	10,322
50 per cent. sulphuric acid treatment :	6,358
7 days soaking in tap water :	3,702

Growth during the first year on fertile soil is vigorous, and normally shoots average about sixteen inches with a maximum around thirty inches. In a hot summer really remarkable growth may occur, and in 1947, in an agricultural soil-type nursery, dressed with compost at twenty tons per acre, the average shoot of one-year seedlings was fifty inches with a maximum of seventy inches.

Recommended density for sowing, where sand or grit is used as a seed covering, is one pound to seventy-two square yards of actual (broadcast) sown area.

W. G. GRAY

Forester, Research Branch

THREE PROVENANCES OF MARITIME PINE IN THE NURSERY

AT WAREHAM RESEARCH Nursery in 1948 we carried out a small sowing of three provenances of maritime pine (*Pinus pinaster Ait.*).

The origins of the seeds used were as follows :

Indent. 48/5021. ex Landes—sand-dune forest area, France.

„ 48/5022. ex Leiria Forest region, Portugal.

„ Local. ex naturally regenerated trees on Wareham Heath.

After only one year, in compost-prepared seedbeds, considerable differences between the three lots were apparent, and if these characteristics are carried into the forest it may well be worth while to follow up the provenance side of this species.

Details of the three lots as 1 + 0 were as follows :

Origin	Mean height inches	Height range inches	Yield of usable 1 + 0's per lb. of seed	Remarks
France ...	4.0	1½-8	3,100	Poorer than the Portugal lot on shoot growth, and poorer than the Wareham lot on root development.
Portugal ...	6.5	1½-14	2,000	Much the largest plants but roots have few laterals. Until late summer this race was conspicuous for its red stems.
Wareham ...	5.0	1½-9	2,200	Very sturdy plants with more lateral roots near the surface than in the other races.

It is interesting to note the good growth of the Portugal lot, considering that 1948 was not a warm season.

Personally, I do not think that maritime pine altogether deserves the bad reputation that it is usually given. It is of course only successful in the warmer parts of the country, but it will succeed on soils far too poor for better species. From experimental plantings at Wareham it is evident that this pine will grow both fast and straight, and without unduly coarse branches if at reasonably close spacing ; the basal bowing so often seen is frequently due to too late thinning of direct sowings.

In the past many millions of maritime pine pit props have been imported from abroad, and I see no reason why home grown ones should not be used. In the future it is likely that, with its very rapid increment, this species might pay well for certain grades of wood pulp.

M. NIMMO

District Officer, Research Branch

RECOVERY OF FROSTED SITKA SPRUCE SEEDLINGS

THE SUCCESSFUL RESULTS obtained in the 1947 experiments at Devilla Forest, Fife, were somewhat marred by a severe ten-degree frost on the 18th September of that year. The 1 + 0 Sitka spruce seedlings, averaging five inches high, were extensively damaged, and about 60 per cent. died back to about 3½ inches in height.

The seed lot of Identity No. 47/6 proved to be of American origin, and it was generally condemned as being "soft" particularly as, in other areas, adjacent seed lots of Canadian origin were less severely damaged. While realising the importance of provenance in relation to the hardiness of forest seedlings, I have often wondered if, in this particular instance, the seedlings were really soft in the accepted sense of the word.

In the first place, the seedlings were subjected to a severe early frost after a very warm summer and mild autumn, and in the middle of an exceptionally vigorous growth which, within my experience, has only been surpassed by the Conservancy crop at Devilla this year. In spite of the severe damage, the seedlings were found to have excellent roots. When lined out this spring, they made a remarkable recovery. They were again damaged, but this time not severely, by the frost of 25th May (7 degrees) this year (1948). In Achray heathland nursery, where we had this American and comparable lots of Canadian origin lined out, the damage was, if anything, more severe on the latter. Notwithstanding this second frosting, the American lot made an excellent recovery and have impressed all who were acquainted with their history.

The remarkable seedlings to be seen in the Conservancy Nursery at Devilla this year are of Canadian origin, and have been only slightly damaged by frost. It should be pointed out, however, that this year's growing season, was, on the whole, much colder, and there was a distinct "hardening off" period in the latter half of September which was exceptionally cold. The present crop had therefore a much better chance of resisting the frost when it did come on 21st September, and in any case it was less severe than in 1947.

One thing at least is certain, that on the light peaty soil of Devilla, a stem height of four inches to eight inches and a root depth of eight to ten inches is common for 1 + 0 Sitka spruce. This enables such seedlings to recover quickly from severe frost damage when lined out. It may yet be possible to check vigorous autumn growth and so reduce early frost damage, either by reduction in the rate of nitrogen applied, or by some mechanical means. There has also been considerable evidence in the past two years that a heavy sowing density greatly increases the risk of damage, as the frosty air tends to "blanket" on top of the seedlings, whereas in the lighter sowing density it appears to drain away before much damage is caused.

W. MACDONALD

Forester, Research Branch

A NOTE ON AUSTRALIAN FORESTRY

BY LORD ROBINSON

Chairman

THIS NOTE IS based on a tour of some of the more important Australian forests and plantations which I made in September, October and November, 1948, under the auspices of the Commonwealth and State Governments. The general arrangements were made by Mr. G. J. Rodger, Director-General of Forests in the Commonwealth, and the detailed arrangements by the heads of the State Forest Services of Western Australia, South Australia, Victoria, Queensland and the Australian Capital Territory. I am indebted to all these gentlemen, their assistants, and to Sir Herbert Gepp for their company on forest tours, and for the great trouble which they took to make my visit interesting and comfortable. Their kindness at all times exceeded all ordinary bounds and I am very grateful to them.

I cannot even attempt to describe here in detail what I saw in the forests and forest establishments. I spent thirty-eight days in the forests, a time too short to view even sample areas of all the important forest regions. An interesting point is that my tours included some forests, which I had visited in 1928 with the Empire Forestry Conference, of which I was able to recall the main features, e.g., the jarrah (*Eucalyptus marginata*) and karri (*E. diversicolor*) forests of Western Australia, the Mount Burr pine plantations in South Australia, and several others.

In order to give you the background for my remarks, I would explain that my tour included a visit by car to the forests in the south-west corner of Western Australia, and a long railway journey from Perth to Adelaide. Thereafter practically all the touring was by car; a series of inspections were made in South Australia, and thence to Melbourne and Gippsland in Eastern Victoria; from Victoria, mostly travelling near the coast, my route took me into New South Wales, and up the coast, with visits to Canberra and some inland forests as far north as Gympie, which is some one hundred miles north of Brisbane; back to Sydney by rail, and then from Sydney to Echuca and the Murray River and on to Adelaide by car.

The distances between places in Australia are considerable—from Perth on the west coast in a straight line to Brisbane on the east coast is a matter of 2,500 miles, and with these distances there are many changes of climate, geology and soils. Much of the country gets less than ten inches of rain per annum, and only one-third gets more than twenty inches. This favoured part is mostly in the north, with a belt of varying width extending along the west and south coasts, and except during the railway journey from Perth to Adelaide and my visit to Canberra and the Sydney—River Murray—Adelaide area, I was never very far from the sea coast, and presumably in the best forest regions.

The characteristic tree of Australia is, of course, the eucalyptus or "gum," of which there are some 200—300 species, but only sixty or eighty of these are used, and eight supply the bulk of the eucalyptus timber. The natural eucalyptus growth ranges from low scrub to some of the most imposing forests in the world. Karri grows commonly to a height of 250 feet, while an actual fire-damaged specimen of *E. regnans* was measured on the ground

and found to be 331 feet to a three-inch top, and 340 feet to the tip. That was in the Great Divide range of Victoria, where an under-storey of tree ferns is common.

Eucalyptus forests make up approximately 95 per cent. of the 75 million acres of Australia's forest area ; the remaining area is softwood, the slow-growing cypress pine (*Callitris* spp.) predominating. There were formerly fairly extensive forests of hoop and bunya " pine " (both *Araucarias*) and kauri (*Agathis* spp.) in Queensland and northern New South Wales. In addition to these natural forests, there are now quite extensive plantations of exotic conifers. *Pinus radiata* is the chief species in the southern or winter rainfall regions and *P. taeda*, *P. caribaea* and *P. patula* in the summer rainfall regions of the north-east coast.

In these notes I refer to some of the matters which impressed me, by their ubiquity, in those forests which I saw. But in self-defence I must make the reservation that over such widespread areas, and with such a great range of conditions, I doubt whether any single all-embracing statement would be proof against legitimate contradiction on some detail.

Fire Damage. This is so universal that I began to ask myself towards the end of my tours whether I had seen a single area of indigenous forest which did not show evidence of fire damage. The losses are two-fold at least : first in the burning up of good timber and the production of defects in good trees which are not actually burned up, and secondly the destruction of regeneration. The losses by fire must be enormous in the aggregate. Some of the burning, which I was told was deliberate with the object of improving extremely poor grazing, seemed to me to verge on the wanton.

The Australian Forest Services have a most difficult problem to solve in the protection of the forests in their charge. When the temperature rises above 100°F. and a strong wind blows, as is often the case in summer, the least carelessness is apt to result in a conflagration.

Apart from fire losses, the waste of timber from the almost universal system of ring-barking has been enormous. Ring-barking is no doubt a necessary and, where it leads to permanent settlement, a successful method of land reclamation, but I saw many examples of good forests which had been ring-barked, abandoned and naturally regenerated once more to forest. Indeed one could observe the whole process, so wasteful in human effort and natural resources, still proceeding in places. Underlying such action there is a grave misconception of the national value of well-managed forests, as measured in terms of production and of permanent employment.

It seemed obvious to me that more care is still required in classifying forest land prior to selection for agricultural settlement, and that, where good forest has to go, more care should be taken to make use of timber beforehand.

Natural Regeneration. In general the regeneration of the indigenous eucalypt forests, by self-seeding or by coppicing, is easy. Provided that sufficient light is admitted to the soil, seedlings of the right species spring up in abundance. Normal exploitation of the old crop, combined with the removal of defective over-mature trees, generally provides the necessary conditions for regeneration. The over-mature trees present a difficulty in point of cost, which it was sought to avoid by ringing. This practice, though effective as regards regeneration, has had to be abandoned because the dead trees form a serious fire hazard. Obviously close utilisation of all wood and timber greatly eases regeneration costs.

In general, eucalypts require great growing space at an early stage, and artificial thinning would appear to be desirable. In the absence of markets for thinnings the process is costly, though I saw some excellent results in, for example, red and spotted gums and messmate.

Rate of Growth of Timber. The rates of growth of trees, both indigenous eucalypts and exotic conifers, are phenomenal as measured by British standards, which are themselves higher than those of the Continent of Europe. If an oak plantation is twenty feet high at twenty years of age, we have to be satisfied, but fast growing eucalypts may be as high in two or three years, and higher in fifteen years than oak or beech reach in one hundred years. Similarly, *Pinus radiata*, *P. taeda* and *P. caribaea* and hoop pine on good sites will grow two to three times as quickly as the fastest growing conifers in Britain, and *P. pinaster*, on sterile sands, twice as quickly as the Scots pine on average sites. Even so superphosphate is sometimes needed (where we might use basic slag) to get the young trees off the mark.

One would expect that the yield of useful timber from eucalypt forests would be high, but in fact, it is disappointingly low—lower in fact than from oak or beech forests. This is due to a number of factors, some of which are probably inter-acting. Much of the mature timber, to say nothing of the over-mature, is defective owing to “pipe,” gum veins and shakes, the last two defects intensified no doubt by fire damage. Further, immature timber and timbers of many species have scarcely been used at all—though shortage of supplies is now beginning to force them on the markets. Major exploitations yielding 10,000 superficial feet per acre were frequently considered quite good, and much lower figures were common.

I ventured the remark that not ten per cent. of the timber which the eucalypt forests produced is ever brought to use, and was informed that the estimate was probably too high. Australian foresters can obviously not rest content with such imperfect utilisation.

The yields from conifer plantations are in marked contrast; 10,000 superficial feet per acre from thinnings (which leave intact a main crop several times as great) between fifteen and twenty-five years of age, are by no means uncommon. These thinnings find a very ready use due to the general lack of softwood timber, and when not converted departmentally are bought up avidly by timber merchants.

Eucalyptus Forests. The points I have been making in the preceding paragraphs have their bearing, of course, on policy and management. Owing to persistent fire damage, there must be a serious lack of intermediate age classes. The main reserve for the future seems to be in the very large area of virgin or imperfectly exploited forest, e.g., in south-east Australia. It is an unsatisfactory reserve, because communications are bad or non-existent, and because growth is stagnant or increment even negative. In all forests, marketable saw timber accounts for a very small percentage of total growth, the remainder being wasted. Correction of these defects must be primary objects of policy and management.

Forest Roads. Roads seem to be the key to the problem, and I was greatly interested to see the construction work which is going on, particularly in New South Wales, in Victoria and in Queensland, and the improved utilisation which then becomes possible. The day of the bullock team (I saw only one) and the logging railway seems to have gone, and the internal combustion engine to have

taken their place. It is true that forest roads can be costly, and their immediate yield comparatively low, but they bring into use and active regrowth forests which have otherwise no productive value (except, of course, their value for conservation of soil and water). Roads are necessary in any event for modern transport, but they also vitalise the forest in three ways, namely by :

- (a) Making for more intensive utilisation, thereby :
- (b) Promoting regeneration,
- (c) Facilitating fire protection.

Even so, further methods of utilisation are urgently required, apart from measures to promote the use of species hitherto neglected. A beginning, but not more, has already been made by the paper pulp companies, which are now using eucalypts, and by the Masonite Company making a product similar to Cellotex. It seems to be a movement which should be encouraged by all legitimate means, including intensive forest products research.

Intensity of Management. In Australia, as elsewhere at the present time, there is the problem of the optimum application of available funds and energies or, stated in another way, whether it is more profitable to manage a relatively small area intensively or a large area extensively.

I do not think there is a general or easy reply to that question. The answer must depend on a whole set of conditions which vary from place to place, and the values produced by one method of treatment or another must first be assessed. It is, in fact, a subject for intensive investigation and research.

Seeing how small have been the results of very extensive management in Australia, my own inclination would be to intensify management progressively, ensuring above all that results which have already been secured are properly safeguarded.

Coniferous Plantations. Plans are afoot in all the States for considerable extensions of coniferous plantations, mainly with exotic pines except in Queensland where the indigenous hoop pine is doing excellently. This movement has everything to commend it. There are vast areas of poor to sterile land which it is now evident will grow conifers very well.

I think that Australian foresters have been rather carried away by the spectacular success of *P. radiata* under certain conditions. The first reaction (some twenty years or so ago) seems to have been to extend plantings into quite unsuitable places, which led to disorders in the health of the pine, or to failure. This lesson has doubtless been learnt by now, but all the same I feel that *P. radiata* is a delicate tree and that unforeseen troubles may arise. It would be a prudent insurance to diversify the plantations, even at the cost of a somewhat lower yield, and to get experience of the next best species, in case of trouble. As we know in Britain, it is possible to be too grasping in forestry as in other human affairs.

I believe it would be wise to take early stock of exotics in Australia, and not only species but also strains of species. It must be doubtful, at least, whether all the trees of value to Australian forestry have yet been tested under the most appropriate conditions, if at all.

Private Forestry. I was struck by the lack of consideration for trees, amounting at times almost to contempt, on the part of private owners ; so much so that it seemed in some districts that there would soon be insufficient

material for shelter for stock, for farm purposes, or for fuel. This seems to be a subject in which the Australian Forest Services might well interest themselves, just as other Forest Services, the world over, are having to do.

Indirect Values of Forests. There appears to be a growing appreciation of the value of forests in relation to water conservation and soil erosion, though action lags behind requirements. The situation varies greatly from State to State. The most interesting is in New South Wales where all the interests (forestry, soil conservation and irrigation) are correlated under a Minister of Conservation. In Victoria there is progressive legislation which has not yet been put into action.

Points of Interest in the State Forests

The following are a few of the more outstanding features of the plantations and indigenous forests which I visited in the course of my tour.

Western Australia

At East Kirup I saw a plantation of Monterey pine, *P. radiata*, only fifteen years old, in which individual trees had already reached a height of 108 feet, with a diameter at breast-height of eighteen inches and a volume of seventy-five cubic feet. By contrast, in the same plantation, but on a laterite soil, growth was very poor, with serious yellowing and die-back. But a spectacular cure for that disorder has been found in spraying the trees with a two-and-a-half per cent. solution of zinc sulphate. On the sterile sands at Gngangara it has been found that maritime pine, *P. pinaster*, remains stunted unless superphosphate is applied; after such applications, it gives excellent results, reaching a height of fifty feet in seventeen years. Both zinc sulphate and superphosphate are needed by this species at Myalup where the soil, though still sandy, is rather better.

South Australia

The south-eastern pine plantations in this State are one of the most interesting and successful afforestation ventures that I have seen. Here are some 90,000 acres of State plantations (about 80,000 acres of them being of *P. radiata*), of which only about 5,000 acres are over twenty years of age. Such is the rate of growth that the plantations already support two large saw mills, cutting out flooring and case-making timbers, and are already yielding large quantities of match veneer logs and pulpwood. The basis of this spectacular development is the very rapid growth of *P. radiata*, which in the highest quality class (I) yields 9,560 cubic feet per acre, and in the lowest (V), 4,120 cubic feet, both in twenty years. It is calculated that ultimately the plantations, mills, etc., will employ in perpetuity one man per twenty-five acres, and it is safe to predict that on that basis the district will become one of the most densely settled and prosperous rural areas in South Australia.

Victoria

The eucalypt forests of this State have suffered terribly from fire. In 1939, catastrophic conflagrations killed off great areas of magnificent *Eucalyptus regnans* forest in the Great Dividing Range. The Forest Service is faced with an extremely difficult fire protection problem, but an elaborate system of general detection and control has been set up, and local control is being aided by large-scale road construction. I think that in the long run the public have got to be brought to an understanding of the position, so that

carelessness in the use of fire is no longer tolerated. In essence that means persistent education of all classes, beginning with the school children. In that connection the institution of school plantations is an interesting venture.

New South Wales

Extensive road construction is being undertaken, some of it in difficult hill country, thus opening up virgin forest of good quality and generally improving essential communications. Combined with this road work, small departmental mills are converting material which commercial sawmills reject. The ground is thus prepared at minimum cost for regeneration. These operations illustrate the essential role which roads play in the forest, not only in promoting better utilisation but also in making silviculture (including fire protection) possible. I also saw some excellent work in the regeneration and thinning of eucalypts.

In the Tumut mountain country there is a most interesting series of coniferous plantations now about twenty years old. *P. radiata* has done very well in spite of snow and frost damage ; some strains of *P. ponderosa* and *P. lambertiana* are excellent, and *P. laricio* and Douglas fir are about as good as the average with us.

Queensland

In this State I saw several thousand acres of first class coniferous (*Pinus caribaea* and *P. taeda*) plantations, in which remunerative thinning operations were proceeding as early as the twelfth year, when the trees had a top height of about forty-five feet. The practice of heavy thinnings follows, but not all the way, that initiated by Craib in South Africa. These plantations are often in replacement of poor eucalypt forest on poor sandy soil. A dose of superphosphate is often required to start the pines. The growth of certain eucalypts is quite phenomenal in certain situations. I saw "flooded gum" eight years old, reaching a height of one hundred feet in damp valley bottoms

In conclusion, looking back to my contacts of 1928 with Australian Forestry, I can congratulate my Australian colleagues very sincerely on the progress made during the interval. They would be the first to admit that there are many outstanding problems of policy, administration and technique, but I believe that they are working on the right lines.

THE CENSUS OF WOODLANDS — SOME IMPRESSIONS

BY J. L. FERGUSON

District Officer, Census of Woodlands

THE WRITER HAS been engaged on the post-war Census of Woodlands since the first trial run in June, 1946, and here sets down some of the impressions, good and bad, of the woodlands and problems created by them in those parts of the country which he has visited.

The Trial Census

As the advance guard of the Census field staff only spent a short time in each of the counties where the methods were to be tried out, it is not possible to say much. In Sussex we spent a few weeks surveying part of Worth Forest, near Balcombe, and some smaller woods nearby. This large area of woodland was found to consist largely of felled land becoming covered with birch, generally of a poor type. It was difficult to decide whether to call this "scrub" or "broadleaved high forest," but in general it was considered that it was unlikely to develop into a utilisable timber crop. Later it was decided that felled areas carrying young growth averaging less than three feet high, such as birch or stool shoots, should still be typed as "felled." A fair amount of coppice with standards and some quite good conifer plantations were also seen here.

In the Banchory district of Kincardineshire we were struck by the vast clear-felled areas (the Canadians and others were very active on Deeside during the war), which were, of course, easy to survey and often gave "stands" of several hundred acres. It appeared that there would be plenty of planting land for the Commission for years to come, as few private estates would be able to undertake replanting on such a scale. The birch growing in this district was generally of a fairly good type. The existing woods were generally even-aged pine, heavily stocked, sometimes with larch and spruce, and were slow-grown but clean, many having been planted at three feet by three feet. In one wood close to Banchory a quantity of spruce regeneration was seen, and it is probable that natural regeneration of pine, spruce and larch could be obtained successfully in many of these plantations. Considerable damage from Pine Shoot Beetle to standing pinewoods adjoining felled areas was seen.

In Nottinghamshire we were impressed by the cleanness and straightness of the old oak plantations in the Dukeries on sandy, gravelly soil, although the girths were not great. The woods on the loams and clays of the east of the county, which *can* grow much larger hardwoods, were unfortunately often scrub and derelict coppice. Here I noticed the wild service tree (*Pyrus torminalis*) for the first time, and here also several stands had to be typed as "Lost to oil wells," unique on the Census.

The Main Census

Bedfordshire

This was the first county completed, and it provided a variety of types. In the north we met considerable areas of that bugbear of Census Surveyors, derelict coppice-with-standards, which had to be classed as either "coppice-with-standards," "broadleaved high forest (with scrub undergrowth)" or "scrub (with scattered standards)." This annoying kind of woodland was to be met all too frequently throughout the Midlands and South of England. The excellent growth of trees on the greensand was

noted, particularly on the Woburn Estate, where, too, exotic pheasants and deer surprised the surveyor at every step.

Surrey, Hampshire and Berkshire

The pine region here was particularly difficult to survey, owing to the uneven boundaries of the semi-natural stands, and to housing encroachments. Damage by fire and by the Army added to the difficulties. Some help was obtained from air photos. We were held up also by the hard weather in January and February, 1947.

It is striking what an excellent race most of the Surrey pine is, very straight, clean and narrow-crowned. Dense masses of natural regeneration were seen on the sandy heaths, too often, alas, destined to be destroyed by fire. Much good pine occurs in the gardens of houses, and had to be typed as "lost." In much of Hampshire and parts of Berkshire and Surrey, coppice with standards of varying quality was found.

Wales

The Census parties moved to Wales in August 1947, and here we soon became aware of the lack of woodland management, and of the persistence of the oak woods in spite of such things as the grazing of coppice stools. Ownership has much to do with this lack of forest sense, as there are few big estates and many of the woods belong to small farmers, who only want enough trees to provide fence stakes and other farm needs. Considerable areas felled in the two wars are now grazed, and might be called "lost." The buzzard was found to be really common throughout Wales, and the pied flycatcher and redstart were noticed as two characteristic birds of the oak woods in North and Mid Wales.

South Midlands

The satisfactory condition of many Herefordshire woods was pleasant to see, and in particular the excellence of the ash. In East Herefordshire and in Worcestershire, however, one met considerable areas of coppice-with-standards, often derelict; larger areas were also met with in Northamptonshire. There the open-cast ironstone workings sometimes made the Ordnance Survey maps bear little resemblance to the actual conditions, as large areas of woodland had been destroyed, and new plantations created, on some of the old "ridge and furrow" workings. With the help of estate maps and a check from air photographs, the survey was made easier.

The Chilterns

It was pleasant to see this region of beech woods, worked on a selection system with natural regeneration, although there is often a shortage of young growth. Some bad examples of devastation were found, but on the whole the woods seem to have suffered not too badly from war fellings, and quite a number were classed as "overstocked." Ring counts showed these woods to be very slow-growing in general, so the tendency was to underestimate their ages. It is to be hoped that this region (which is almost unique in Britain) will remain a beech region with natural regeneration, and that felled and devastated areas will be replanted mainly with that species.

Conclusion

At the time of writing (February, 1949), the Census has a few months to run, and by the end the writer will have seen further parts of the country. Census experience so far has shown how great a proportion of the woods marked in green on the one inch to the mile maps are felled or of little value, and how great is the problem of rehabilitation; the final Census figures will give us the complete picture for the whole country.

NOTES ON THE STATE FORESTS IN LINCOLNSHIRE

BY ROBERT PAYNE

District Officer, East England

LAUGHTON FOREST

Situation. Laughton Forest lies in the north-west corner of Lindsey, the northern division of Lincolnshire, very close to the River Trent about fifteen miles from its mouth, and midway between the industrial towns of Gainsborough and Scunthorpe.

Area. Its total area is 2,144 acres, of which 2,050 acres are plantable and have been planted up.

Topography. The main block of the forest occupies a bold hill and ridge which rise prominently above the surrounding countryside. The highest point is at Hardwick Hill, 132 feet above sea level. The surrounding country, which includes the remainder of the forest, is occupied by the Trent flats, which are about ten feet above the sea. The main ridge has a steep south-west escarpment.

Geology and Soil. The main block lies on the Triassic and Lias measures, and the lower portions on Recent measures of the Trent estuary. Most of the forest is covered, to a varying depth, by blown sand. Reddish Keuper Marl of the Triassic series is exposed in road cuttings on the western escarpment, whilst yellow clay of the Lias comes to the surface in several places in the east. The blown sand varies greatly in depth. It is buttressed against the western slopes in great dunes to well over thirty feet deep, whilst a thinner covering is present over the plateau and ridges. The lower regions are also sand-covered, often with dunes. The sand itself is very fine and easily blown by the wind; the area in fact, was mostly a waste of blowing sand and *Molinia* bogs before afforestation commenced in 1927. On the steeper slopes run-off in storms is rapid, and soil erosion easily occurs.

Drainage is often a problem. The numerous wet hollows have a widely and rapidly fluctuating water table, and it is often difficult to get drains out of them. The areas on the Trent flats are old marshland, and water is usually near the surface. There are numerous shallow lakes about the area, some several acres in extent. One of the largest is on the highest part of the plateau, apparently held by the clay below the sand.

Climate. Rainfall is about twenty-five inches a year, winter rainfall being usually predominant. Fire danger is seldom absent from the area from March to November, as the very sandy soil dries out within a few days after even the heaviest rain. Frost is often severe and is more frequent on the lower lying areas; late spring frosts are fairly regular on the lower parts, although the higher regions often escape them. Exposure to the prevailing south-west wind is considerable on Hardwick Hill, and windblow is a factor to be reckoned with. Strong cold easterly winds often blow for weeks at a time in March and April, greatly increasing the fire risk.

State of the area when Acquired. The main part of the forest was leased in 1926, and the rest was purchased. At this time the area was a sandy waste,

rabbit infested, and the haunt of rare birds and plants, as it had always been. The upland area was a desolate spread of *Molinia* and *Calluna* heath, with boggy hollows and patches of scrub birch. The main hill and some of the lower areas were deserts of blowing sand. There were a few patches of Scots pine scattered over the area. The whole region was used only for sporting purposes.

Plantations made by the Forestry Commission. The first planting was done in 1927 and Corsican pine has been extensively planted on the exposed sandy area, on vegetation varying from *Carex arenaria* to pure *Calluna*. In places ploughing was done, and on blowing sand the area was first "thatched" with birch wattle fences. In general, the Corsican pine is flourishing, especially on areas of *Carex arenaria* and on bracken. Growth has been considerably slower on heather areas. Unfortunately, a considerable quantity of the "Ursuline" variety of Corsican pine was planted, and such areas are not very promising.

Scots pine has been used on the rougher areas, and on bracken, *Molinia* and, in places, to beat up failed Corsican pine areas. It grows very vigorously at Laughton, though somewhat coarsely. There is an area of thirty-five acres of natural regeneration of Scots pine at Peacock Wood, which has just been established satisfactorily.

Sitka spruce was chosen for planting on the wetter *Molinia* areas on a large scale, often on turfs. The results have been discouraging. In many eighteen-year-old plantations, the trees are little more than bushes, only eighteen inches high. The site has proved unsuitable for Sitka spruce because of the very sandy soil, the dry climate, the late spring frosts, and the widely and rapidly fluctuating water table. Conversion of the worst of these areas to Scots pine is now being done.

Tsuga and *Thuja* have been tried experimentally. They are growing well where they are out of the spring frost zone.

Japanese larch has also been tried, but not with an encouraging result.

Beech. The small plantings of beech are proving quite successful on certain sites. Growth is most vigorous where there is considerable bracken growth, little spring frost, and a gravelly soil. On adjoining areas of different type, growth is poor. It might be possible to introduce beech on a larger scale as an underplanting later on.

Birch, sycamore and Black Italian poplar are all disappointing.

Summary. There is no doubt that this is pre-eminently a pine area: Corsican and Scots pines both flourish. Beech has possibilities on selected sites, but there appears to be no economic justification for growing other species on a large scale.

Protection. *Fire* is an ever present bogey at Laughton from March to November. The dry climate, light sandy soil, inflammable vegetation and large stands of conifers under twenty years of age, demand great care and vigilance in the danger season. Until 1943 the main block was devoid of any appreciable firebreaks or roads, and a number of large fires occurred. Since then compartment boundaries have been cleared of vegetation, ploughed and levelled, and, in the last three years, ten and a half miles of slag roads have been laid down to give quick access to most parts of the forest. Ploughed strips are maintained on dangerous boundaries, and a fire tower was erected on Hardwick Hill in 1946. A mobile dam unit stands by during the fire danger

season. Close liaison is maintained with County Fire Services and neighbouring military camps. Special watch has to be kept at gull-breeding and blackberry seasons. Thousands of black-headed gulls breed on the lakes, and people in search of their eggs are often careless with matches and picnic fires.

Insects. Laughton shared the dubious honour with Bawtry Forest of first showing an intensive attack of *Evetria purdeyi* on its Corsican pine. In 1945 and 1946 a considerable area was affected, many of the trees losing their leading shoots. At this period a ban was put on the removal of Corsican pine from Laughton Nursery to other forests and only Scots pine was planted. However, the attack now appears to have died out, the trees are making growth again, and the ban is lifted.

Neomyzaphis is very prevalent on the sickly Sitka spruce.

Rabbits infest adjoining lands, and active vigilance by warreners is necessary to keep them outside the fences.

Utilisation. First thinnings in Corsican and Scots pines, P.27—30, were commenced in F.Y. 48, and most of the area in need of thinning has now been completed. The thinnings are converted to pitprops, pointed hedge stakes and firewood. A ready market for all materials is available. The pitprops go mostly to East Midlands coalfields, the stakes to local farmers, and the firewood to Gainsborough and Scunthorpe. There is also a limited market for birch twigs and rustic poles. Christmas trees form a useful sideline, as many of the Sitka spruce on areas being converted to Scots pine make ready sales during the season.

The yield per acre of Corsican and Scots pines in first thinnings is very variable owing to the irregular nature of much of the crop. In the better stands it is about 275 cubic feet per acre.

Nurseries. The established nursery is ten acres in area and is of fine estuarine sand, suitable for the growth of Scots and Corsican pine seedlings and transplants. A yield of thirty-three thousand first year seedlings per pound of Scots pine seed resulted from F.Y. 48 sowings. Survival of transplants was about 90 per cent.

Composting is done on the site, with water from a standpipe, using straw or bracken with hopwaste or dried blood. Hopwaste is readily available, often in quantities sufficient for direct application at fifteen to twenty tons per acre. The soil is very acid, and rather deficient in potash and phosphates. Rape and turnip are grown for greencrop and sheep folded on.

The great danger at the nursery is from windblow of the light sand ; this can be disastrous soon after seed germination. It is necessary to take extensive precautions against blow by erecting close lines of vertical shelter and covering the beds with grit. Weeds are not unduly troublesome ; *Poa annua* is present to a moderate degree.

During the past few years many of the ploughed rides have been used as heathland nurseries. Results have been good, with little expenditure ; but the rides are now growing over, as planned, and they are being given up for use as nurseries.

Staffing and Labour. Laughton is run by a Forester and Foreman, both of whom live in the forest. There is a labour strength of just under forty workers, of which about a quarter are women. The latter have proved to be very

efficient on nursery work, and have also done considerable quantities of brashing and preparation of ground for planting. The labour supply position is good now. It was difficult during the later war years, but has improved considerably since 1945. Most of the workers come from local villages and hamlets, although numbers of Irish casual workers have been employed at various times and seasons. Arrears of brashing were helped along by using German prisoner-of-war labour in F.Y. 48.

Other Features of Interest. Besides being a prominent feature of the present day landscape, the forest area has been of considerable importance in the past. There are traces of an old Roman port near Laughton (the Trent estuary then being undrained and marshy), and Roman boats have been dug up. Fragments of Roman pottery are also found in the sand at Peacock Wood. Finds of earlier date have been made by archaeologists on the upper part of the forest, and the exposed cuttings of the Trias, rare in Lincolnshire, are of interest to local geologists. There is an old pack horse track leading across Hardwick Hill from Ferry to Scotton, and a spring on the hillside is known as "Robin Hood's Well."

Laughton has always been the haunt of rare birds and plants. A glance at records of only fifty years ago is quite breath-taking. Even today the forest forms a nature reserve in this highly cultivated countryside. The lakes attract numerous wild fowl, such as pintail, shovellers, shelduck, teal and, at certain seasons, other rarer species. Black-headed gulls breed in thousands in May; snipe and woodcock are common. Curlews still nest on the sandy rides and the rarer hawks, including hen harriers, are occasionally reported. Black game were common until a few years ago.

Plant life includes many species not found elsewhere in Lincolnshire. The lovely marsh gentian, *Gentiana pneumonanthe*, marsh cinquefoil, marsh violet, creeping willow, and yellow loosestrife are quite frequently met with.

Mammals are not numerous, for the gamekeepers and warreners keep some species down. There are as yet no squirrels. Lizards are common in the sand.

The establishment of the forest is undoubtedly changing the wild life of the area. Some species of plants and birds are going out, and on the other hand, new species are coming in. One feature which has been remarked on is the drying up of the lakes. As the plantations grow the water table is being lowered, and several of the lakes never known to dry up before are now quite waterless.

The growth of Laughton Forest has also changed the aspect of this area. Since afforestation commenced the local people have seen the transformation of a barren waste into a thriving forest giving support to a fair proportion of the local population.

WILLINGHAM FOREST

Situation. Lying in central Lindsey, North Lincolnshire, Willingham Forest is made up of four large blocks of land on the north and east of Market Rasen. It lies close to the foot of the Lincoln Wolds and contains Hamilton Hill, an outlier from them.

Area. The total area is 1,903 acres, of which 1,816 are plantable, and 1,031 acres have been planted to date; the first planting was in 1939.

Topography. This is mainly a flat area, lying at the foot of the Wolds, about one hundred feet above sea level : with the isolated Hamilton Hill a prominent feature of the landscape. The highest point is 205 feet above sea level. A few shallow valleys cut through the area, but in general the wooded area is flat and boggy. There are considerable blocks of bare land which are gradually being afforested.

Soil. Willingham lies on the Jurassic measures at the foot of the Cretaceous Wolds, and the soil is heavy clay overlain with sand to varying depths. Hamilton Hill is capped with boulder clay in which are chalk fragments, and on the flat areas clay approaches nearest to the surface in the east and south. The sand is medium fine and, on open land, blows easily in strong winds.

Drainage. Much of the area is naturally boggy, and much draining needs to be done to maintain suitable forest conditions in the establishment period. It is often difficult to drain well, as the soft sand banks soon crumble. Maintenance of drains is a heavy item of expenditure.

Climate. About twenty-six inches of rain fall per annum, mostly in winter. Snow falls are frequent and sometimes severe, owing to the proximity of the Wolds and the eastern exposure. Spring droughts are common, usually accompanied by very cold drying east winds.

Frost is severe at times, and late spring frosts occur fairly regularly towards the end of May, especially on the shallow valley areas where early autumn frosts sometimes do damage in September. With the exception of Hamilton Hill, the area is not open to gales from the south-west. The prevailing wind from February till October is from the east, and certain areas are much exposed to this.

State of Area when Acquired. The land was purchased in 1938, and included considerable areas of good mature Scots pine (with individual trees containing one hundred cubic feet), oak, and Norway spruce ; these were felled during the 1939-45 war. Much of the area was derelict farmland, with poor pasture, weedy arable land and gorse, though some land was in a fair state of cultivation. There were also plantations of scrubby birch on *Molinia* and open heaths of *Calluna*.

Plantations made by the Forestry Commission. The first plantations were made in F.Y. 39. Oak was planted pure on the clay of Hamilton Hill, mixed with Scots pine on intermediate soils, with Scots pine planted pure on sandy, frostier areas. The pure oak plantations have grown well, although management was often difficult during the war years, as the area was requisitioned as a bombing range. Oak has also done well where mixed with Scots pine. The mixture (1 S.P. and 3 Oak per row) now presents certain problems : it is necessary to lop or trim the pine to prevent suppression, whipping or other damage to the oak. Where the oak has done well this is fairly straightforward ; but in some cases there has been a partial failure of the oak (Willingham Park), and there is insufficient left for a full crop. Great care and much supervision is therefore required in carrying out this cleaning operation. About forty acres of pure oak were planted on an old woodland site in F.Y.48.

Scots pine is eminently suitable for Willingham ; it grows to a good form and is easily established. Some plantations, however, have been badly damaged by tortrix (*Evetria buoliana*) in early life.

Corsican pine has been tried on a smaller scale and promises well. Much of the derelict agricultural land is ideal for this species, and larger plantings are now being made. The value of the 1941 areas of Corsican pine has been greatly lessened by the use of about two-thirds of Ursuline variety. Natural oak seedlings are growing through much of this area, and may eventually produce a mixed crop.

European larch has been planted on some of the worst frost areas, and is therefore very poor. The area is not suited to larch, although fair results may be obtained on the less frosty regions.

Douglas fir has been underplanted under natural birch on the northern part of the forest. The site and condition are rather against this species and in general the trees are not promising.

Natural birch grows prolifically on old woodland areas, but is of an inferior type.

Planting is usually done after ploughing on open land. A shallow furrow is cut under the vegetation and the trees planted in it. It is inadvisable to plant on the upturned furrow slice, as the plants often die through drought on this dry sandy soil. Moles are a nuisance, often burrowing along the furrows and burying small plants (especially C.P.). Intensive trapping before planting, and frequent firming of plants afterwards are necessary.

On old woodland sites it is usually possible to plant directly after clearing, without further preparation, although in wetter areas, where *Molinia* grows, it is necessary to screef carefully and widely.

Protection. *Fire* danger is serious. The sandy soil, inflammable vegetation, large area of conifer plantations, together with its popularity with the public and intersection by main roads, make fire patrol and other precautions necessary for the greater part of the time between March and November. A railway line passes along one of the boundaries, and sparks from engines have been the cause of numerous fires. The danger is aggravated by the steep incline on the line at this point, and the frequent passage up of heavy iron ore trains to Scunthorpe. The danger has been considerably lessened in the past year by clearing and ploughing a fifty-foot strip on the boundary, and a thirty-five foot strip a short way beyond this in the forest.

Insects. Tortrix (*Evetria buoliana*) damage has been heavy on plantations of P.39 and P.40 Scots pine, but they now show signs of recovery.

Rabbits are only too plentiful in the region around the forest, and breed nearly all the year round in the sandy soil. Special vigilance is required to keep them down inside the fences. *Hares* are sometimes a nuisance in hard weather. *Moles* also give trouble in the nursery, and on newly planted areas.

Nurseries. The nursery at Willingham is twelve acres in extent and adjoins the Forester's house in the centre of the Forest. It has a light sandy soil which is easily worked but liable to blow in dry March winds. At such times clouds of sand blow for days on end from fallow and surrounding agricultural land. The nursery was rather foul with couch grass until 1947, when vigorous methods were put in hand to clean it, and assisted by the dry summer, the position to-day has much improved. Spurrey is another troublesome weed in some sections, and difficult to get rid of.

The pH of the soil is around 4.8 ; there tends to be a deficiency in potash. Hopwaste and farmyard manure are available and freely used. The layout of the nursery lends itself to easy mechanical cultivation, which is mostly done by contract. Hedges of Lawson cypress help to break the wind, but it is necessary to use vertical lath shelter in spring, and to cover the seedbeds with grit to give maximum protection from wind-blow. The beds are never raised on this sandy soil.

The nursery is well suited to the production of Scots and Corsican pines. Good one-plus-one transplants are obtained, and yields of seedlings are above average. (S.P. about 26,000 per lb. in F.Y.48). Some losses occur with transplants owing to weeding troubles, but these should be reduced as the nursery gets cleaner. Surplus stocks are lined out in the fire lines.

Staffing and Employment. Willingham is at present run by a Forester and a Foreman with a ganger and a regular staff of about twenty-four forest workers. A number of girls are employed, especially in the nursery, where they prove efficient at lifting, grading, and weeding. The labour supply position is good owing to the nearness of Market Rasen, a town with no industries. A strong backbone to the labour force is given by local men who have worked in the neighbourhood on farms or woods for most of their lives.

Other Features of Interest. The forester's house, Chapel Hill Farm, takes its name from an old artificial mound nearby. The River Rase flows past the house on its way through the forest.

Bird life at Willingham is interesting but not spectacular. A century ago the old gorse heaths were haunted by buzzards and hawks now gone, although there are still occasional reports of such rarities being seen for a few days in the year. There is a rich population of small birds, especially in the old hardwood areas and bushy places. Blackcaps, redstarts, warblers, and nightingales are frequent. (Willingham must be one of the northernmost regular haunts of the nightingale). The growing up of large blocks of pine forest may cause considerable changes in the bird population.

A few badgers still live in deep setts in the sand. Foxes are frequent. A few pairs only of red squirrels survive in the area ; they may increase with the growth of the forest. Weasels and stoats are common.

Plant life at Willingham is fairly typical of a sandy heathland area, and therefore in many ways in contrast with the surrounding countryside of heavy clay or chalk wolds. Heather, bracken, and *Molinia* are dominant in many areas. In those regions plants rare in Lincolnshire occur, such as cotton grass, sundew, hard fern, and goldenrod.

The southern end of the forest abuts on an old hardwood region, which lies chiefly on heavy clay without the covering of sand. Here, quite a different flora occurs, with bramble, honeysuckle, and raspberry dominant ; and such herbs as primrose, lily-of-the-valley, and *Ranunculus auricomus* frequently occur.

Willingham Woods have long been popular with the public, and numbers of people visit them each year. The numerous public roads make this easy, and the planting of ornamental belts of lime, red oak, and horse chestnut which is now going on, should do much to preserve the beauties of this region.

BARDNEY FOREST

Situation. Bardney Forest lies in south-eastern Lindsey, North Lincolnshire. It is scattered over a wide area of the countryside in ten separate blocks, between the small towns of Wragby and Woodhall Spa.

Area. The total area of the forest is 2,846 acres ; of this 2,719 acres are plantable, and about 1,865 acres have been planted by the Forestry Commission, or by the previous owners.

Topography. The forest is spread over one of the most thinly-populated agricultural regions of Lincolnshire. The land is flat, except in the northern blocks where it becomes more undulating as it approaches the Wold region. Wide shallow valleys pass through the area, and there is a general slope to the south-east, with drainage to the River Witham which defines the boundary of the Fens. The countryside is exposed, with bare stretches of agricultural land surrounding the numerous hardwood blocks. Elevation is usually between twenty-five and fifty feet above sea level, with the highest point of 130 feet at Sotby.

Soil and Geology. On the Jurassic measures. The basic soils of the forest areas are of Oxford and Kimmeridge Clays, practically the whole area being overlain with boulder clay in which are numerous chalk fragments. Near Woodhall Spa is a region overlain with riverine sands and gravels. The forest soil, in general, is an extremely heavy clay. The Woodhall Spa block, however, provides a complete contrast, by being very sandy with gravel.

Drainage is a problem. The flatter areas on the clay soils are often wet, and water stands on the surface for months at a time. The old woodland areas have usually been skilfully drained in the past, and it is often found that when the old drains are opened up on re-planting they are sufficient. The main drains are often deep, but shallow drains serve to draw off surface water from new planting areas.

Climate. An annual rainfall of about twenty-seven inches occurs, mostly in winter. Snowfalls are frequent but not usually heavy. Blizzards sometimes cause isolation of the area, owing to the exposed nature of the countryside. Summer droughts occur in most years, and at these times the heavy clay soil dries hard and cracks open, often resulting in the death of newly planted trees.

Frost is a serious drawback at Bardney. The low-lying, wet clay areas bordering the Fens, or beside streams, often suffer severely from frosts when they do not occur in other regions. Late spring frosts occur almost without fail in the third or fourth week of May, and in "early" seasons regularly cut back the oak until it leaves the frost layer. Lammas shoots on oak are also often killed by early autumn frosts, such as occurred on September 20th, 1948. The higher parts of the forest suffer less severely.

Winds are not a serious problem here, unless, of course, wind firm margins of the woods are interfered with. Young Douglas fir and pine often need firming after continuous winds, owing to the heavy compacting nature of the soil. The prevailing wind is south-west, with a period of cold easterly winds in the spring and summer.

State of the Area when Acquired. The forest is held freehold, and the first acquisition was in 1932, and consisted of Southrey Block, New Park Block and Bucknall Wood. The greater portion of the forest before acquisition consisted of large blocks of derelict woodland scattered through an intensively agricultural area.

Such areas as New Park, Austacre Wood, Southrey Wood, Birch Wood, Halstead Wood, College Wood, etc., contained thickets of hazel, lime, blackthorn, ash and oak coppice of about ten to fifteen years growth. A few standards were scattered through, and there were poor areas of natural birch, aspen and ash regeneration. The coppice was laced together with brambles and honeysuckle, there were dense areas of *Deschampsia caespitosa*, the drains were neglected and the fences poor.

A few woods contained areas of young plantations, notably Hatton Wood with European larch, Norway spruce (P.24), and older oak. The Woodhall Spa areas on sand were mostly open heathland, with *Calluna*, *Molinia*, bracken and scrub birch and oak. Also acquired were considerable areas of agricultural land, usually in a poor state after years of neglect; Hatton, Sotby and Horsington blocks are largely agricultural. Much of the land was ill-drained, the hedges were unkempt and there was often a dense growth of thorn bushes.

Acquired plantations.—European larch has grown fairly well but a high proportion of the trees are pumped, and there seems little chance of this species reaching maturity. Norway spruce is fair in growth away from the frosty regions.

There are some most interesting areas of mixed hardwoods aged about sixty years. The main species are oak and lime, which are mostly from coppiced stools, although a considerable number of maiden oaks occur. Lime is frequent all through Bardney Forest and must have been extensively grown at one time; it is said to have been planted to provide honey for bees. It is growing extremely well with the oak, and it will be interesting to see the final crop. Some birch and ash are scattered through the oak and lime, but in general they are very rough. There is copious ash regeneration on the forest floor, but this seems to fade away very early, and seldom reaches the small pole stage. Birch is growing to a good form on pockets of sandier soil at Birch Wood and Halstead.

Plantations made by Forestry Commission. *Oak* is the obvious choice of species for the clay areas, and has been planted on a larger scale than any other. It grows reasonably well at Bardney, but in the frostier areas and patches of dense grass vegetation it is slow to start, sometimes making very little growth for the first ten years. On less frosty sites, with lighter vegetation, growth is clean, rapid and good.

Ash is unsuited to Bardney; in practically every plantation failure is now apparent. The cold, wet, heavy soil and frosty conditions are against it. It forks badly and, although growing in some places to a small pole stage, it then begins to fade off and die back. Copious natural regeneration of ash on these sites is no indication of their suitability for successful growth.

Oak and ash have been planted together in many places. Alternate groups of the two species amongst coppice, with a total of 100 groups to the acre, have been planted in New Park. Rows of oak groups, five trees to the group, the groups nine feet from centre to centre, have been planted alternately with rows of single ash on more open coppice areas in Southrey Wood. In most cases the ash has failed.

Oak in groups of five to twenty-four trees, at the rate of 100 groups per acre, has been planted in coppice, or in a matrix of Scots pine or Norway spruce where the coppice cover was poor. On old agricultural land oak has

been planted in more intimate mixture with Scots pine, i.e., three oak and one Scots pine alternating along the rows, planted after ploughing and subsoiling.

Beech promises well in its early years ; but *Douglas fir*, which has been planted under hardwood pole crops on both clays and sands, is not encouraging.

Scots pine and *Corsican pine* have been planted on the sand at Woodhall Spa ; the Scots pine have been seriously crippled by an intensive *Evetria* attack, and the Corsican pine were destroyed by the construction of an aerodrome. On the clay, however, Scots pine grows vigorously and may be used as a cleaning crop to suppress the dense vegetation prior to planting oak or beech. *Norway spruce* planted under the birch scrub is fair.

Summary of Results. The growing of oak has been tried at Bardney under many different systems and conditions. Its growth is promising or good, but slow in the early years. Frost accounts in some measure for this slowness, by cutting back the current shoots and causing a bushy habit. I do not consider this, however, to be the primary cause. In my opinion, this initial period of slow growth (up to fifteen years for two feet), is largely caused by the bitter competition which the oak has to wage with the vegetation. These slow areas are usually in zones of very dense grassy growth, often *Deschampsia caespitosa*, but sometimes a mixture of other grass species ; they are also wetter, and frostier than the areas of better growth. Some trees have gone away with little check except frosting ; they have put on vigorous shoots, whilst those two feet away are still almost as small as they were when planted. Each plant seems to stand almost still until its roots have established superiority over the vegetation. Then it leaps into growth—frost notwithstanding. If this root competition is at the bottom of the business, it may be that well-rooted plants well planted (i.e., below the turf mat) are those which get away earlier than the others. The uneven growth is not so apparent on areas of light ground vegetation. Frosting however still occurs on many such sites.

Group planting has now been abandoned in favour of strip planting. Groups of oak in coppice, at the density of one hundred groups of nine trees per acre, have proved difficult and costly to maintain in thick coppice. When they reach coppice level (especially in low coppice, hazel, etc.) there are not sufficient trees to form a canopy ; height growth tends to slow off and the selection of final crop trees is limited. Groups in Scots pine or Norway spruce have similar drawbacks on this scale. Larger groups planted amongst conifers already at least four feet high might possibly derive benefit from the nurse, but where the two species are planted at the same time, little benefit appears to be derived by the oak. On less frosty areas the oak is just as good or better without a nurse at all. In coppice, strips of oak are much easier to maintain than groups, so long as a space is left unplanted between the coppice and the first row of oak.

Ash planting has ceased at Bardney, as all such plantings have proved failures. Beech underplantings of birch areas promise well, but to get the best growth of beech it is necessary to clear the birch before the beech is out of frost danger. It still remains to see how beech continues after this stage.

Protection. Fire. With the exception of Woodhall Spa area, this is not a dangerous forest from the fire point of view. There is a constant threat at Woodhall Spa to the coniferous areas in dry seasons, as it closely adjoins the town and many people visit the woods. Many of the hardwood areas are covered with lily-of-the-valley in the spring and there is some danger from the public lighting picnic fires, whilst collecting the lilies.

Insects. Plantations of Scots pine at Woodhall have suffered severely from *Evetria buoliana*, and the trees have been quite crippled. There are some indications, however, that they are slowly beginning to recover. They are also attacked heavily by *Cecidomyia baeri*, which causes extensive needle casting.

Fungus. On clay areas, Scots pine planted as a nurse to oak often suffers from *Melampsora pinitorqua*; this rust-fungus spends the other half of its life-cycle on aspen, which seeds and coppices abundantly on these areas.

Rabbits are frequent in coppice areas, but fairly easy to keep outside the netting fences. Owing to the wet heavy clay, there are few warrens, the rabbits lying out in dense ground cover.

Utilisation. The thinning of some oak and lime stands, about sixty years old, is now going on. The marking is done by the Forestry Commission, and the thinnings are sold standing. The out-turn is mainly in the form of pitprops. There are extensive areas of lime in this neighbourhood, and in many of the villages round about almost all the beams in the older houses are of this timber, and in such places it is hard and sound to this day.

Staffing and Employment. The forest is managed by a Forester who lives at one of the central blocks, with foremen at the eastern and western blocks. Labour supply is a difficult problem at Bardney. The area is thinly populated, and most of the villagers work on the farms. There is a huge sugar-beet factory and canning works at Bardney village, and a plastic factory at Wragby, which take most of the available labour. For the past two years about ten Polish workers have been regularly employed and have proved most satisfactory. The regular staff, including the Poles, totals about thirty. At certain times it is possible to have labour from agricultural camps to help with scrub clearing.

Other Features of Interest. One of the most striking features about the bird life of Bardney Forest is the abundance of nightingales in the summer season; each of the hardwood blocks has its population, and their singing is a delight to hear. There is a considerable variety of small bird life; the woods form a sanctuary for them in this intensively cultivated region. Nightjars are common and their eggs are often found during the weeding season. All three British species of woodpecker are found.

Bardney has a varied flora. The clay areas carry a vegetation of bramble, honeysuckle, primrose, lily-of-the-valley, anemone, dogs mercury and bluebell on drier areas; and *Deschampsia caespitosa*, *Juncus*, aspen, and sallow in wetter areas. On the sand is a flora of *Calluna*, *Molinia*, bracken, *Erica tetralix*, hard fern, and bog myrtle. The chalky areas towards the Wolds have a flora of wild strawberry, willow herb, bramble, centaury, orchis, and geum. Uncommon plants are meadow rue, *Campanula latifolia* (giant campanula), *Genista tinctoria*, butterfly orchis, yellow wort (*Blackstonia perfoliata*), *Ranunculus auricomus*, *Corydalis claviculata*, *Potentilla norvegica*, and adder's-tongue (*Ophioglossum vulgare*).

Rabbits and hares abound; foxes are common and breed in the forest. Badgers are not frequent. A few red squirrels still occur, chiefly in conifers about Woodhall Spa. Grey squirrels have not yet reached the forest but are reported within ten miles of it. Voles are numerous and often a nuisance.

WIGSLEY FOREST

Situation. Wigsley Forest consists of five separate blocks scattered between Newark-on-Trent and Lincoln City. It lies mostly in north-west Kesteven, the southern division of Lincolnshire, with some 250 acres in Nottinghamshire. It is bounded on the west by the Trent, on the east by the Witham, and on the north by the Foss Dyke. Newark lies three miles from the southern portion, and Lincoln is four miles from the northern block.

Area. Total 1,446 acres ; plantable 1,427 acres ; planted to date 629 acres.

Topography. The region around the forest is flat, with slight hills between the valleys of the Trent and Witham. The forest blocks themselves are quite flat. The region is bounded on the east by the Cliff, a bold limestone ridge about 200 feet high running due north through Lincolnshire from Grantham to the Humber. Average elevation of the forest is fifty feet above sea level.

Geology and Soils. The forest lies on Lower Lias sands, and clays of the Jurassic measures, with the exception of the north-west block, Wigsley Wood, which lies partly on the Triassic Series.

The soil is very variable. At Stapleford and Wigsley blocks clay is overlain to a depth of several feet by sand with a shallow pebble layer near the surface. On Stapleford Moor there is an extremely hard and thick iron pan about eight to fourteen inches below the surface. At Tunman Wood areas of sandy soil alternate with areas of heavy clay. At Skellingthorpe Wood the soil is a very heavy clay.

Drainage is often difficult. The water table is very near the surface on the low-lying areas, and it is difficult to get sufficient fall to lead the water away. The water table in some of the areas appears to be affected by the rise and fall of the river Trent. Drainage is to both Trent and Witham.

Climate Rainfall is in the region of twenty-six inches per annum, with frequent spring and summer droughts. Frosts are not a major problem, except at Skellingthorpe where hardwoods are liable to damage by late spring frosts. The prevailing wind is south-west ; the forest is not unduly exposed to gales.

State of Area when Acquired. Wigsley Wood, the first acquisition, dates from 1937, and has been added to at intervals since ; the main blocks at Stapleford were acquired in 1945 and form the most important part of the Forest.

Stapleford Woods, when acquired, were covered with derelict scrub, unfenced, and rabbit-infested, including a luxuriant crop of rhododendrons in thickets twenty feet high. There were some existing plantations of Japanese larch and Scots pine, with patches of Douglas fir, Norway spruce and Sitka spruce. These plantations were mostly planted in 1924, but some were quite young (P.37). In general they were poor. The Japanese larch had grown fairly well, but was beginning to die off ; in most areas it was very patchy, having been choked out by a thicket of natural birch. The Scots and Corsican pines were vigorous, but coarse.

Stapleford Moor had apparently never been cultivated, and carried patches of scrub birch alternating with wide reaches of pure *Molinia*. Tunman Wood was a thicket of hazel coppice, birch and bramble, typical derelict woodland. Wigsley Wood was in a similar state, but contained areas of *Molinia*. Skellingthorpe Wood was derelict woodland with poor coppice in the small pole stage. Several areas of poor agricultural land, adjoining the various blocks, were also acquired.

Plantations made by Forestry Commission. On the sandy areas of Stapleford, Wigsley and Tunman Woods, Scots pine and Corsican pine are being planted, as conditions are favourable for these species ; on the clay areas little planting has so far been done. Scots pine has been used on areas of dense vegetation as a cleaning crop, and grows well. Douglas fir has been underplanted both on sand and clay, under birch ; it is not encouraging on the sand, but promising on some of the clay areas. Norway spruce and *Abies* have been tried on a small scale, but are not good.

Oak has recently been tried on an experimental scale at Skellingthorpe on the clay, in intimate mixture with Scots pine. *Oak* seems a suitable species there, but it is difficult to assess the best method of establishment. Frost occurs in spring and there is a rapid degeneration of site when the coppice areas are cleared, leaving the young oaks to struggle with a dense mat of vegetation.

Before planting Corsican pine on the *Molinia* areas of Stapleford Moor, the area was sub-soiled and ploughed to rupture the pan. It was interesting to note the prolific growth of gorse seedlings on the upturned soil, on land which normally is devoid of all vegetation but *Molinia* and *Deschampsia flexuosa*.

Clearing rhododendrons at Stapleford Woods presents a problem. After many trials and experiments it was found least costly to winch out the dense clumps of rhododendrons with a tractor, and to cut the remaining scrub of birch, light rhododendron and bramble by hand. Considerable areas of young natural birch in dense thickets are being left to form a crop amongst the areas planted with Corsican pine ; birch grows to a very good form at Stapleford.

Protection. *Fire.* Stapleford Wood and Moor carry a high fire risk. The public frequent the area, and fires are often started in the scrub by picnickers, blackberry-pickers and smokers. Once a fire starts it frequently smoulders for a long time, owing to the thick layer of raw humus and surface peat.

Rabbits. The scrubby areas on sandy soil are a paradise for rabbits which breed nearly all the year round. As planting proceeds, and the boundary fences are extended, their numbers are steadily being reduced.

Utilisation. Thinnings have been carried out in acquired Japanese larch by outside merchants, after marking by Forestry Commission. There is a good market for small birch poles for brush-back making, and racecourses are supplied with bundles of birch twigs for making jumps.

Staffing and Employment. The area is run by a Forester, who lives at Newark pending the building of houses at Stapleford. There are two gangers, one at Stapleford, and the other at the smaller blocks. The labour supply position is difficult, and it is a slow business building up an adequate labour force. Local industries at Newark and Lincoln absorb most of the urban populations and the surrounding farmlands employ most of the rural people. The present staff numbers eighteen, but it is possible at certain seasons to obtain Displaced Persons or Irish labour from agricultural camps. This is especially valuable for the heavy task of scrub clearing.

Flora. There is a great variety of vegetation at Wigsley. On the sandy areas there are distinct zones of pure bracken, *Calluna*, natural birch, willow-herb, bramble, and *Molinia* communities. On the heavier soils a more typical hardwood flora occurs—hazel, dogwood, primrose, anemone, dogs

mercury, bramble, *Deschampsia caespitosa*, and honeysuckle. Wild daffodils and lily-of-the-valley occur in Skellingthorpe Woods.

Fauna. A host of small birds finds sanctuary at Stapleford Woods ; warblers and finches abound. Nightingales are plentiful in summer. Turtle doves and wood pigeons are numerous. Tree creepers are often to be seen on the wellingtonias at Stapleford, where they roost in the deep crevices in the spongy bark. Kestrels and sparrowhawks breed in the larches and older pines. Snipe are common at Wigsley Wood and Skellingthorpe. Greater spotted and green woodpeckers are often to be seen in the hardwood areas.

Rabbits, hares and foxes are common. Grey squirrels occur on a limited scale at Stapleford Wood. Voles are numerous in the rank grass at Skellingthorpe, and cause considerable damage. During hard weather they have a habit of climbing lime poles and gnawing the bark, at considerable heights from the ground.

BOURNE FOREST

Situation. Bourne Forest lies mostly in South Kesteven, Lincolnshire, but partly in Rutlandshire. It is made up of eight separate blocks in the triangle formed by the towns of Grantham, Stamford and Bourne. The Great North Road passes along its western limit at Twyford block.

Area. The total area is 2,500 acres : of this, approximately 1,600 acres have been planted.

Topography. This scattered forest lies on an upland plateau, dissected by shallow valleys, with a general slope from the west, around 400 feet, eastwards down to the edge of the Fens at about 500 feet above sea level.

Geology and Soil. The eastern blocks of the forest lie on the Oxford clay of the Middle Oolite measures, and the western areas on the Great Oolite limestone. Practically the whole region is overlain with boulder clay. The soil of most of the forest is a heavy clay, but there are lighter sands at some blocks, notably at Ingoldsbys Wood ; while lime fragments are found near the surface on parts of the western blocks. Drainage is difficult, on the lower flat areas, drains being frequent and deep, and flow slight. On the limestone areas, such as Twyford, drainage is by large sinks or swallow holes, very few drains leaving the forest.

Climate. Rainfall is about twenty-seven inches a year. Snow is not normally heavy. Frost is frequent, but trouble is not usually experienced from late spring or early autumn frosts except in the lowest parts of the forest. Gales are frequent in winter.

State of Area when Acquired. The original acquisition was that of Bourne Wood in 1926. The greater part of the ground carried a coppice growth of varying age and density. The timber was felled before acquisition and the ground lay derelict. Over some parts advance growth was not many years old, and there were a few stretches of open bracken. A few of the older scrub coppices contained some European larch about twenty-five years old. The scrub coppice contained the following main species : ash, oak, lime, birch, hazel, field maple, blackthorn, hawthorn, spindle, dogwood, and service. Some poor rough pasture land was also acquired ; this was in a neglected state and contained much thorn and bramble ; some of this land has been taken back into cultivation since 1939.

Plantations made by Forestry Commission. In the past the chief species planted was ash. Considerable areas of natural regeneration of this species were also accepted as a crop, gaps being filled up by planting. In Bourne Woods the ash was mixed with European larch, usually in alternate rows ; there are small areas of ash planted pure. At Pickworth and Kirby Underwood whole blocks of natural ash occurred and were accepted.

On the whole, the choice of ash at Bourne Forest has proved a mistake, for most of it has failed. It is not a tree suited to these cold heavy clays, and growth has been poor even where the trees have survived. At Bourne Wood it has grown best on a few tiny pockets of more loamy soil with a vegetation of light bramble and honeysuckle. On the bracken ground it has developed poorly, and in many cases failed completely. On the hazel, blackthorn and bramble areas it is extremely poor. In general it has suffered severely from frost, and is badly forked. On the natural regeneration areas, the ash appears to have faded out soon after its acceptance as the crop, since the growth is now little better than derelict scrub.

The European larch at Bourne Wood is also poor, and there are few areas of any promise. Douglas fir has been planted on a small scale at Bourne Wood, and at twenty years old is growing vigorously ; it has recently been thinned for the first time. Sitka spruce, planted on a small scale, has failed.

Oak is growing well on the few areas where it has been planted. It was formerly planted in the form of groups and lines in coppice, but it is now planted pure on the less frosty areas. A large stretch of old pasture land was planted with oak and ash after subsoiling, and some parts were sown with acorns. Despite heavy early damage by voles, the oak is promising ; the ash has failed. Beech underplanting is promising. Black Italian poplar has grown well on selected sites. Natural birch grows well on patches of lighter soil and lime coppice flourishes.

During the last few years, planting at Bourne has been restricted to oak, Douglas fir and beech, all of which show promise.

Protection. *Fire.* Fire danger is low. This is predominantly a hardwood area on heavy wet clay, the vegetation is not normally dangerously inflammable, and there are no railways through the plantations. Nevertheless as Bourne Wood is much frequented by the townspeople of Bourne vigilance is necessary at danger seasons.

Mammals. Rabbits are a nuisance, as the old scrub areas form ideal cover for them. They are difficult to control in the dense blackthorn owing to their inaccessibility to dogs and men. Voles are abundant on the grassy areas, and have done considerable, though only occasional, damage to young oak. Grey squirrels are common. Deer are found at Pickworth and Little Haw Wood, but are not numerous enough to cause significant damage.

Utilisation. Most thinnings are done by outside contractors after Forestry Commission marking ; such operations have so far been on a limited scale. Of recent years it has been the practice to sell standing coppice to local merchants preparatory to planting. The difficulties of labour supply, and the high expense of clearing such areas ourselves, make this a most helpful method. First, a fencing and pole merchant takes all the better grade material which requires a licence, and then firewood merchants deal with the remaining scrub.

Prices paid for such areas range from £5 to £15 per acre ; the merchants agree to clear everything down to about six inches stump height, and usually finish cutting well before planting commences. There is a ready market for all kinds of stakes, binders, bean and pea rods ; and small birch poles are disposed of for brush-back making at £1 per hundred lineal feet.

Staffing and Labour. Bourne Forest is at present staffed by a Forester assisted by two Foremen. One of the Foremen supervises the western block, and the other the eastern areas. Labour is in short supply ; the average is fifteen men. This number is inadequate to deal with the large amount of work to be done on areas as yet untreated. The difficulty is offset to a considerable degree by contracting with merchants for scrub clearing and thinning. The labour shortage limits progress at Bourne.

The reasons for the dearth of men are lack of accommodation, the thinly-populated countryside, and the fact that the forest is centred in a rich agricultural region where men work on the farms by tradition. Plans for new houses are being prepared.

Other Features of Interest. The various blocks differ widely in soil and flora ; conditions range from the heavy sodden clays bordering the Fens, with deep sluggish drains and jungles of blackthorn, to the dry lighter soils of the limestone plateau with its swallow holes and typical calciphilous flora.

The flora is rich in species not common in Lincolnshire. On the limestone may be found *Anemone pulsatilla*, *Daphne laureola*, butterfly and pyramidal orchis, rock-rose, viper's bugloss, service tree, spindle-berry, and carline thistle. The area of Pickworth and Little Haw Woods is especially interesting, and the famous Clipsham Quarries at the former have a wealth of rare plants. On the lower clays there is quite a different vegetation of bracken and brambles. Unusual plants may be found here too, such as wood vetch, wood pea, giant and nettle-leaved campanulas, and *Genista tinctoria*. The woods form a last sanctuary for such plants in an intensively cultivated countryside.

A few hooded crows winter here, but they are not common.

Clipsham Quarries adjoin one of the blocks, and in fact work is now being extended into the forest as the seam of limestone is followed farther and farther afield. The stone quarried is a warm buff-coloured oolite and has recently received publicity by being chosen for the rebuilding of the House of Commons.

SOME OBSERVATIONS ON THE HALWILL MOORS, DEVONSHIRE

BY C. R. WELLINGTON

Forester, South-West England

AFFORESTATION WORK has been carried out by the Commission on the moors of south-west England, continuously since 1921. Roughly, the area is bounded by Okehampton on the east, and runs north-west towards Hartland Point, including the older forest areas of Halwill and Hartland. A general description for readers not conversant with this part of the country will perhaps assist them to form a picture of the areas discussed.

Elevation : 250 to 700 feet, with small and gradual rises. The planted moorlands are situated in the low lying land at elevations about 300—450 feet.

Soil. Clay loam, with stiff yellow clay subsoil of one to two feet in depth, again underlaid with blue clay up to thirty feet deep. The top clay loam varies from five to eight inches on an average, becoming deeper by alluvial action near brook sides. There is an almost complete absence of stone, except for a small layer of shillet at the higher levels around the 600 feet contour. These conditions result in severe waterlogging in the rainy season and quick drying out in droughts.

Rainfall. 50—65 inches per annum.

Exposure. Subject to severe Atlantic gales from westerly directions. These are extreme, of course, on the coast at Hartland Point.

Flora. The general flora consists of an admixture of *Molinia*, *Ulex nanus*, *Calluna* and *Erica*, with sparse patches of *Ulex europaeus* and *Salix repens*. (This last is a dwarf willow indigenous to the South-west, which has very small leaves, grows to a height of two feet, and has very long underground roots, sometimes reaching as far as twelve yards, strong enough to hold up a power plough).

Bracken on the moorland types is unknown, except for a few isolated patches occurring on higher ground or on short slopes. Rushes are plentiful. Pure *Molinia* only occurs in a few peaty pockets.

Past History of Land. About nine-tenths of the land afforested (and a few odd plantations re-afforested after one crop only of pitwood size) was ploughed and cropped in the agricultural boom around 1880. Ploughing was done with the "batt" method of six furrows each way, thus making regular gutters at every six feet for the water to run off. During the subsequent slumps most of the lower-lying and wetter land went out of cultivation. During the late war a considerable acreage was reclaimed by the Devon War Agricultural Committee and also by private owners, and sown to oats; potatoes were also grown on the drier slopes. After a period this reclaimed land reverted to a rush vegetation, no doubt brought about by the action of deeper ploughing and the destroying of the old batts (or drainage channels), thereby retarding the flow of top water.

Progress of Plantations. I will try to convey a picture of progress at Halwill Forest, by a group of years set down as to species used and their accommodation to the conditions. Forestry being a long term business, success and

failure take time to assess. When dealing with difficult conditions for afforestation, especially in the initial stages of the Commission's work, failures were bound to occur on marginal types of forest land.

Date of Planting	Species used	Preparation of Ground	Remarks
1921	Sitka spruce, Norway spruce, Scots pine over a small area.	Flat planted with mattock and spade; some hand drainage done to bogs and wetter areas.	Small patches on <i>Molinia</i> ground good, up to 750—800 cu. ft. per acre; variable results; growth 60 ft. down to 3 ft.
1921-1924	Sitka spruce, Norway spruce. On the drier patches: Scots pine, Japanese larch, European larch.	Flat planted with mattock and spade; some hand drainage to bogs and wetter areas.	Individual patches on <i>Molinia</i> / <i>Juncus</i> peat pockets very good. <i>Ulex</i> / <i>Calluna</i> areas very poor; growth slow, some areas as little as 3 ft. E.L. was a complete failure.
1925	Norway spruce, Sitka spruce. Few acres S.S./D.F., mixture. Douglas fir. Mostly pure 60 acres in all.	Flat planted with mattock and spade; some hand drainage in wet soaks and bogs.	S.S./D.F. mixtures on dryer slopes very promising. Old woodland sites, S.S., N.S. very slow. D.F., where pure, complete failure, later replaced with S.P.
1926-1928	Norway spruce, Sitka spruce, Scots pine, Corsican pine, Douglas fir.	Flat planted with mattock and spade; bogs and wet soaks hand drained.	Spruces on <i>Molinia</i> / <i>Juncus</i> type flora growing well. S.P. on dryer <i>Ulex</i> / <i>Calluna</i> type, good growth up to first ten years, now falling off. C.P. failure, promising for first 5 years, subject to <i>Armillaria</i> .
1929-1930	Norway spruce, Sitka spruce, Scots pine, European larch, Douglas fir.	Flat planted with spade and mattock; bogs and wet soaks hand drained.	50 acres S.S., N.S., and S.P. planted on furrows, horse ploughed. Indifferent growth, some still in check. Good growth only on peaty <i>Molinia</i> bogs. <i>Ulex</i> / <i>Calluna</i> area still in check. D.F. on drier sites too exposed; soils too shallow; not successful. S.P. good initial growth but falling off.
1931-1933	Norway spruce, Sitka spruce.	Planting in mounds generally adopted; turf drains and mains cut by hand.	Condition varies with flora, plantations on <i>Molinia</i> / <i>Ulex</i> type showing promise. <i>Ulex</i> / <i>Calluna</i> areas in check.

Date of Planting	Species used	Preparation of Ground	Remarks
1934-1948	S.S. and N.S., pure ; N.S./S.P. mixture ; N.S./Lodgepole pine mixture ; Hemlock pure, L.Cyp. „ J.L. „ <i>Picea omarika</i> pure, White spruce pure.	Power ploughing from 1934 onwards, varying in depth. (a) Ransomes S.F. Major. (b) Oliver 218 B, Double furrow. (c) R.L.R., Single furrow. (d) Massey Harris Grub breaker. Depth ploughed respectively : (a) 7—8 inches. (b) 7—8 inches. (c) 12—14 inches. (d) 12—14 inches.	Plantations formed on the upturned furrow. Results vary considerably, from very badly checked to vigorous growth. Establishment still seems to be affected by soil conditions indicated by the original flora, irrespective of the depth of cultivation.

Observations. The progress of the earlier plantations has been very irregular. It was hoped that the shelter and root action of the advanced patches would eventually close the gaps ; this is happening on some areas where sufficient of the crop has established itself, but on areas where the majority of plants went into very bad check, other species have been interplanted in an effort to make a canopy.

The forest generally, owing to its damp shallow soils, is essentially a spruce area, but even with the advent of drainage by furrow ploughing, spruces do not show the improvement in growth which would normally be expected.

Growth from planting onwards. Observations on the behaviour of the plants after planting are interesting. For the first few years after ploughing the trees maintain a normal growth and colour ; some six months later dwarf gorse (*Ulex nanus*) commences to germinate at the edges of the furrows ; as the gorse increases in height the tree gradually loses annual growth and colour ; and finally goes in check.

It is worth recording that on damp shallow soils which before ploughing carried a mixed vegetation of *Calluna*, *Ulex nanus* and *Molinia*, *Ulex nanus* is now the dominating plant ; its dense spreading action has shut out most of the former flora. Under these conditions the trees invariably check.

There appear to be three main types of land included in the plantings after ploughing, which took place from 1934 onwards. These vary in their previous history, ground flora, and the results of afforestation as follows :—

- (a) Land resumed for agriculture (temporarily) in the war of 1914-1918, which had since reverted to a *Juncus* vegetation.

Result of planting : very good, with good growth and uniformity. Preparation of ground was by the method of single or double furrow ploughing to a depth of seven or eight inches.

- (b) Land farmed in 1914-1918 war, but gone a stage farther back to the original plant association with more *Calluna*/*Molinia*/*Ulex nanus* mixture type of vegetation.

Result : some check ; not so good as type (a) but looking to date as though a stand will result.

- (c) Land of moorland type with no cultivation since the eighteenth century.

Result : Very dense *Ulex nanus* with bad check of trees.

Preparation and results are briefly—(A) For Spruces :

- (1) Ploughed by single or double furrow type, going to a depth of seven inches. Very badly checked on *Ulex* types, any growth present being in soaks with a *Molinia* or *Juncus* flora.
 - (2) Ploughed by heavier and deeper cutting ploughs from one foot to fourteen inches in depth, since 1941. Promising on *Molinia-Juncus* type of vegetation, but check on *Ulex* type.
- (B) For Pines—Normal growth throughout.

Discussion. Going back to my remarks on the absence of check, better growth, and uniformity shown on land which was formerly (but only temporarily) used for agriculture, readers may assume that the manurial factor has contributed to the benefit of growth. On such shallow soils, after two or three straw crops and subsequent leaching over from six to ten years, any manure would have by this time been used up. Recent soil analyses have confirmed this.

If an aerial photograph were taken of the forest as it is to-day, it would show up as a patchwork, with extremes of growth coinciding with changes in ground vegetation.

To a forester whose work has been more with afforestation of scrub and coppice areas, where incidentally the same difficulties of establishment do not arise, it really means beginning the study of tree life and growth in relation to soil and ground flora all over again.

An experiment in adding phosphates to deficient soils, in the form of basic slag, was tried out at this unit in 1929. The result is very interesting, in that the slag produced the desired effect on the spruces but unfortunately on the vegetation also, with the result that the *Ulex* vegetation thrived and monopolised the soil, resulting, in the end, in checked forest trees.

Suggestions for Future Afforestation. I would suggest that land be clean ploughed to a depth of not more than seven inches, left open to winter frosts, summer disced, and ridged up in the following autumn before planting. The advantages to be expected from this treatment are :—

- (1) Weeding would be almost eliminated.
- (2) Existing flora would be checked over a period sufficiently long for the plants to make canopy.
- (3) Fire danger, which in this type of land is very acute, would be greatly reduced.
- (4) Management would be very much simplified, i.e., extraction and thinning, as contrasted with deep ploughed land.

There is a risk that in very heavy clay deep ploughing will not weather sufficiently ; as an example, the batts of four-inch work of the eighteenth century, open to all the effects of the weather, are still plainly visible. Furrows cut in heavy clays quickly grass over and bind.

In 1943 a small experiment was made of clean ploughing with a deep-ploughed control on similar type land. The land was disced down direct, and flat planted, with hand contour drains at intervals ; unfortunately the job was

too hurried, and insufficient weathering and discing was done. However the plants look more promising so far than those on the normal ploughed control area. An interesting point is the line of *Juncus* running down each row which was given two ounces of basic slag per plant. Between the rows *Erica* is reappearing, but not in profusion. However, the high initial cost of clear ploughing, cultivation and drainage, is a disadvantage.

Notes on Mixtures. A mixture of Norway spruce with lodgepole pine was introduced from P.37; the pine has overgrown the spruces, which are practically an undercover. It looks quite probable that many trees of the nurse crop will have to be eliminated by ringbarking; the spruce crop looks more healthy than pure spruce on similar type land. It is important in this mixture to use Norway spruce, owing to the very rapid growth of the nurse trees.

Scots pine/Norway spruce Mixture. Scots pine not so fast as lodgepole pine. Plantations of pure Scots pine have gone back after seventeen years; this species does well in young stages, and will probably produce the desired effect of getting the spruce crop established.

Sitka spruce/Lawson cypress mixture. Too early to form an opinion as to establishment; spruces generally in check. Lawson cypress proving most accommodating on the worst types of vegetation. There is general evidence that this species can be used more extensively as a nurse on poor types.

Notes on less usual species. *Picea omorika* is a failure. Will not stand up to the rank vegetation found in this district, and appears frost tender under our conditions.

White spruce (P. glauca), not used very extensively, but looks very promising to date and is much faster than Norway spruce in its younger stages; very frost-hardy.

Western hemlock (Tsuga heterophylla). Planted on former agricultural areas which had reverted mainly to *Juncus*, has done exceedingly well.

Further Observations. There is a possibility that with very close planting, say three feet by three feet on ordinary furrow ploughing, the plants would make sufficient early growth to shut out the dense flora and become established at an earlier date. Generally, from the results of clean ploughing so far, I would prefer this method.

N.B. Dwarf gorse or furze (*Ulex nanus*) is commonly found in south and south-west England and is of shorter growth than *U. europaeus*. It is of a dense spreading nature, and in its advanced stage becomes a complete mat. It blooms in August, September and October, and after a mild winter also blooms in early spring.

THE BLACK WOOD OF RANNOCH

BY A. WHAYMAN

Forester, East Scotland

THERE STILL REMAIN in Perthshire approximately 670 acres of native pine woods, which according to the *New Statistical Account of Scotland*, 1838, "is considered as part of the old Caledonian Forest which at one time extended from Glencoe to Braemar, a distance of not less than eighty miles, and from Glen Lyon to the Spean, Loch Laggan and the Spey, comprehending a tract of mountains, glens and morasses and blue lakes of upwards of 2,100 square miles."

This remnant of the ancient forest is called "The Black Wood of Rannoch," doubtless because of its sombre appearance. The part of Perthshire in which these native pine woods are to be found is, according to the *First Statistical Account* (1791), "highly elevated and the air is uncommonly moist, damp and cold."

The Black Wood of Rannoch, which is in the parish of Fortingal, lies on the south side of Loch Rannoch (the *slios garbh* or Slisgarrow, the rough side, to distinguish it from the gentler and smoother slopes of the north side or *slios min*). The woods stretch from the lochside at 670 feet to about 1,000 feet above sea level, and are approximately five miles west of the village of Kinloch Rannoch. As far as is known, there are no signs of habitation by humans within these woods, although they are bounded on the west by Camghouran and on the east by Carie, both former crofting communities. It seems quite certain, however, that fugitives from justice found sanctuary within its ample coverts.

The inhabitants of the Black Wood in bygone days were the wild boar, the wild cat, red deer, roe deer, the marten, the polecat, the badger and, of course, the wolf. It is possible that the elk and the white Caledonian cow at one time grazed in these woods. No wolves, wild boars, martens, or polecats are to be found in the Black Wood nowadays. Rabbits, mountain hares, squirrels, red and roe deer, wild cats and sometimes foxes can be seen. The usual woodland birds of the region are to be found and in addition the capercaillie, although once extinct, has once more been breeding in these woods.

Local tradition has it that it was at Rannoch and not Lochaber that the last wolf in Scotland was killed. It was killed, so the story goes, with a potato masher by the wife of a miller when it was attempting to steal her child. She was handsomely rewarded and the mill was given the name of Mulinvaddie or "the mill of the wolf." The Rev. John Sinclair, who was a local historian, claims that, as potatoes were not introduced into the Highlands until the 18th century, this explodes the claim of Sir Ewen Cameron of Lochailort to have killed the last wolf in 1680, and transfers the honour from Lochaber to Rannoch.

Robert the Bruce and his men doubtless knew the Black Wood, for it was one of his followers, Duncan the Fat, who by his marriage to a daughter of the Earl of Lennox became the first Robertson chief to own land in Rannoch. One of his sons, Thomas, got a charter of the lands of Struan from Robert III in 1398, and these lands were entailed by him in the family of his elder half-brother, Robert of Atholl. One of Robert of Atholl's sons, Duncan of Atholl

and Lord of Rannoch, was one of the hostages sent to England for the ransom of James I in 1432. It was from Robert, one of Duncan's sons, that the Robertsons of Struan sprang, having lands in both Struan and Rannoch. For apprehending the murderers of King James I (of Scotland), he was given a grant of his estates in 1439.

The Black Wood was part of the Robertson possessions which were sold to the Wentworth family in 1857, and which was bought by the Forestry Commission in 1947. 200 years previous to this, the Black Wood was first in State hands when, from 1749 to 1784, the estate was run by "The Commissioners of Forfeighted Estates and Barons of the Exchequer."

It is interesting to speculate as to why there should be, at Rannoch, a remnant of the old Caledonian Forest.

Scotland in early times could be roughly divided into two parts, one scantily wooded with some cultivation, and the other covered with forest and morass, having little cultivation. The people hated trees which they struggled to eliminate from the ground they wanted to cultivate. The forests also harboured wolves and other enemies of their flocks. Legislation was passed to try to improve and preserve these forests. We find, for example, that King James I ordained that persons would be fined forty shillings who "steallis greene wood or peallis the bark off trees or destriciard woodes." And in 1457 all holders of land from the King were told that on Whit-Sunday "all their tenentes (must) plant wooddes and trees and make hedges." Vast areas were set alight to destroy trees, and in 1503 legislation was passed imposing a fine of £5 "for those who make muirburn after March."

In spite of the apparent need to preserve trees in other parts of Scotland, there must have been no such need to protect the trees from the inhabitants of Rannoch, rather did the trees of Rannoch protect the inhabitants of that district. Mr. Ramsay, who was factor for the Commissioners of Forfeighted Estates from 1749 to 1751, said that Rannoch was "a part noted for barbarity, thieving and rebellion." The Rev. Macara also wrote in the *First Statistical Account of 1791* "before the year 1745, Rannoch was in an uncivilized, barbarous condition."

Macara also goes on to describe how the bands of freebooters from Rannoch extracted "black meal" from inhabitants living between Stirling and "Cupar of Angus" to save their property from being plundered. A Gaelic proverb refers to an outlaw as *Cheann fo'n choille* or "the man whose head is in the wood." Rannoch had plenty of outlaws and therefore trees.

Very little authentic information is available about Rannoch before the 18th century, although there is reason to believe that there was a sawmill at Rannoch belonging to the Robertsons of Struan in 1695. The Robertsons, although popular landlords, did not do much to improve their estates; they were on the whole content to live off the natural resources of these estates. The timber from the Black Wood was in great demand for building and furniture because of its durability, and must have been quite a source of income to the proprietor.

Alexander Robertson, the 13th Chief of Struan, after his return from his first exile on the Continent, did do something to improve the husbandry of his estate, but did not do anything for the woodlands except to use them as a source of income. In 1732 there is a record of a hundred trees of 20 feet long being sold to the laird of Logiealmond. It was requested that "your wright, or who else ycu please, were here to prevent any mistake; for the

trees of that length must be cut on purpose." In the following year (1733) Struan also supplied wood for the building of General Wade's bridge over the Tay at Aberfeldy. The roof of the present church at Amulree was constructed from timber which had been used at this bridge. Many of the tenement houses built in Perth after the '45 used wood from the Black Wood in their construction ; it was also used in Commissioner Street, Crieff.

After the death of the 13th chief in 1749, the estate was taken over by the Commissioners of Forfeited Estates, and it is from the records of these commissioners that we obtain most of the information about the Black Wood. The income from the estate was largely used for improving the conditions of the people, by introducing trades and tradesmen, and building roads and bridges. Soldiers were sent to garrison the area and, after some hangings, Rannoch settled down to a period of comparative agricultural development and rural prosperity.

In 1751 there must have been a " Fir Wood of Carrie " as it was let for three years to cut 2,000 trees at a rent of £350 ; but it could not have been very important, for in 1755 Ensign James Small, who had the previous year been appointed factor, states that there was " an immense deal of birk and alder," but the only valuable timber was that of " fir woods and called Black Wood of Rannoch."

In 1756 there was a request from a Captain James Stuart for timber to build a boat on Loch Rannoch for " transporting meal, firing, etc., for the use of troupes in that district. The one that was built at the expense of the government being decayed and used up."

About this time a start was made to enclose the Black Wood, and in 1759 a mason was employed in building a dyke. Four years later the factor, in a report, states that " Above 30 men employed, enclosing the wood with a Pealing." He goes on to say that " meal and works so dear " he could " get no workmen under 8d. a day."

In this same year, 1763, there was a fire which was got under control by the prompt action of one Isobel Cameron. She was coming from Glen Lyon, saw the fire, ran some miles and gave the alarm. For " her earnest and anxious service " she was given 10s. by the factor. The cause of the fire is one, which is, alas, still too common even yet :—

" Some idle boys and herds carried fire early one morning to the back of the Black Wood and there kindled a mureburn and went home."

There is a further report of another fire in 1765, which is so similar to the previous one that it might even be the same one. In a letter written by James Small, the factor, on 3rd June, 1765, it is stated that " Fir woods set on fire on Saturday last and if it had got leave to spread 20 yards further some hundred thousand trees would have been destroyed. The whole of the best part of the woods would have been lost had not a servant girl, who was sent on an errand by her mistress, hastened to give the alarm. The weather was so dry and the fire took such a hold that it took a number of people 24 hours to extinguish it. About a hundred trees destroyed had ventured to reward girl with a crown, but if proprietor would give more making every possible enquiry for guilty person."

In 1763 two offers were made by Sir Robert Menzies for a " tack " of the land and woods of the " Slisgarrow." £125 sterling would be paid for the Fir Woods. He also offered £200 per annum for permission to cut 1,000

trees annually. He stated that 1,000 trees is all that could be afforded to be cut from the Black Wood and gives as his reason—"There was in Glen Lyon in the neighbourhood a very great Fir Wood, which by extending the haggies (yearly cuttings) to a greater extent than it could bear, is now quite exhausted." Because another party thought that the wood could afford to cut 2,500 annually, his offer was not accepted.

Evidence of some sort of protection and management of the Black Wood being undertaken is given in a report by James Small, dated 1765, who comments on "The fine appearance of young firs in lately enclosed grounds in Black Wood." He further goes on to say that it will be "necessary by enclosure and herding to hinder cattle from pasturing on ground till the firs are above being hurt."

The proposed enclosing of the whole of the Black Wood and the exclusion of the crofters' black cattle from it caused some misgivings, especially to those of Camghouran. In a petition sent by them to the Commissioners of Forfeited Estates it is stated that "the petitioners mean not to dispute that posterity may eventually be benefited by the proposed inclosure of the whole of the wood, but the immediate consequence of it must bear exceeding hard upon the petitioners and their families." Some sort of agreement must have been reached, as is shown by the boundary of the Black Wood, there being still a few scattered clumps of old Scots Pine outside the enclosure.

In 1783, £20 was given to John Cameron, forester, with "power to employ men of his own repairing fences, gathering cones, winning and sowing fir seed and cutting away birch to make room for young firs." This same John Cameron wrote to Edinburgh, saying that the wages of the two men he was employing could not be less than £20.

The letting of the cutting rights of the Black Wood throws some interesting light on the affairs of Alexander Cumming, a tacksman, who had either too much or not enough. In 1733 he is "a great loser by his tack of the woods" and says that he will give up unless he is limited to a 100 trees a year and the price reduced fifteen shillings sterling per ton. Three years later he asks for at least 15 tons of wood for "unless this is granted he might lose the Earl of Breadalbane, the first, or second best customer the fir wood ever had, as unless his commission was answered his servants would go to Perth for foreign timber."

In 1784 the "tack of the fir woods, sawmill and house" was given to John Robertson of Tulliebelton, Merchant and Provost of Perth, "to cut 2,000 fir trees yearly and no more, for the space of three years, and for the tack duty of £350 sterling."

In the same year, a request was made by Robert Campbell, the sawmiller, for a house to be built at Dall costing £21 10s. 6d. This was to be "a public house wherein he could lodge and entertain his guests." This request seems to have been granted, for at all events there was a public house at Dall, not far from the present hostel and near the old sawmill which, incidentally, is still standing. The mill, which was water driven, seems to have had some form of frame saws, and the pits which were used for hand sawing were only recently filled in.

About this time the estate was handed back to the representative of the original owners. The population of Rannoch at this time was much more than it could support, and consequently many of them had to seek a livelihood elsewhere. This exodus was also helped by the policy of the Barons

of the Exchequer of evicting tenants to make room for larger farms. The introduction of sheep farming and the fact that sheep farming, apart from being more profitable than arable farming, needed less labour, all made up the picture that is all too familiar in the Highlands.

At the beginning of the 19th century a public company from the south bought the Black Wood from the Robertsons and started felling operations. Transport was their great difficulty, but labour was plentiful and cheap. To offset the transport difficulties, an elaborate system of canals was built within the Black Wood. Into these canals the timber was thrown and was then man-handled into collecting basins. Three levels of canals and collecting basins can still be seen today. From the collecting basins the logs were sent down a shoot to the level below and finally into the loch. Many of the logs, because of their weight and also because of the speed at which they entered the water, stuck in the bottom of the loch. It is said that some can still be seen lying at the bottom of the loch, but the writer has not seen any of these logs.

After entering the water, the logs were bound into rafts and floated down to the end of the loch, where there was a sluice gate of some kind to prevent the rafts going down the river. The remains of the sluice were visible until the exit from the loch was drained in the hydro-electric constructional work which was carried on in 1931. It has been stated that the timber was floated down the Tummel in rafts, but it is more likely that the rafts were broken up at the end of the loch and the trees sent singly on their way to the Tay via Loch Tummel. Free logging rather than rafting is the more likely way that these logs were taken to the Tay, but once the Tay was reached then rafting might have been possible, and it certainly would have been necessary below Perth. The final destination of the logs was supposed to be Dundee, but many of these rafts crossed the North Sea and were to be found on the coasts of Holland and Denmark.

When one considers all the difficulties with which the scheme had to contend, it is not surprising that it was abandoned owing to financial losses, for a high proportion of the logs felled must have been lost before they reached Dundee. The company, however, did provide work during very difficult times when conditions in the Highlands, due to potato disease and poor harvests, were very bad. Food was supplied to the workmen and soup kitchens were opened. There is a knoll at the top of the Black Wood known as the "knoll of the soup."

In 1895, not long after the Black Wood had become the property of the Wentworth family, deer forests were formed and the Black Wood was again enclosed. This time it was to keep deer in and consequently not many young trees were able to survive. At the present time the absence of young trees is one of the most noticeable features of the Black Wood.

With the advent of the West Highland Railway, the Black Wood again played its part in improving the communications of Scotland. A sawmill was set up by the side of the road near Inniscalden—an opening in the Black Wood—and over a thousand trees were cut and used in the building of this railway. The present system of roads in the Black Wood was made towards the end of the 19th century, and many of them follow the line of the old canals, being built in many cases on the side of them.

Although plantations were made on part of the area of the Black Wood that had been felled, no real silvicultural operations were carried out in the Black Wood. It was essentially a sporting estate. Numerous young

trees from the Black Wood were planted in other parts of the Dall Estate, and the curious practice of building a kind of dyke around the plant to prevent it from being blown over was adopted.

Labour being cheap and the material being literally on the doorstep, it is not surprising to find that in 1856 improvements including panelling with Scots pine were carried out at Dall House. An hotel, the Loch Rannoch Hotel, was built by the proprietor of Dall and timber for its building came from the Black Wood.

The Great War of 1914-1918 found the Black Wood a little depleted but still standing, and in 1918 it was scheduled to be felled. The cessation of hostilities in the same year came as a reprieve for the doomed woodland. From 1918 until the outbreak of another war in 1939, the Black Wood was regularly cut over, the wood being used for estate purposes. It is safe to assume that on the average about 350 trees were cut annually to supply local needs. At this time deer and other enemies of trees, including hares and rabbits, were allowed to multiply ; as no endeavour was made to exterminate these pests, not many young pine managed to survive, and this is, in my opinion, the reason that one does not find many trees younger than sixty years of age in the Black Wood.

One will, however, find trees of between six and eight years old which have managed to survive owing to the migration of deer to Glen Lyon ; the migration being caused by the manoeuvres, live firing exercises, etc., of the troops that were stationed in the district during the 1939-45 war. The war of 1939-45 took its toll of woodlands and this time the Black Wood was not so lucky. The Canadian Forestry Corps set up a mill near Dall and "creamed" the Black Wood, leaving a small portion of it untouched. In this part one can still see very fine timber trees. The wood, however, consists for the most part of open, heavily branched trees.

Whilst not attempting to describe the Black Wood in its present state, it is interesting to observe that there appear to be three distinct types of trees :—

- (1) Heavily branched with a beech-like habit.
- (2) Tall spire-like habits with short horizontal branches.
- (3) Smooth-barked, clean-stemmed, with a fine straight bole.

It may be that the prevalence of the first type of tree is due entirely to the fact that it has always been left, preference being given to a better timber tree during the many times the wood has been cut over.

Experiments are, however, being conducted to discover if there are three distinct types of trees, and to ascertain if the different traits of these types are hereditary or just the result of environment. The wood has again been enclosed and in 1948, like 1758, it is to protect the young trees and to prevent them getting damaged by game, sheep or cattle, that the fence has been erected.

It is hoped that by careful management the Black Wood may regenerate itself naturally and that there may be in Rannoch, for all time, a fragment of the old Caledonian Forest.

MILLBUIE FOREST, BLACK ISLE

BY W. MACKAY

Forester, North Scotland

Millbuie Forest, situated in the east end of the Black Isle, was acquired by the Forestry Commission in 1936. The first tractor ploughing was done in 1937 and planting commenced in F.Y. 38.

The Forest extends to roughly 6,000 acres (more or less all plantable). By the end of F.Y. 49 over 5,000 acres will have been planted. The area has more or less been ploughed by Caterpillar tractors and the main species planted was, and still is, Scots pine. Japanese larch has been used mainly for fire belt purposes. Within the last few years trials have been made with Douglas fir. When ploughing commenced in 1937 a Ransome double-furrow plough was used. This, however, was unsatisfactory, as the plough only gave a depth of six to seven inches. This plough was given up and the Uni-trac No. 2 single furrow was used with more satisfactory results. It gave a furrow of ten to fourteen inches in depth. I may mention that this plough was strengthened by that great plough expert—Mr. K. MacKenzie, Evanton—and did good work for us for many years.

I have seen many types of ploughs at work on forest lands in the Black Isle, but I am of the opinion that so far the Haddington and Solotrac ploughs can do the job quite satisfactorily. This, of course, refers to the Black Isle and Millbuie forest in general, where thousands of acres have been ploughed since 1937.

Newhall area was the first part of Millbuie to be acquired ; this area extends to about 2,000 acres. The vegetation here was mostly *Scirpus* and heather. The land was more or less waterlogged, and I understand it was used as a grouse moor and so far as I could see very few grouse at that. Today one can see thousands of acres of healthy pines growing on land that, to my knowledge anyway, produced nothing or next to it.

There was a gullery on Newhall moor at that time, but during the last few years the gulls have disappeared. As the young trees grew up the gulls had to find a fresh home. The gulls made their nests on this land and during the war years their eggs were sought after by many.

To the stranger the Black Isle would sound to be an island. This is not the case, however, the Black Isle is in fact a peninsula about thirty-two miles long by two to ten miles wide. The forest lands runs through the top or ridge, with arable land to the north and south side. This top ridge is called Millbuie, and means in the Gaelic "yellow ridge"; but I think this name could be altered now, and called "green ridge" which is more appropriate to forestry and its workings.

CWMOGWR FOREST

BY MISS LILIAN M. JONES

Temporary Tracer, South Wales

AS PART OF the Staff Training Scheme in the South Wales Conservancy, I was enabled to make a closer acquaintance with a forest, and my impressions of a day's visit under expert guidance to Cwmogwr Forest are compressed into this short note.

After a very pleasant journey via Llantrisant and Cwm Ogwr Fach, we arrive at the base of operations—Glyn Ogwr. Here, Miss Copp and myself are introduced to Forester Brown who, with Mr. Slow, while on their tour of inspection, will try to enlighten two very green "freshers" into the Commission on how a State Forest is worked.

Soon we are on Forestry Commission land, walking through Cwm Dimbath, after which this part of the forest is named. And now I am being introduced to two-year-old specimens of Norway spruce and Japanese larch. Prior to this my knowledge of species was a meagre S.S., J.L., or N.S., etc., confined to a field map. The planting of species in relation to their habitat is now explained. Owing to their hardiness Sitka spruce and Scots pine are planted on high bleak places, but where the ground is moist and damp Norway spruce is substituted. A fine example of this is pointed out to me. Before us, on a slope, is a P.39 area with Scots pine and Japanese larch. It looks like a weird and wonderful camouflage design, with the broad patches of blue-black interspersed with the reddish brown of the larch. However, the nature of the ground is very apparent. Yet another example of species and their habitat is pointed out in two-year-old Norway spruce planted on a slope. They are all flourishing until they contact heather-clad ground, and there they look very under the weather—the ground being too acid.

We now come to an area which had not been cleared prior to planting. The process of girdling the existing scrub oak was thought more economical than felling. Consequently an incision is made into the bark all round the tree, and it gradually decays without injuring trees already planted.

After ten minutes of stiff climbing we are on Daren y Dimbath, about 1,200 feet above sea level. And what a magnificent position! It is like scanning a six inch map that is real and has substance. A "ride" is a myth no longer. They stretch out before me, strips of yellow against the blue-black blocks of conifers and, in ten to twenty years time, will form extraction routes for timber. We are informed that negotiations for land that will ultimately join the four scattered parts which form Cwmogwr Forest are in progress. From this elevated position one realizes more acutely the tremendous work entailed in afforestation, its eternal duration and the full programme of the Forestry Commission.

We are now en route to Mynydd Maendy, the second forest in the group that is Cwmogwr. Whereas we had seen the result of planting in a valley, Mynydd Maendy consists of conifers planted on broad open spaces. They evidently like their position as they look healthy and flourishing. Gradually descending, we finally arrive at our starting point, Glyn Ogwr, feeling very hot and rather limp. I am referring to Miss Copp and myself, of course. The morning's tour has been both instructive and invigorating, and

has certainly toned up the muscles. We have been through bracken and briar ; up hill and down dale ; waded streams and jumped them ; scaled walls and crawled through sheep holes ; trapezed barbed wire and almost brought it away with us. However, after a rest and some tea, very kindly supplied by Mrs. Brown, we are all set for Cwmogwr Part II.

A third site, Braich y Cymmer, although in the Garw Valley, comes under the Ogwr group. We are in a mining valley where the mountain is immediately at the back door of the houses. As we climb, with our knees to our noses, I think that trees cannot possibly flourish in such a bleak and barren place. Still climbing, I can now see the shape of this odd piece of land and think how apt is the Welsh word *braich*. It is a typical "arm"—we are standing at the wrist end with steep slopes either side, with land gradually broadening to the shoulder. On our right a gang of men are actually planting Hybrid larch. I am intrigued with the canvas bags slung across their shoulders, containing transplants. When their supply is exhausted they re-load from a nearby dump. Each man is allocated a row, where he plants to the correct spacing with the aid of a staff. One man has just consented to my taking a snap-shot of himself in the process of planting. I am amused by an incident related by the foreman. Evidently some of the inhabitants of this area are rather notorious for their misdeeds. The younger element thought the planting of trees on their mountains outrageous and swore that they would be uprooted. However, a few friendly talks by the foreman have convinced them of their folly, and now they have become ardent critics, and are outraged if a tree is planted out of line!

We say good-bye to Braich y Cymmer, and are on our way to our last port of call—Pennsylvania Wood, which is a little west of Aberkenfig. We are informed that this small piece of old woodland has only recently been acquired by the Forestry Commission. Felling had taken place and there remained thick scrub and undergrowth to be cleared prior to planting. I remarked what an eyesore this was from the road. Evidently the Forestry Commission has a camouflage programme, too, as a verge of laburnum shrubs is going to be planted along the road, which will conceal, to a certain extent, this scarred piece of land.

We are homeward bound—our tour of inspection is over. It has been enjoyable and most instructive. May I express my appreciation to the persons responsible for introducing such a sensible scheme, whereby a beginner like myself may glean first-hand information. Having visited a forest which covered the preliminary stages of afforestation, I shall look forward with interest to visiting one in the final stages, and where, perhaps, I shall hear the magic word **TIMBER ! ! !**

SELECTION OF SPECIES AT RADNOR FOREST

BY C. E. PEATY

District Officer, North Wales

SITUATED ON THE Welsh Marches in the north-east of Radnorshire, and occupying the north and east slopes of the Radnor Forest massif, the main forest area lies five miles west of the country town of Presteigne, with an additional outlying block within a mile of the town. Agricultural holdings totalling 450 acres are contained within the forest area of 4,274 acres. The first plantations were laid out in 1926.

Topographically, the area consists of smooth hills up to 2,200 feet high, intersected by deep narrow valleys with, to the west, the mountainous country of the upper reaches of the Wye and Severn culminating in the Plynllymmon Range (2,468 ft.) and, to the east, the land falling gently down to the rolling country of Herefordshire.

The plantations lie within a range of elevations from 900 to 2,000 feet, and mainly occupy hill slopes, the only flat ground being small areas on the hill tops. These hill tops and extreme upper slopes at the head of the valleys are subject to severe exposure, the only shelter from the prevailing south-west wind being afforded by the north to north-east aspect of the forest.

The rainfall on the lowest slopes averages 45 inches per annum, but is probably nearer 65 inches at the highest elevations. Heavy snowfalls may be frequent in the early months of the year, and in January, 1940, a grazed frost severely damaged many of the plantations, particularly those of Douglas fir. Late spring frosts occur in the valley bottoms. Generally speaking, however, the climate of the region is mild.

Geologically the area consists of Ludlow sandstone and Silurian shale, the surface rock disintegrating readily. The mineral soil is a reddish-brown loam, varying from nine inches to several feet in depth and containing shale fragments. Peat is found up to two feet thick on the main plateaux, with podsol formation in places; on the lower slopes the peat rarely exceeds a thickness of two inches.

The vegetation falls briefly into three main types governed by the topographical position, as follows:—

- (a) The uppermost slopes and hill tops are of *Calluna/Erica* moorland with *Vaccinium*, sedges and *Juncus* locally abundant.
- (b) The intermediate slopes carry a coarse grass/bracken mixture, with gorse prevalent in places. On the deeper soiled and more sheltered sites the bracken is often dense. Bramble, raspberry and willow herb grow abundantly in damp sheltered situations.
- (c) Fine grass with mosses in the wet rocky hollows, and luxuriant bracken in places, are characteristic of the lowest ground, which supported cattle prior to afforestation.

Types of Ground and Species

1. **Valley Bottoms.**—Mineral soil with bracken and grass, patches of thin peat with heather and loose shale. Well drained but subject to severe frosts.

On the mineral soil Norway spruce has done very well, but on the heather it has checked for some years. Both Norway spruce and small areas of Sitka spruce are now getting away well (Cwm-y-Gerwyn), although the latter has been set back more often by frosts.

On the shale accumulation, lodgepole pine was planted with some Sitka spruce ; poor soil conditions and repeated frosting have stunted the Sitka but the pine are doing very well.

2. **Steep Lower Slopes.**—These carry heather/bilberry peat over rock, planted with Norway spruce and Japanese larch. On such areas Norway spruce has got away slowly but is now forming an even crop ready for brashing. In places an alternate row N.S./S.S. mixture has resulted in an uneven crop with the Sitka suppressing the slower Norway spruce ; where patches of bracken occur the two species are coming up evenly.

The Japanese larch has done very well, producing an even, well shaped crop, as good as any at Radnor.

3. **Sheltered lowest slopes on mineral soil.**—Vegetation is chiefly grasses and bracken. Various species have been tried ; Douglas fir, *Tsuga*, *Abies grandis* and Sitka spruce have all grown vigorously, although the *Abies grandis* seems to have been slower than the others in getting away.

The Douglas fir is rough and ice-broken, but where planted in mixture with *Tsuga*, it appears to have retained a good form and not been frosted much. There is, unfortunately, very little of it on these sites.

4. **Small rocky faces interspersed with screes.**—Pockets of heather/bilberry and mosses on thin peat. Ground generally extremely steep but well sheltered, subject to accumulation of snow.

Under these conditions, larch has grown very well, retaining a good form, but has unfortunately suffered heavily from drifted snow, considerable areas being laid flat. This, of course, might have happened to any species as the position was aggravated by the bad war-time labour situation delaying thinnings.

The damage extends to a Sitka spruce/lodgepole pine mixture, on the same slope but above the Japanese larch, at 1,900 feet. This has grown quite well but not very evenly, the pine having outgrown the spruce, although not sufficiently to cause suppression.

5. **Dry Intermediate and Lower Slopes.**—The vegetation here is heather, gorse and bracken. Not very exposed but liable to strong gusty winds ; these areas carry European larch, Japanese larch, or Douglas firs.

With one or two exceptions (Ednol hill, opposite Cwm Mawr, sheltered position, 1,100 feet) the European larch has formed a rough open crop with heavy undergrowth, largely as a result of severe die-back. Quality variations are apparent with the different races and, of a bad lot, the Scottish varieties are by far the best. Where Scottish races have been planted on bracken slopes not open to exposure, European larch (P.37) shows indication of doing really well, but will need close observation over some years yet to come.

Both Douglas fir and Japanese larch have grown very vigorously on these slopes, but have taken on a very coarse form which has been worsened in the case of the Douglas fir by severe ice damage. Where an area of heather has retarded its growth (Cwm y Gerwyn), the Japanese larch is of improved quality.

6. Old Woodlands

Main Beat.—Here the woodlands were never extensive, being chiefly shelter belts with an occasional small plantation, and one larger area of approximately forty acres. Generally the woods occupied either dry bracken grass slopes or steep lower slopes. The species were ninety per cent. European larch, with a balance of Norway spruce or Scots pine.

The trees on the first-named sites have almost all been felled within the last fifteen years, and replanted with Sitka spruce, which has got away very rapidly and is now forming good even stands. On the second class of ground, the trees were felled many years before the planting of the present plantations, and appear to have had little or no beneficial effect on them.

Presteigne Beat.—Here the old woods consist of oak coppice on a loose soil over limestone and shale. Between 1930 and 1936 some 360 acres were cleared and re-afforested with European and Hybrid larches and Scots pine, with Sitka spruce in wet pockets of ground.

The European larch has grown very well, and is of good form; many of the trees are cankered to varying extents, but there is no die-back or poor colouring of the shoots. Hybrid larch and Scots pine have both done very well, and show great promise; whereas the Sitka spruce has, in all cases, grown very slowly and does not look well; the site obviously does not suit this species.

7. Peat Moorland.—Heather/bilberry vegetation. These areas are generally well exposed on the shoulders and tops of hills, and planted with Sitka spruce, S.S./N.S., N.S./S.P., or S.S./S.P. mixtures.

The S.S./N.S. mixture is described in (2) above; the N.S./S.P. mixture, which was planted at the same period, has resulted in a very rough crop of Scots pine suppressing many of the Norway spruce. Had not the pine been smashed up badly in the 1940 ice-storm, more harm might have been done to the spruce; as it was many of the dominated spruce were freed from suppression when the pines lost their leaders. The pines are now being cut out in order to form a good crop of pure spruce.

From 1933 onwards, these areas were extensively planted with Sitka spruce on turves, and good, vigorous, even crops are now forming the finest blocks in the forest.

The S.S./S.P. alternate row and 2/1 mixtures have been tried since 1940 on ploughed-up areas of earlier checked Norway spruce (Forest-fach and Glydre). The ploughing seems to have induced a more even growth than occurred before, but no benefit is yet apparent from the use of the Scots pine.

8. Steep heather/bilberry slopes on upper limits.—These areas are all open to severe exposure and lie on very poor thin peat over dry stony soil. They are also subject to snow avalanches.

Mixtures of Norway spruce with Scots pine and of Norway spruce with mountain pine (*Pinus mugo*) have been extensively planted on these areas. The spruce has severely checked, and is now getting away slowly; but it has escaped suppression by the more vigorous pine, as the latter has proved to be of the non-erect type. Both species have been periodically blasted and severely broken over a large area by snow storms.

One small area of Sitka spruce/Corsican pine in alternate rows, planted in 1929 (Cwm y Gerwyn) has done very well and is forming an even, good quality crop.

Notes on Individual Species**A. Pure Crops :—**

Sitka Spruce has grown vigorously on all sites except heather/bilberry areas, where it has got away more slowly, but nevertheless is still doing better than any other species.

Norway spruce has done very well in valley bottoms, but has been extensively planted on upper bilberry slopes where it has got away extremely slowly, with many checked patches. It has also been severely blasted on the upper areas. On the lower dry, moderately sheltered, bilberry slopes, with patches of gorse, it has grown slowly but evenly.

Douglas fir has grown vigorously but coarsely on all sites, as instanced at Cwm y Gerwyn, Vron and Ednol Hill, which are chiefly intermediate or lower gorse/bracken areas. It suffered severely in the 1940 ice storm and subsequent blizzards, and it seems quite unsuited to this forest, unless severely restricted to the most sheltered sites.

Scots pine has been taken far too high at Radnor on the intermediate and upper slopes ; and even in fairly sheltered sites (Cwm y Gerwyn P.33 and Cwm Mawr P.27) it has been severely and repeatedly blasted and hopelessly smashed by ice storms, suffering even more severely than the Douglas fir.

Lodgepole pine has been planted in small amounts on upper bilberry areas and on loose shale covered with mosses (Cwm y Gerwyn), in some cases on very exposed sites. Everywhere this species has done well.

Mountain pine (*Pinus mugo*) has been planted in mixture with Norway spruce on high bilberry ground open to exposure and snow drifts. Almost all the trees have followed the bushy form, but are quite vigorous, although periodically blasted and smashed.

Corsican pine in mixture (alternate row) with Sitka spruce in a very exposed position on a bilberry area at 1,800 feet, this species has done very well. It has kept up with the spruce and retained a good form, and does not appear to have suffered much in ice storms.

Japanese larch has grown very vigorously on bracken slopes and mineral soil, but becomes rough and poorly shaped. On dry, poor heather and heather/bilberry areas, sometimes over rock, it grows moderately fast and evenly, and retains a good form, showing great promise.

European larch has been extensively planted on very poor, sometimes wet, bilberry areas open to severe exposure from the south-west wind (Fforest Fach P.32). On these areas it has done very badly, but results vary with different races. Some 250 acres at Presteigne at 900 feet elevation on a dry, stony site are doing very well ; apart from cankering the form is good. There is no sign of die-back or shoot discoloration.

Tsuga heterophylla planted on a sheltered bracken slope at 1,000 feet, in mixture with Douglas fir (Rhiw Fawr, P.30) has done very well. Height growth is as good as, while form and quality are superior to, those of the Douglas fir.

Abies nobilis. A few small groups covering one or two acres on intermediate and fairly sheltered bracken and bilberry slopes have done extremely well (Ednol Hill).

Abies grandis shows great promise on the lower bracken and bilberry slopes at 1,200 feet.

B. Mixtures :—

J.L./S.S., 1/1.* At Cwm y Gerwyn P.29, 1,400 feet on old fields open to moderate exposure, the larch has grown the more vigorously of the two, and has suppressed many of the spruce. The situation was aggravated by war-time labour difficulties delaying the thinning ; had the plantation been entered earlier far more spruce—all of good quality—might have been saved.

Earlier experiments in cutting out the larch leaders and brashing into the green branches to give the spruce more room, have definitely encouraged the spruce, but at the same time the ultimate task of thinning the plantation has been made more expensive, as the larch have continued to send out vigorous coarse laterals and have little sale value.

A complete removal of the larch at say 12—15 years might have resulted in a plantation of even, good quality Sitka spruce.

Had it been tried in a sheltered hollow, the mixture might have been more satisfactory ; but a similar project at 1,400 feet in a less exposed position on Ednol Hill has ended in exactly the same way.

S.P./N.S., 1/2. This mixture was tried in P.27 and P.28 on Ednol Hill, Fforest Fach, and Cwm Mawr. These sites at twelve to sixteen hundred feet elevation are all only moderately exposed, but the pine has been smashed by storms and is now virtually worthless ; the spruce has been suppressed, and in many instances severely damaged, by neighbouring rough pines. It has been found necessary to cut out the pine to save the spruce.

S.S./N.S., 1/1. Planted at Fforest Fach, P.32, at 1,400 feet, moderately exposed on heather/bilberry moorland. The Sitka has out-grown the Norway spruce, except where occasional bracken patches occur. Thus there has been heavy wastage of Norway spruce by suppression.

Douglas fir/Tsuga, 1/1. In a sheltered position near the bottom of a valley at 1,000 feet (Rhiw Fawr) both these species have grown vigorously, but the Douglas fir is, as elsewhere in the forest, very rough and, if anything, less tall than the *Tsuga*.

***Abies nobilis*/Sitka spruce, 1/1.** Planted in P.28 on moderately well sheltered bilberry ground at 1,450 feet, slope moderate to steep. This is a mixture of alternate trees in the rows, and it might be said to be the most evenly balanced mixture in the forest. Both species are very healthy, have grown well and retained a good form. If there is any variation between the two it is in the slightly superior quality of the *Abies nobilis* over the Sitka spruce, the former has fewer kinks and is altogether of a nicer form.

***Abies nobilis*/Douglas fir, 1/1.** Site and age as above. Alternate trees in the rows. This mixture again demonstrates the poor showing of Douglas fir at Radnor. The *Abies nobilis* is of infinitely superior quality, and has grown more rapidly (an average lead of about three feet out of thirty feet in twenty years).

***Abies nobilis*/European larch, 1/1.** Site and age as above, and alternate trees in the rows. The *Abies nobilis* is far superior to the larch, almost all of which is suffering severely from die-back ; in due course all the larch will be suppressed out of existence.

* Figures 1/1, 1/2, etc., refer to the arrangement of the species in rows unless otherwise stated.

**Proposals for Allocating Species to Particular Classes
of Ground**

1. Extreme bottom of valleys where late spring frosts occur :—
 (a) on mineral soil—Norway spruce ;
 (b) on heather and loose stone—Lodgepole pine.
 2. Steep lower heather/bilberry slopes on thin peat :— Japanese larch,
 Lodgepole pine. Corsican pine on the poorest ground.
 3. Sheltered lowest slopes on mineral soil :—
 Norway spruce, *Abies grandis*, *Tsuga*. Douglas fir on selected
 sites only.
 4. Small rocky faces and screes :—
 Japanese larch, Lodgepole pine. Corsican pine on screes.
 5. Dry intermediate and bracken slopes not open to exposure :—
 Norway spruce. *Abies grandis* on selected sites.
 6. Old woodlands :—
 (a) Coniferous :—Norway or Sitka spruce ;
 (b) Hardwood :—Japanese, Hybrid or European larches, to kill
 off the coppice.
- Rocky patches :—
 Scots or Corsican pines. Occasional wet hollows :—
 Norway spruce.
7. Peat moorland, heather/bilberry vegetation :—
 Plough and plant Sitka spruce.
 8. Steep heather/bilberry slopes on upper limits, severe exposure :—
 Sitka spruce or *Abies nobilis* ; or mixtures of Sitka spruce
 with Corsican pine, Lodgepole pine or *Abies nobilis* ; all on
 turves.
 9. An additional type of area which we will very shortly have to treat is
 the European larch plantation that has died back and is now too open ever to
 form canopy, and is slowly becoming a jungle of weeds. My suggestions for
 treating such areas :—

Standing European larch areas : Thin out where necessary and
 underplant with *Abies grandis* or *Tsuga*. Where the crop is extremely
 rough and open, clean up and replant with Sitka spruce or *Abies
 nobilis*, as these plantations are mainly on exposed areas.

THE HIGH ELEVATION EXPERIMENT AT BEDDGELERT FOREST

BY R. D. PINCHIN

District Officer, Research Branch

THIS EXPERIMENT which is illustrated by a photograph in the central inset is a study of the effect of altitude and exposure on a steep mountain slope of grass-gorse type using the six species : Sitka spruce, Norway spruce, Japanese larch, European larch, lodgepole pine, and beech. It is laid out in a latin square chessboard with five replications in an isolated position on the north side of Cwm Du. Each plot measures about one and a half chains by three chains (the longer dimension running down the slope), and has an area of about four square chains, or .4 of an acre.

The range of altitude is 1,250 to 1,800 feet, and the aspect is south-easterly. The upper two of the five series are fully exposed to the south-west and prevailing wind, but the lower portion of the experiment receives a certain amount of local shelter from the surrounding hills, though winds in the valley may at times be of great strength. The area is fully exposed to the south-east but is protected to the north and north-west by the hills behind.

It is estimated that the mean annual rainfall in this region is well over one hundred inches, and in the early months of the year heavy snowfalls are of common occurrence ; considerable damage was done by a snow avalanche in March, 1936. Late frosts do not normally occur on this site, but considerable damage may be caused to young shoot growth by the cold winds on the upper part of the area.

The soil is slightly podsolised and, in the lower part, consists of a thin dark brown loam on a bluish clay loam two to three inches thick, over a deep brown clay loam. In the upper part it is a shallow brown loam. The steepest slope occurs in the middle two series (III and IV) and is approximately fifty degrees.

In general there is a falling off in the rate of growth and quality of the plants, as one would expect, towards the higher altitudes, with the exception of the two western plots in series II, which are on a better soil type. This has given better results than for the same plots in series I below.

An assessment of the height and shoot growth for each species at the different elevations was carried out in October, 1946, by taking a belt across the middle of each block. The results are shown in the following table :—

HIGH ELEVATION EXPERIMENT, BEDDGELERT

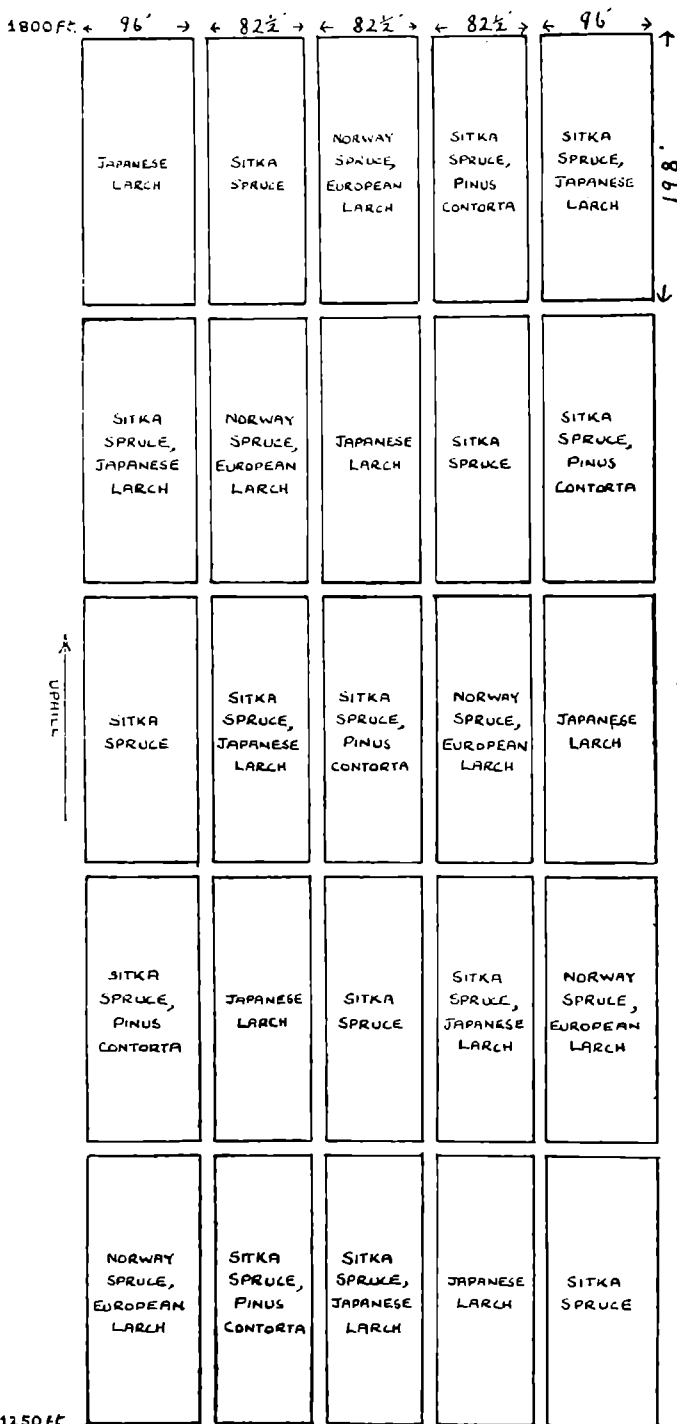
Series :	I (lowest)		II		III		IV		V (highest)	
	1,250—1,340 feet		1,340—1,460 feet		1,460—1,600 feet		1,600—1,740 feet		1,740—1,800 feet	
Species	Mean height feet	Mean shoot inches	Mean height feet	Mean shoot inches	Mean height feet	Mean shoot inches	Mean height feet	Mean shoot inches	Mean height feet	Mean shoot inches
Approximate elevation ...	1,250—1,340 feet		1,340—1,460 feet		1,460—1,600 feet		1,600—1,740 feet		1,740—1,800 feet	
Sitka spruce...	17.5	14.8	15.7	12.6	10.5	9.5	9.1	8.6	5.0	4.7
Japanese larch ...	18.5	13.3	15.5	12.4	12.9	10.5	6.9	4.0	5.4	2.6
Mixed :										
Sitka spruce with	17.5	13.4	16.8	14.1	13.5	11.7	7.4	7.1	3.4	3.0
Japanese larch ...	17.3	12.0	14.3	9.9	12.8	10.9	8.2	6.1	3.2	1.4
Mixed :										
Sitka spruce with	14.2	13.6	15.2	13.3	11.7	10.3	7.3	6.1	4.1	3.4
Lodgepole pine ...	13.8	13.3	12.1	8.7	10.7	11.1	6.5	7.8	3.4	3.8
Mixed :										
Norway spruce with	7.9	10.5	10.5	10.8	7.4	9.0	3.3	2.8	1.9	2.1
European larch ...	3.2	5.1	3.3	3.0	3.3	3.3	1.8	1.6	Dead	
Beech	5.1	—	4.1	—	From here upwards heights are 1—3½ feet Shoots 1—10 inches, negligible where exposed					

Mixed plots are 50 per cent. of each species, in one-row—one-row mixture.

Assessed October, 1946, at age 18 years.

BEDDGELERT FOREST

EXPERIMENT-12-1929.



Notes on Species

Sitka spruce. Taken all round this is the best species on the site, particularly at the high altitudes, and it appears to be satisfactory up to and including the 3rd series where, in the pure plot, heights range from 5—13 feet and shoots 3—14 inches. In the 4th series, above, there is good growth on better patches of soil, with heights ranging from 5½ to 13 feet and shoots 4—14 inches, and the general vigour and colour is good. Here many trees are showing the effects of the strong wind in misshapen tops ; aphid defoliation tends to be severe in some places.

In the top series (Series V) the Sitka have badly blasted tops and distorted branches, and are very irregular in growth. The foliage of many trees is quite strong and dark-coloured, however, and they have the appearance that they will survive the exposure indefinitely in a straggling form. Heights range from 2—10 feet and shoots 1—10 inches ; mean 5.0 feet and 4.7 inches.

On the deeper soils in the lower two series (Series I and II), Sitka appears to be well suited to the site and is growing very strongly, maintaining an average annual height increment of 12.0 inches. The main defect of the crop here is the physical damage caused to the tops through breaking of the leading shoots by the wind. Out of one sample taken across the middle of the block of pure Sitka, 62.9 per cent. of the trees showed some form of damage to the tops over the last three years. Recovery appears to be very rapid, however, in most cases. The foliage is mainly of a dark green colour, and dense shade has killed out the ground vegetation. It appears that up to an elevation of about 1,460 feet quite good crops of Sitka can be produced on this site, and reasonable growth might be expected up to about 1,600 feet. There would, however, be no justification for extending the existing planting limit of 1,500 feet beyond this.

Concerning the effect of mixing Sitka spruce with other species, it is worth noting that in Series I, II, and III, where the Japanese larch have grown quite well, the Sitka are better in mixture with this species than in the pure blocks. In mixture with lodgepole pine the mixture has only produced better Sitka in Series III.

Japanese larch. This species has put on slightly more growth than Sitka spruce in Series I, where it is a vigorous and healthy crop, apart from damage by wind to the tops as in the case of Sitka. The stems tend to be rather crooked, but the trees are, in the main, quite healthy and have produced an abundance of foliage which has killed out the ground vegetation. As we ascend the slope the Japanese larch compare less and less favourably with Sitka spruce in form, height growth, vigour and stocking.

In Series I and II (up to 1,460 feet) the larch, so far, is reasonably good as a tree crop on this type of site ; in Series IV and V (above 1,600 feet) it is severely affected by exposure, several trees having been blown down in Series IV while most of the stems are leaning and deformed. Foliage is sparse and, in general, browned and blasted by the wind. Misshapen and dead tops are frequent, and many trees are growing bushy in habit through the abnormal development of side branches.

In the top series (Series V) only a few good individual trees 6 to 7 feet in height can be found. Many plants have been killed outright. The condition of the tops of those which are still alive is, by visual estimate, as follows : Tops dead, 50 per cent. ; tops dying, 30 per cent. ; leading shoot growing, 20 per cent.

Heights range from $2\frac{1}{2}$ —9 feet ; shoots, 0—11 inches ; mean, 5.4 feet, 2.6 inches.

Lodgepole pine. (*Pinus contorta*). This species is growing at a promising rate in Series I where it is about equal to the Sitka on the same type of ground. As far up as Series III (1,600 feet) it is satisfactory, though slightly less in average height than the Sitka, with which it is mixed. In Series II and upwards failures become more numerous, and quite a few trees have been suppressed by the Sitka in Series II and III. The leading shoots show a much greater resistance to wind damage than those of Sitka spruce.

In the top two exposed series (Series IV and V) a few lodgepole pines have been blown down (only one in Series V), and the general development of the branching system is one-sided with a certain amount of distortion. A large number of plants have died. On good soil sites at this altitude good groups occur here and there, but in general the foliage tends to be rather yellowish.

Norway spruce. By comparison with lodgepole pine this is a slow growing species. It is best in Series II on a good soil site, where it attains a maximum height of 21 feet, with a maximum shoot of 14 inches. The trees here are now putting on a fairly even annual increment of about 10 inches and are of good form and colour. Wind damage is negligible, largely, no doubt, owing to the shelter afforded by taller blocks of Sitka spruce and Japanese larch on the windward side. Up to and including Series III, the Norway is reasonably healthy and growing well, though tending to be slow and irregular.

In Series III and upwards many failures have occurred, and in Series IV the needles are mainly short and scanty and often browned by the wind. Several have been blown down.

In Series V most of the plants are stunted and dying, the living ones having assumed a bushy habit through repeated dying back of the tops. One or two strong individual plants can be found here and there, but the majority are very poor specimens indeed. Above 1,600 feet Norway spruce would be quite useless for forming plantations on an exposed site of this kind at Beddgelert.

European larch. This species has failed at all altitudes in this experiment. Most of the living trees continue to produce growth from lower branches while the tops remain dead, and as this new growth attains exposure height it, in turn, is killed back. Stocking varies from about 30 per cent. in Series I to almost zero in Series V, where only one or two specimens remain alive.

Beech. This hardwood species appears to be adapted to the soil type, but will not put on much height growth under the conditions of exposure. In sheltered positions on the north-eastern side in Series I it has reached a maximum height of $7\frac{1}{2}$ feet with shoots up to 10 inches. In exposed sites it remains a bush 1 — $3\frac{1}{2}$ feet in height, with negligible shoot growth.

FORESTRY AND AMENITY

BY E. W. MARSH

Forester, North-East England

HOW OFTEN DO we hear or read complaints of the large scale afforestation schemes now in progress, especially with regard to the planting of pure conifer crops ! We all know the usual formula : " Why do you plant all these ugly conifers, why not our native hardwoods, the oak, beech, ash and elm ? Why must we have our beautiful hillsides clothed by these legions of regimented conifers ? " Such remarks become the more annoying not only by their constant repetition, but also because they come largely from people with no knowledge of trees or of their requirements.

However, let us pause to consider, before hurriedly retorting that the present demand is for softwoods, or that the land we have at our disposal could not possibly grow hardwoods, and try to look at the picture, not from the forester's point of view of so many acres to be planted in the current season's programme, but from the viewpoint of the average citizen, who envisages vast forests of dark trees arising, shutting out well-known views, and giving him miles of rather gloomy and forbidding plantations. It must be admitted that in the early and pole stages, crops of pine and spruce can be anything but pleasing when looked at without any thought of the rate of growth or form of stem which the forester so often is thinking of. We should consider public opinion as far as is practicable if we are to have the public support and co-operation we require, not only as a measure of fire protection, but because our operations require public funds for their execution ; the public will, therefore, expect a little return, over and above the knowledge that a vast pit-prop and telegraph pole factory is being produced in their midst.

But where lies the remedy ? To embark on large-scale planting of the more valuable hardwoods on our barren and exposed hills and moors, is, of course, out of the question, but much can be done in the way of amenity planting alongside road and ride, provided a certain amount of thought is given at the outset. Where beech, oak, sycamore, elm or hornbeam will grow, we can introduce them, either as continuous belts, or as isolated groups in places when they will best catch the eye, or even as single trees spread over the length of the road or ride in question. Each method will have its advantages and disadvantages, both from the point of view of forest management, and from that of scenic effect. To plant, along a ride, a thick belt of a slower-growing hardwood, through which thinnings from the more rapidly developing conifers within will have to be extracted, may lead to complications, and cause the local forester to think unsympathetically of amenity planting. However, where a system of cutting racks for extraction purposes is employed, no difficulty should occur, as the racks will come through the hardwood belt to the ride, and with a little forethought as to the lay-out of such racks at planting time, waste, by the cutting out of hardwoods before they are of marketable size, can be avoided. On steep hillsides, where racking may not be practicable, it will be better to plant clumps of ornamentals, or scatter them at widely spaced intervals, rather than to plant continuous belts. This will allow extraction between without damage. Whichever method is adopted, it will be necessary to allow extra width to the ride, so that the ornamental trees will have room to develop without being overshadowed by the plantations behind, and also so that they do not encroach on the space required on the ride for the stacking of produce or for extraction.

On the better class of soils, the list of trees which could be included for ornamental effect is considerable, including beech (both green and copper varieties), oaks (common, turkey and red), sycamore, Norway maple, various species of elms, hornbeam, horse chestnut, sweet chestnut, lime, gean, bird cherry, crab, laburnum, poplars (black, white, Lombardy and hybrids), *Prunus pissardi*, whitebeam, service tree, etc. Ornamental shrubs can also have their place, but it must be realised that constant attention will be required with these, so that they do not disappear, after a year or two, beneath a thick mass of bracken or willow herb ; and unless the necessary time and money is to be made available to keep them clear of rubbish, they are perhaps better not planted.

On the poorer soils, such as the heather-clad moorland areas, our choice of trees is limited. But we have two trees which can and should be employed when all else fails, the rowan and the birch. These so-called forest weeds can be put to good advantage, the rowan probably at its best when spaced out at fairly wide intervals, and the birch as groups, when and where the best effect can be produced. These groups of birch can serve a dual purpose, for they can, in emergency, serve as a convenient source of fire beaters. Other species which have proved successful on moorland areas are the grey and Oregon alders. The employment of Japanese larch in fire belts has done quite a lot to relieve the continuous dark blocks of pine and spruce, and on rides where no fire belts are planned, there is no reason why this species should not be planted in the rideside rows, say every fourth or fifth tree.

Peat areas are perhaps the most difficult ones on which to introduce amenity trees. This is the more unfortunate, as these areas, being largely planted with pure spruce, can be the most monotonous of all. However, in most cases there will be places where the mineral soil outcrops, or the peat thins out a little, bringing the underlying soil, probably a stiff clay, to within a few inches of the surface. Such places may probably be the best for the introduction of clumps of birch, rowan, grey alder, or even some of the smaller and more shrubby willows. Japanese larch may again prove a useful stand-by, and in any case the application of small quantities of a phosphatic fertiliser, may make the difference between success and failure.

To sum up, the main thing to be considered is the planning of the lay-out of plantations at the time of planting, in order to allow all the room that will be required on the rides when the crop has developed, and thinning and extraction is necessary. Too often, in the past, roads and rides have been laid out far too narrow, and when the first thinning occurs, or in some cases at an even earlier date, it has been necessary to remove one or two rows of trees from the ridesides, to allow the necessary width for extraction, stacking or fire protection, or to allow for the grading and excavation which may be necessary in the construction of metalled roads.

It is obviously no use planting ornamental margins to our roads and rides if they have to be removed later to give the required width for later development of the plantation. Further the necessary maintenance work must be planned and carried out so that those ornamental trees which are planted can grow and develop as they should, and not be spoiled or smothered, by the rank growth of undesirable weed species.

NATURAL REGENERATION

BY D. WATT

Student, Glentress Forest School

AN AMAZING QUANTITY of naturally regenerated seedlings was to be seen during the summer of 1948 in the forests of the North-East of Scotland. Scots pine seedlings were thriving on forest tracks and throughout the woods where the ground had been disturbed by dragging operations. On the newly constructed roads throughout the forests they seemed to find optimum conditions for growth ; especially where water or vehicles had banked the light gravel on the roads into miniature sandhills. Larch seedlings were also prominent although not in such numbers as were the Scots pine.

The reason for this profusion of natural seedlings would appear to be the combination of several favourable factors occurring throughout the year. Those were :

- (a) A good seed year, 1947—48.
- (b) A spring and summer very favourable to the growth of seedlings.
- (c) In the older Commission forests, owing to the large amount of thinning and dragging being done, the soil had been disturbed, giving the seed an excellent bed in which to germinate.

As germination would appear to have been so successful, I take it as proof of the usefulness of the heathland nursery, and an indication of the type of soil on which Scots pine do actually thrive.

Natural regeneration of conifers has not been common practice in the woodlands of this country, and on most of the areas acquired by the Forestry Commission the soil is not in a suitable condition for such regeneration to be successful. There are three main requirements for natural regeneration :

- (a) Good seed bearing trees.
- (b) Good germinating conditions.
- (c) Complete exclusion of stock and rabbits.

If these requirements are satisfied then we may expect to obtain natural regeneration, and I believe that this method, which has been used successfully on several of the older estates in the North-East of Scotland, will be very extensively used in our State forests to provide the next rotation.

RECENT DIRECT SOWING EXPERIMENTS ON THE YORKSHIRE HEATHLANDS

BY J. W. L. ZEHETMAYR

District Officer, Research Branch

DIRECT SOWING TRIALS have been made by Research Branch from time to time since 1921 with varying success. The great development of ploughing during the war has led to a new series being laid down owing to the very much improved sowing medium thus made available. In P.47 and 48 sowings of about half to one acre were made in various parts of North England and Scotland. Two of these in the Broxa Experimental Reserve (Langdale Forest, near Scarborough) have given such excellent results to date that a short note may be of interest. The sites are at 700 feet above sea level, fully exposed on a flat heather-clad plateau. R.L.R. ploughing turned out ridges sixteen inches high, and patches were then prepared for sowing. In P.47 a step was cut in the side of the ridge; losses by falling earth led to a change in P.48 to a mound in the furrow bottom. The patches are about six inches square and at normal four and a half feet spacing. Species are Scots pine and Sitka spruce, sown at approximately ten and twenty seeds per patch respectively.

In the P.47 experiment, trials of various manures were made, using both organic fertilisers and artificial fertilisers containing Nitrogen (N) Phosphorus (P) and Potassium (K). The most successful was one pound of hopwaste compost and one and a half ounces of an N.P.K. fertiliser (as described below) which has given two-year seedlings averaging eight inches high for Scots pine and nine inches for Sitka spruce, with individuals of the latter ranging up to fourteen inches. Unfortunately the compost is too bulky for general use, as about one ton, or seventy cubic feet, per acre would be required.

However, results not far below these are obtained in three other essentially practical treatments:—

Adcompost (a proprietary manure probably containing a mixture of artificials with some organic materials), N.P., and N.P.K. (made up of 0.75 ounces hoof and horn, .6 ounces ground mineral phosphates and 0.15 ounces muriate of potash per sowing patch).

All these treatments include nitrogen and phosphate; phosphate tried alone however, only gives a height growth of two to three inches compared to the five to six inches of the combination. The conclusion on which the P.49 work is being based is that both N. and P. are essential. (*Note.*—N. has not been tried alone here, but general experience shows it is unlikely to be successful without P.)

Stocking of the patches is now 83 per cent. for Sitka spruce and over 90 per cent. for Scots pine (including unmanured controls). Virtually no plants have been lost since the end of P.47.

At the time the P.48 experiment was laid down, only the first-year results of the first experiment were available, and the importance of N. was not so obvious. Accordingly three manurial treatments were tried, P., P.K., and N.P.K., combined with two other new treatments: prepared tilth on the patches (T), and use of sand cover (C). The best treatment, N.P.K.

(T.C.) for both species, has produced first-year seedlings averaging 1.4 inches for both species, which is about as good as the P.47 experiment at the same age. The indications are that tilth and cover are slightly beneficial. Stocking of both species is virtually complete, this being an improvement for the first year compared to the P.47 experiments.

To follow up these experiments, about three acres of sowings are being made in P.49 to investigate the following points :

- (i) The value of potash. Indications so far are that it is slightly beneficial here.
- (ii) The tilth and cover treatments are being repeated, since the effects are only small, they need confirmation in a second season.
- (iii) The value of broom as a nurse to sown crops.
- (iv) Sowing of other species, lodgepole pine, Japanese larch, Norway spruce, *Tsuga*, *Thuja*, Douglas fir, and *Abies grandis*.
- (v) The cost of establishment of one acre of Scots pine/Sitka spruce sowing with the N.P.K. (T.C.) treatment. Each operation will be separately costed so that any proved to have little effect on growth may be omitted as uneconomic.

Granted a reasonable season it should be possible within two years to say whether field scale sowings are practicable in this area. The merits of planting versus sowing have still not been settled in Europe after decades of controversy. Through force of circumstances, planting has had a long start in Great Britain, and much intensive research is needed on the possibilities and problems of sowing.

VEGETATIONAL CHANGES FOLLOWING THE AFFORESTATION OF CALLUNA HEATHS IN YORKSHIRE

BY J. WEATHERELL

Forester, Research Branch

IMMEDIATELY A PLANTATION begins to grow, itself an ecological change, the scene is set for further and consequent changes above and below ground. The vigour of the natural vegetation suffers because of ever-increasing shade, and with the formation of canopy it is either eliminated or markedly suppressed. The first thinning, allowing as it does more light to reach the forest floor, is usually followed by vegetation new to the area. There may or may not be re-entry of original natural species, depending on available light and soil changes. The spontaneous entry of new forms of vegetation suggests changing fertility, and knowledge of the natural environment of such new species will indicate improving or deteriorating conditions. There is ample evidence on the Allerston Forest podsols that Sitka spruce responds to the companionship of pines and larches. Dramatic responses by Sitka spruce and other species to broom as a nurse have been obtained.

All plant associations are not mutually or individually helpful. In recent years it has been demonstrated that on podsolized heath at Allerston a dense growth of *Calluna* can be correlated with lack of vigour in Sitka spruce. Removal of living *Calluna* by hoeing or mulching results in vigorous trees of excellent colour ; control plots of spruce which were not so treated remained yellow and in check.

The following examples of vegetational changes are given for the podsolized plateau of Wykeham Forest in the North Riding of Yorkshire. Geologically the area is Lower Calcareous Grit of the Middle Oolite. There are one and a half to two inches of peat, with iron pan at six to seven inches below the surface. Elevation is 650 feet above sea level. Soil preparation for planting was done mainly by tractor ploughing four to six inches deep in the early years, nine to ten inches deep from 1931 onwards. Examples are from the areas of deeper ploughing where tree growth has been better.

The original vegetation was :

Calluna vulgaris (dominant), *Erica tetralix* (wetter sites), *Erica cinerea* (drier sites), *Empetrum nigrum*, *Juncus squarrosus*, *Juncus bufonius*, *Scirpus caespitosus*, *Carex flava*, *Eriophorum vaginatum*, *Eriophorum angustifolium*, *Molinia caerulea*, *Nardus stricta*.

Mosses were affected by burning and are not recorded.

The following table gives the current position (1948) relative to introduced tree species :

Tree species	State of Original vegetation	New species in the vegetation
Scots pine (thinned)	Suppressed	Toadstools abundant
Lodgepole pine (not thinned) ...	Suppressed	Toadstools frequent

Tree species	State of Original vegetation	New species in the vegetation
Japanese larch (thinned)	Suppressed	Toadstools abundant, <i>Deschampsia flexuosa</i> , <i>Agrostis</i> sp., <i>Holcus</i> sp.
Birch (not thinned)	Heavily suppressed	Toadstools frequent (including <i>Boletus scaber</i> , and <i>Amanita</i> spp.) <i>Deschampsia flexuosa</i>
Sitka spruce nursed by other species— Not thinned	Suppressed	Toadstools in open parts
Sitka spruce nursed by broom, but too young for full canopy	Partly suppressed	<i>Rubus</i> sp., fern sp., <i>Deschampsia flexuosa</i> , moss spp.
European larch (not thinned)... ..	Markedly suppressed	Toadstools frequent, <i>Deschampsia flexuosa</i>

A useful point relative to at least certain grasses is that for fruiting, they appear to be sensitive to light. Thus the presence or absence of seed-bearing stems might be indirectly correlated with :

- (a) breakdown of needle litter ;
- (b) light requirements of under-planted species.

Such correlations could be useful for management of woodlands.

MECHANICAL DRAINING FOR AFFORESTATION

BY D. ROSS

Forester, West Scotland

IT MAY PERHAPS be of interest to foresters to learn of the development of the Cuthbertson draining machine. At present there are three types of Cuthbertson plough in operation in all parts of the world. These are Type F, Type S and Type A. The writer believes that the first two lead the world in their class ; the third is still undergoing tests and modification.

Existing Types

1. *Cuthbertson Type F*

This machine was first tried out at Minard Forest in July, 1945. The first ploughing was done at five feet spacing, and many of those who saw the initial experiments believed that this was the solution to the problem. Unfortunately this was not the case, and 1946 saw a reversion to a spacing based on thirty chains of drains per acre, spreading the turves by hand.

2. *Cuthbertson Type S*

This was developed in late 1945 and early 1946 for use in sugar cane plantations. It coped most satisfactorily with the task of cleaning out old drains, for which Type F is not suitable owing to the discs being too far forward ; this allows the sides of the drains to fall in and clog up the sock.

3. *Cuthbertson Type A*

Work started on this machine in July, 1947, and it has not been perfected at the time of writing. The object is to produce a machine to make an entirely mechanical job of laying mounds. Such a machine should be fitted with a double mouldboard and with transverse cutters, to provide turves two feet six inches long, eight inches high and twelve to fifteen inches wide on both sides of the furrow, with the vegetation side undermost. I consider this the ideal size of turf to sit tight upon uneven ground, and to reduce weeding costs by blanketing the vegetation. Various trials have been held at Kilmichael, Twiglees, and elsewhere, but much development remains to be done.

Present and Future Techniques with Types F and A

1. *Type F*

As has been said earlier, this machine was designed when close ploughing (five feet to five feet six inches) was in vogue. Hence the short-armed moving (trailing) mould-board which resulted in the spoil being left close to the edge of the drain. This made the furrows very difficult to cross when the tractor was cutting the main drains.

For ploughing at wider spacing, I recommend that two main mould-boards and two long-armed moving mould-boards be supplied with each plough, one of each for right-hand delivery of spoil as at present, and one for left-hand delivery. Changing from left to right-hand delivery, and vice versa, would always give the tractor the benefit of pulling down the slope, and would also ensure that the spoil was left on the lower side of the drain. This is

important, as the spoil would not then impede the free flow of surface water into the drain ; and it would help with the spreading of turves, which would not then have to be thrown across the drain. Once the problem of carrying the alternative mould-boards has been solved, a further advantage would be that the machine could plough up gentle slopes and still throw the spoil downhill, thus obviating the tractor having to travel light on the return journey. Contractors have reduced light travelling to the minimum by working in and out from the main drains, which results in the spoil from every alternate drain being thrown uphill which, as said above, is not ideal. Subsoilers should also be fitted to all mould-boards ; on mineral soils they would soon repay their cost.

2. *Type A*

As I have said before, this was intended to be a turf-cutting and spreading machine, and not a draining machine. In view of the difficulty of getting an even distribution of turves upon both sides of the drain when ploughing across the slope, this machine should be operated straight up and down the slope, with the mould board on an even keel.

This would then be followed by a type F plough, which would cut much deeper drains across the slope, and as a consequence across the turf drains. With such a technique, drains could probably be reduced from thirty to eighteen chains per acre, according to the nature of the ground.

At Twiggles the attempt was made to combine turfing and draining in the one operation. This is impossible, since either the drains will be effective and the turves far too thick, or else the turves will be of the correct thickness and the drains too shallow. I believe that to attempt to compromise in depth will result in failure, both from the point of view of draining and of mounding. It should be appreciated that all parts of A and F Types are completely interchangeable, and it is a simple matter to convert Type F into Type A and vice versa. At present the right-hand delivery main and trailing mould-boards are the standard fitting with Type F ploughs, and all that is required to make each existing plough completely convertible are the following :

- One left-hand delivery main mould-board
- One left-hand delivery trailing mould-board
- One double (mounding) mould-board
- One short armed disc
- One transverse cutter.

The existing beam and transport do not require modification, but one extra short-armed disc will be needed, since Type A is fitted with two short-armed discs, and Type F with one short-armed and one long-armed disc.

The cost of these extra parts would be completely out-weighted by the advantage of having each plough fully equipped to tackle varying techniques on all types of ground.

Probable Future Developments

The next step is to perfect a turf spreading attachment to the existing Type A. When this has been achieved the present costly job of manual turf spreading will be largely eliminated.

Further models may be developed, such as three and four furrow ploughs, once difficulties such as shortage of materials and the lack of a suitable tractor have been overcome. I may add that a pet dream of mine is of a

draining machine and a tractor combined in one unit, on the lines of the well-known Ferguson system. Until that dream is realised we must hope for an improvement in existing types of tractors. The ideal machine would be a tractor of about forty horse-power and two tons weight, with tracks thirty-six inches wide and longer than the machine, exerting a ground pressure of one pound per square inch. It should be fitted with a first-class winch, carried about the centre of the machine, capable of both forward and backward pull. Once such a machine has been developed, hill ploughing will become a comparatively simple operation.

HINTS ON FENCING

BY R. G. MURRAY

Forester, West Scotland

WHEN FENCING IS mentioned there is a general impression that the work implies the sticking in of stobs at regular intervals, and connecting them up with wire—all quite simple! However, foresters unlucky enough to be working in the mountainous districts find it very much more difficult, and sometimes a rather heartbreaking operation, especially in a place where the fence line runs through an area that is a succession of solid rock, scree, and large boulders.

I remember one fence where, after all the hard labour expended in boring granite, fixing iron standards and strainers, wiring, and generally completing, a sudden landslide removed some three chains and left the remainder so badly stretched and weakened, that major repairs were necessary. From then on, I made a point of crossing the potentially dangerous areas with separate sections of one to two chains in length, thus localising possible damage.

At another point, after erection of a fence over a scree area, stones accumulated, embedding the fence and eventually laying a lengthy section flat, causing a great deal of work in unearthing (unstoning, I should say) the fence and re-erecting. It was found to be much easier to pass scree areas, by fitting up a series of wooden gates, tied with light wire at the foot, so that whilst these were quite secure against stock, rabbits and deer, any sudden piling up of loose stones caused the ties to break, allowing the gates to lift, and the sliding mass of stones to pass on unhindered. Periodical inspection would often show these gates lifted, but undamaged. It was quite an easy matter to clear the fence line and to re-tie the gates in a few minutes.

Fencing across streams can sometimes be very troublesome if it is necessary to put up water gates, as is so often the case in sheep country. A good plan is to put a straining post at either side, with four wires put across together from one side to the other, and twisted with a bar to form a cable. This provides a very secure hanging for the water gate, and in many cases, with the assistance of supporting wires above, a very handy crossing place; often the only place a person could cross dry-shod when rivers were in spate.

Fencing across lengthy bogs can at times be very difficult. The problem in this case is how to have a straining post firm and strong when the surrounding area is a soft and apparently bottomless mass. Digging a hole presents no difficulty, and placing the strainer is just too easy; but to keep it in, so that it may be a secure anchorage, is not so simple. Various means are employed to create solidity; the commonest is to fix bars or plates to that part of the strainer which is underground, and so prevent the post from rising, or yielding to a pull.

Abrupt and cliff-like changes in ground levels, representing a drop (or rise) of six to seven feet, can be passed with the aid of an outsized straining post covering both levels. The top part of the post forms the terminating point of one section, and the bottom part of the same post the commencing point for next section. This type of straining post is usually and aptly termed "Double-Decker."

However, erecting a fence on high ground and encountering a succession of difficulties has compensations, in that it can be a much more interesting operation as compared with a more straightforward job on lower ground.

PROTECTION OF FOREST FENCES BY TARRING OF NETTING

BY O. R. SARSBY

Forester, North-West England

IN THE FOREST Year 1948, I decided to emulate the Derwent Valley Water Board and to try to preserve the existing netting fences surrounding our Hope Forest area ; and I am now of the opinion that this operation is a practical and economical method of preserving and prolonging the life of such fences while still erect, and thus saving materials and labour.

Tools needed for the job are :

1. Boiler suits for protection of clothes
2. Buckets, 3—4 gallon capacity
3. Gas goggles and gloves
4. Quantity of " Staple-Secured " Cocoa Sweeping Brushes with short handle
5. Some 50 and 5 gallon drums (for distribution of tar), and a quantity of tar such as can be obtained locally at the Hathersage Gas Works. This tar is of such consistency that it needs no heating whatsoever, and can be applied on any normal warm day.

Method. To effect the operation the men team up in three's ; two to apply and brush in the tar from one side of the fence, and the third man to brush the residual tar into the netting from the other side of the fence.

While any normal warm day is suitable for the operation, dull warm weather is much preferred by the operators to warm bright weather, since the fumes from the tar affect the complexion when the pores of the skin are open, e.g., through sweating. The date from which tarring may take place is round about April and May.

The tar when applied to netting, etc., lasts on an average from four to five years before needing attention again. I have found that when using this method of preservation, the overall costs of tarring a chain of fencing to last eight to ten years are approximately 13s. per chain (including wet time), i.e., 6s. 6d. per chain per application. Whereas the overall cost of erecting a chain of stock, sheep and rabbit proof fencing to last eight to ten years would be approximately 47s. 8d. (this excludes wet time.)

The decided advantages of this method of preservation can be clearly seen especially in areas where the atmosphere, etc., curtails the life of wire netting fences. As to the effectiveness of this method, the Derwent Valley Water Board are still using it with great success, as they have done for the past thirty years ; they have netting thirty years old which is still intact and doing the job which is required of it to-day.

PLOUGHING PLANS

BY I. O. ROBERTSON

District Officer, Director's Office, Scotland

AT GLEN DEVON FOREST ploughing has been used for three years, and the results are satisfactory as regards growth. The ground is suitable, being neither steep nor too stony; a few places are too steep, but these are small and are turfed by spade. This particular unit is entirely hill country and although in southern Perthshire, closely resembles the Border hills. The ground is old sheep grazing land which has gone back. The highest point is 1,250 feet, but the compartments included in this plan lie between eight hundred and a thousand feet, with an eastern aspect. The soil is poor, and the complete neglect of drains has resulted in a heavy growth of *Juncus conglomeratus*, *Juncus articulatus*, *Molinia caerulea*, *Nardus stricta*, and *Eriophorum vaginatum*. One or two of the lower and as yet unplanted compartments give an inferior grazing, but the higher ground has large areas of deep peat.

The trees planted in 1947 and 1948 on ploughed ground are getting away quite well, but there are other considerations which must be borne in mind. Furrows simplify measuring and spacing, and definitely increase the speed of planting, and these advantages tend to obscure the disadvantages, some of which will not be encountered until the cleaning and thinning stage. Produce will then have to be dragged over the ridges and furrows. In places, like Glen Devon, where the ploughing has been deep, this will constitute an obstacle to low costs of extraction. Considerable thought was given to these and other points, and a ploughing plan was drawn up for the eighty-seven acres to be planted in 1949.

The main points to be considered for this area were as follows :—

- (1) Ploughing had to be deep to aid drainage of peat areas.
- (2) Ploughing should not be up and down the slopes as scouring resulted. (A point already proved in P.47 and P.48).
- (3) Furrows and ridges about eight inches deep would make extraction of produce difficult, and therefore furrows should be ploughed at an acute angle to the rides.
- (4) Extraction routes should be planned in conjunction with roads and rides, before ploughing.
- (5) Areas allocated to different species requiring different planting distances should be marked out before ploughing.

With these points in mind some intensive field work was put in and, due mainly to the enthusiasm of the foreman-in-charge, the ground was well marked out for the tractor driver and plough.

Pegs marked out the line of the proposed road, which has been planned to circumnavigate the entire forest, making full use of contours. Rides dividing the area into compartments were also pegged out, and care taken that such roads and rides would cross any existing or proposed drains at right angles, to simplify future bridges. The planning of rides for the area was rather difficult, as deep gullies cut the hillside in several places, and a ride on one side of a gully is only half the answer. However, by placing the rides always on the south side of the burns, each section of the compartment was served.

The wetter areas to take Norway spruce were marked out so that the ploughing here would be at $4\frac{1}{2}$ feet spacing instead of the 5 feet elsewhere. By this time, the area was looking rather peg-ridden, but the planning programme was not yet completed. The angle of the furrows to the rides was considered of major importance in order to have the lines of trees joining the rides at acute angles to facilitate extraction, so that produce could be dragged along the lines to feed the main rides in herring-bone formation. Actually this was found to be impractical on the ground, as such a formation would necessitate dragging uphill in certain areas. The same result could be achieved here by ploughing in parallel lines almost throughout the area. The steepness of the ground in some places made this difficult, as up and down ploughing was undesirable if scouring was to be avoided. Eventually a compromise was worked out, and before the plough arrived the entire area was marked out for every possibility.

It was further decided to leave every twentieth row unploughed, forming an additional extraction line where produce would have to be dragged across the furrows. An inspection path was also pegged out, running across the hill along the contour.

The tractor driver arrived and was considerably worried by the array of pegs, posts, and stobs which covered the ground in apparent disorder, but once he got the idea he co-operated extremely well. The direction in which the furrows were to run in each compartment was laid down for him, and under the supervision of the foreman the plough was lifted at one peg and lowered at another until the whole area was covered to our satisfaction. In this particular instance it so happened that the ploughing was almost always in the same line, and this allowed the plough a long economical run without turning.

The sum total of all this work is that the roads and rides have been left unploughed, and show up throughout the areas as bare ground. Dragging lines and inspection paths are likewise unploughed ; the angle of the furrows to the rides will aid future extraction and facilitate drainage, as the direction is obliquely downhill towards a ride or road with its accompanying drain. Areas for Norway spruce have been ploughed with closer furrows, and the whole area covered to best advantage with steep run-offs avoided. In other words, several aspects of forest management and utilisation have been incorporated in one operation.

[The acreage ploughed was seventy-seven acres at a contract cost per acre of seventeen shillings ; the time taken was sixteen days. The ploughing was done by an outfit hired from the Department of Agriculture for Scotland. F. OLIVER, *Conservator, East Scotland.*]

PLANTING BAGS

BY A. H. W. PYPER

Student, Glentress Forest School

THE DESIGN OF the planting bag, as used by the Forestry Commission at the present time, fulfils only one requirement—it holds plants. The question rises involuntarily to one's mind—"Surely, that is enough?"

The writer will endeavour to point out the obvious answer to that question, and to assist those readers who are not acquainted with the planting bag under discussion, here are the approximate dimensions and material specifications :—Length, 25 inches ; depth, 13 inches ; width, 3 inches. The back of the bag is longer by some 6 inches, which affords protection to the wearer's clothes. Attached to the back of the bag at the top corners, is a strap about $1\frac{1}{2}$ inches in width. A similar strap is attached 6 inches below it. The top strap is for the shoulder, the lower for the waist. No adjustment can be made to those straps except by knotting. The material used for the carrier portion is strong hessian, the straps are also hessian but with a heavier weave.

The planting bag is intended primarily to protect the delicate roots of the plants from drying influences such as wind and sun. The inference, then is that the plant roots must be kept damp. This dampness transfers itself from plant to bag, which over the course of a normal day's planting usually deteriorates to moist, or even wet, conditions. Bear in mind, that hessian is not waterproof, and that the wearer of the bag usually has this cold damp bag pressing against his thigh or buttock during planting. The strap supporting the bag loses width by stretching. The stretching being caused by the weight of the plants, moisture and earth clinging to the roots, and this weight, incidentally, may range from ten to fifty pounds. A narrow strap cuts into the toughest shoulder over a period of hours—visualise a gamekeeper with such a strap to his game-bag !

The shape of the bag is somewhat controversial, because of the various sizes of plants carried. If Scots pine plants, aged one-plus-one, are used, then the bag is suitable. But, consider Sitka or Norway spruce, which may be 15—18 inches long ! The waist strap cannot be adjusted, therefore each time the planter bends to insert a plant into the earth, the bag slips round to the front of his body, and continual readjustment of the bag is necessary, after each plant is inserted and "firmed up." Obviously, the disadvantages of such a bag with its consequent discomforts does not assist the planter, but helps to delay the planting programme where time is quite a vital factor.

To conclude, the writer puts forward the suggestion that the standard planting bag be re-designed. Why not a carrier in the shape of that used for carrying cricket gear, with smaller dimensions, of course ?

Alternatively, the standard bag could be modified, viz. :—wider straps which are adjustable—waterproof material next to wearer's body and a wider base.

THE SUPPRESSION OF COPPICE BY WEEDING

BY B. R. HAMMOND

Forester, South-West England

MANY FORESTERS will know the great amount of weeding required to establish a forest crop ; and during the first three years, on old hardwood areas, it is safe to say all of them will be troubled with coppice shoots. It is remarkable the vigour such stools can show. During the past five years I have examined carefully the effect of the growth of the tree crop on the coppice stools, and have found it possible to tabulate the results of these observations.

The area on which these results were noted is an old hardwood stand on chalk downland, with a rainfall of about thirty inches per year, and an elevation ranging from 450 to 800 feet, the slope being generally from the north of the forest to the south. The principal tree crop is beech, from one to eleven years old, and the main coppice weeds are oak, ash, privet, birch, dogwood, willow, hornbeam, hazel, field maple, and wayfaring tree, with smaller quantities of spindle, guelder rose, buckthorn, and elder.

It has been the policy to weed hard from the start, and the results may be shown in the form of table as set out below. There have been exceptions of course, but it has been a source of interest to me to see how closely most species adhere to the general habit.

Age of Plantation	1st Year		2nd Year	3rd Year	4th Year	5th and Later Years
Species	1st Weeding	2nd Weeding	3rd Weeding	4th Weeding	5th Weeding	Remarks
Oak From Main-crop Stools	Vigorous	Vigorous	Vigorous	Vigorous	Weaker	Weakening up to 9th year. Killed only by suppression
Oak From Coppice Stools	Vigorous	Vigorous	Weaker	Dying or Dead	Dead	This result is unreliable, as coppice oak varies much in vigour
Ash From Main-crop Stools	Vigorous	Vigorous	Weaker	Dying or Dead	Dead	Sometimes longer on young standard coppice
Ash From Coppice Stools	Vigorous	Weaker	Very Weak	Dead		Will grow weakly sometimes from 4th year if crop is backward

Age of Plantation	1st Year		2nd Year	3rd Year	4th Year	5th and Later Years
Species	1st Weeding	2nd Weeding	3rd Weeding	4th Weeding	5th Weeding	Remarks
Privet	Vigorous	Vigorous	Vigorous	Weaker	Very Weak	Killed only when canopy closes
Birch	Vigorous	Vigorous	Weaker	Dead		As for ash
Dogwood	Vigorous	Vigorous	Uncertain			Generally dislikes cutting over
Sallow	Vigorous	Vigorous	Vigorous	Weaker	Very Weak	Dies at 5th year
Hornbeam	Vigorous	Vigorous	Weaker	Very Weak	Dead	Results not proved
Hazel (10-20 year Stools)	Vigorous	Vigorous	Vigorous	Weaker	Very Weak	Dies at 5th or 6th year
Field Maple	Vigorous		Uncertain			
Wayfaring Tree	Vigorous		Vigorous	Vigorous	Vigorous	Weakens and dies as light recedes
Spindle, Guelder rose, Elder	Vigorous		Results uncertain			Generally killed at 5th year

Note.—All above results obtained from an area where beech growth is vigorous (height at 5 years in plantation 12-14 feet, and at 12 years from 18 to 22 feet) and suppression by side branches is strong. These findings may not apply to areas where growth of the main crop is slower.

It will be noted that oak from main-crop stools, ash from young vigorous coppice stools, birch, hazel and wayfaring tree are all troublesome up to the fifth year, with sallow also a nuisance.

In theory this suggests that after five years the crop will generally have suppressed, or the weeding will have killed, the coppice, but this is not so in practice; for who can say after a crop has been weeded in, say, its second or third year, that every coppice shoot has been cut—they cannot, and thus we have the insidious tree coppice creeping in, which calls for a “cleaning” later on.

A study of the power of coppice to withstand cutting is of great importance for the proper control of coppice weeding operations.

THE TREATMENT OF A SHEEP-DAMAGED OAK PLANTATION AT NAGSHEAD—FOREST OF DEAN

BY C. H. DAVIES

Forester, Dean Forest

DURING THE WAR years of 1942-1946, much damage was done to the young oak plantations in the Nagshead Inclosure by sheep which invaded the area through damaged gates and fences, while the area was in the occupation of the military.

One plantation of P.38 oak was extensively damaged and early in 1947 looked quite hopeless as regards ever becoming a plantation of any value ; the average height at eight years was about 2 feet 6 inches, the majority being just round topped bushes, the average stem diameter at base being three-quarters of an inch.

Early in 1947 it was decided to make a coppicing experiment. So in April, 1947, I selected ten of the most damaged rows in the area ; five of these rows were screefed about a foot diameter around the base of all plants. The idea being for this operation to give the expected coppice shoots a good start and to be free of weed growth. Having completed the screefing, every plant in the ten rows was cut off at ground level. The cutting operation was done with No. 2 reap hooks, which had been previously ground down thin, about six inches back from the point, and then sharpened to a clean cutting edge. In the actual cutting operation the hook was hooked around the butt of the plant at ground level, the top of the plant gripped by the operator's left hand and pulled slightly towards his left foot ; then a sharp pull on the hook (not a chop) resulted in a good clean sloping cut, which is necessary in all coppicing operations.

The result of this experiment proved quite successful, 99 per cent. of the stools threw an average of three stems per stool, and by October, 1947 many of the stems had grown to a height of four feet, the average being 2 feet 9 inches, with many stems half an inch diameter at base.

Screefing proved to be quite unnecessary, in fact, I think it advisable to leave grass, etc., which gives protection to the young shoots against late spring frosts.

During April, 1948, a further nine acres were coppiced in this plantation, the following systems being adopted. Ten rows were coppiced, with four rows of the original plants left as a control. This again proved as successful as the 1947 operation ; the stools produced an average of three stems, of an average height of 2 feet 9 inches ; some measured up to 4 feet 6 inches, and one in particular attained the height of 6 feet 2 inches in seven months. I personally prefer the shorter stems, which are of a more robust and stouter nature.

In conclusion, just a few words on what I consider is the best sized stool to coppice. On examination of the above area, during late November, 1947, I found that a stem of about half an inch in diameter gives two to three good sized shoots, and that the stool is more quickly grown over by the new wood. Many of the stools of an inch diameter are now more than half covered with new wood, this having taken about seven months to form. So after two growing seasons, my opinion is, that no trace of any of the coppiced stools will be visible.

THE BRASHING AND THINNING OF SPRUCES AND DOUGLAS FIR

BY R. J. JENNINGS

Forester, North Wales

IN THE OLDER forests of the Commission the brashing and thinning of several thousand acres is now taking place, and owing to the accumulated arrears of work due to the war, few units are up to date with their programmes. Unless the supply of labour is plentiful, a large annual thinning or brashing acreage will present some problems. At Kerry Forest in North Wales Conservancy we had completed by 1947 almost 300 acres of brashing and 100 acres of first thinning, and the following observations may be of interest to foresters whose areas have not yet reached this stage.

Our experience of costing and the prices of operations here may not agree with that of others; wet weather can make an enormous difference to the amount of money spent on a job. But the quantity of work a man can do in a day should not vary much on different forests in fair weather, and I have quoted our costs and prices because figures seem to be all important these days.

Technical Notes includes the recommendation that the complete brashing of plantations should not be undertaken without specific instructions. One row in three appears to be considered sufficient, and in an effort to conform with regulations and get speedily over the ground this one-third brashing was done; but on entering to mark thinnings the following difficulties were encountered:

- (1) The forester or foreman has difficulty in marking the tree to be cut because of protruding branches; in the spruces these distract the attention by scratching the face and hands; they prevent a good view of the crown of the tree and seriously hamper the job.
- (2) The axeman following finds that before a tree can be cut or the axe swung he will, in the majority of cases, have to trim up not only the tree he is about to cut, but also those on either side of it to clear the passage for his axe.
- (3) In Sitka spruce especially, the time taken in pulling down the severed tree is often several minutes, owing to the dense branching and restricted space: further difficulty is also experienced in manhandling the poles to the tush or rank from which the horse will haul them.
- (4) When extraction is undertaken by horse it is not possible for the haulier to go in any direction other than straight up and down the rows, as no horse or man will face unbrashed Sitka spruce for many minutes.

It will already be seen that the problems encountered due to partial brashing were so many that it was obviously necessary to examine thoroughly the costs of both brashing and cutting operations to find out whether money was actually being saved. A half-acre plot was completely brashed on day-work at a cost of £6 11s. 0d. per acre. An adjoining plot was brashed every third row for £2 2s. 10d. per acre. Both plots were in P.26 Sitka spruce. Thinning was then carried out in both plots. The volume per acre cut was

238 cubic feet, costing 4½d. per cubic foot in the completely brashed plot, and 8½d. in the other. This will be found to cost £4 14s. 2½d. and £8 3s. 7½d. per acre. The minimum wage at this time was £4 10s. 0d. per week.

Let us now see the costs of both operations together :—

	<i>Complete brashing</i>	<i>Brashing every third row</i>
	£ s. d.	£ s. d.
Brashing per acre :	6 11 0	2 2 10
Thinning per acre :	4 14 2½	8 3 7½
	<hr style="width: 100%;"/>	<hr style="width: 100%;"/>
	£11 5 2½	£10 6 5½
	<hr style="width: 100%;"/>	<hr style="width: 100%;"/>

which gives a saving of 18s. 9d. per acre on the one-third brashed plot, or rather less than 1d. per cubic foot on the thinning after brashing. At first sight this appears to be well worth considering, but we are by no means yet out of the wood. Neither are the thinnings. It is not possible to work a horse up and down semi-brashed rows of trees, which is what one row in three amounts to, and although tushing can be done in between rows which have been brashed on one side, the poles have yet to be put together in numbers by the men in readiness for the horse. This means pulling poles again through unbrashed rows of trees, and this is a most slow and painful process, resulting in scratched hands and faces, torn clothes and general dissatisfaction in all directions. This manhandling of poles, added to the forester's time spent in marking, will more than cancel out the 18s. 9d. per acre previously saved; and it is far more economical in the first place to undertake complete brashing for satisfactory work by man and horse. When it became apparent that complete brashing would have to be undertaken, the question of piecework was immediately considered, as the operation is one that lends itself well to the method of payment by results.

This was found to be the solution to the problem, and now at Kerry almost all brashing is done on piecework and the rates below are now being paid. The unit we work to is the square chain and the men usually work in pairs.

Sitka spruce : £6 per acre for complete brashing except for very small trees; even these are brashed at eye level.

Douglas fir : £4 15s. 0d. to £6 per acre depending on the density of the stand and the habit of the tree. This species at 6-foot spacing is much easier to work in than the spruces.

Norway spruce : Generally £5 10s. 0d. to £6 per acre.

Japanese larch has been brashed completely at £2 18s. 0d. per acre by knocking off the branches with bill hook or slasher, but I consider it is inviting trouble in the form of canker to brash any larch with an edged tool. A certain percentage of trees carry live or very persistent branches and these, when knocked off, leave a hole frequently half an inch across or more, with a depth of anything up to an inch in the trunk of the tree; it will probably be wiser in the long run to use a saw for all brashing.

After trying many saws, the men here favour Skelton's sixteen-inch to twenty-inch curved type down-cutting saws, with socket and nine-inch handle. A longer handle enables them to use two hands and consequently to put more weight on the saw, but most men at Kerry seem to like one hand on the branches they are cutting. We have used a saw made by Thomas Scott, a similar type to Skelton's; this saw is good, but set at a severe angle from the socket, which makes it somewhat awkward to use. The double-edged wooden box-handle saws are almost useless.

It is not a good practice to allow men to sharpen their own saws. Much time and a great many saws can be wasted in this way, and a popular pastime for youths on daywork in the past has been the sharpening of saws sitting down : this job can be done as many times a day as the ganger is foolish enough to allow. With a brashing gang of some eighteen men we keep four or five spare saws, and the used ones are taken down at night to an experienced man, who charges 1s. per saw for sharpening and setting. A saw ought to last well over a week. No workman is allowed to sharpen a saw, he obtains a replacement when required.

The marking for thinning does not present many problems, but with a large programme of several hundred acres per year, it is not possible for the Forester (as in the past) to do all the marking, and he must train gangers and foremen to the job. Confidence can only be obtained with plenty of practice, and the best way of training is to give careful guidance and then leave the man to the job. To return frequently with criticisms will do more harm than good, and a man will not become proficient in this way. Quite a good way of training a man to mark thinnings is to send him in the wood to mark the small poles and obvious trees to be cut, he can go ahead with many acres and the cutters can follow behind him. The forester can then mark the remainder.

There are of course objections to this procedure, but if sales of small poles are good, there is no reason why these should not be extracted and dispatched before the pitwood and scaffold poles are cut. We have found that this method saves much grading and handling on the ride, and it is easier for a horse to haul cut poles of one grade than mixed sizes.

Extraction from plantations of first thinnings by horse is not an easy matter unless the ground is reasonably clear of brash. It is well worth while to send a boy ahead of the axemen, with a fork to clear the runs for the horse.

The cutters here are paid piecework rates for cutting poles, usually from 3d. to 6d. per pole, and this includes carrying the poles to the nearest cleared row ready for dragging out by the horse. The more straightforward the job is made for the haulier, the cheaper and quicker will be extraction. The felling charge of 2d. per cube as allowed by Timber Control is insufficient for the felling of first and second thinnings, and it is not reasonable to expect the operation to cost the same as clear felling for the following reasons : In a clear-cut the trees, which are usually of greater volume than those taken out in thinnings, can be thrown in any direction without fear of damage to adjoining trees, and what is of more importance, fall to earth of their own accord, not having to be lifted bodily and dragged to the ground before trimming out is possible. It is not uncommon to see four men heaving on the butt of a tree containing perhaps two to three cubic feet, which has become fast owing to perhaps a double leader or large crown ; much time must be spent on this kind of thing and in consequence it is very difficult to show any profit on first thinnings.

Sales of standing thinnings may appear revolutionary, but at Kerry it has proved quite successful and the following procedure has recently been adopted. The Department marks and measures the thinnings to be cut in a plantation and sells them standing to a timber merchant *of good repute*. With limited labour this method is enabling us to catch up with arrears of work, by releasing labour for current operations.

Some foresters doubting the wisdom of this procedure will immediately ask how do we know that the merchant's axemen do not cut trees that have not been marked by the Forestry Commission ? Can we be certain that

odd trees are not taken out now and again? The answer, of course, is that we can never be absolutely sure, but with good supervision on our part the danger from this kind of practice can be reduced to a minimum, and it is unlikely that a good merchant will encourage it. A distinctive scribe made for the forester by a local blacksmith could be used if there were grounds for suspicion of dishonesty, and the fear of this alone should not be allowed to prevent the Department from disposing of standing thinnings to merchants and by this method showing a good profit.

Summary

It is not practical to thin and extract produce from spruce or Douglas fir plantations with only 33 per cent. brashing. For easy access and working facilities 90 per cent. of the crop requires brashing. Any money saved on brashing will be lost in cutting and extraction. Brashing in all species has been undertaken quite satisfactorily on piecework at Kerry. The amount that can be expected of one man in a good day's work is in the region of two to two-and-a-half square chains, depending on species and density of the stand.

To send fellers into plantations which are partially brashed will result in the trimming of standing and final crop trees with axes to give the necessary working space, with consequent barking and damage to standing trees.

The best saw at this forest has proved to be the sixteen or twenty-inch curved pruning saw with downward cut, made by Skeltons of Sheffield.

For straightforward and rapid extraction by horse it pays to clear brush from every third row, and to draw the poles by hand to the rows ready for the horse.

The best returns from thinnings at Kerry Forest have been obtained by selling marked and measured standing trees to well-known merchants.

Since writing the above, we have undertaken in 1948 a considerable acreage of Douglas fir and spruce brashing both at Kerry and St. Asaph Forests. Our experience has been similar to previous work, but the following additional observations seem worthy of mention.

For economic reasons we have continued to brash the minimum in all species, but as one row in three was insufficient, the men were instructed to brash every other row completely, or, as an alternative, the two insides of two adjacent rows, which is about 50 per cent. of the crop.

The piecework rate set was the same in both methods, but as the workers on the two sides of two rows were unable to earn satisfactory wages when compared with the single row men, closer inspection revealed the reason for this.

The actual breaking into the branches and commencing sawing takes up most of the time spent. Once a clear passage has been cut for sawing, the remainder of the branches are removed fairly rapidly. The man brashing two sides has to open out twice the number of trees compared with his opposite number on single rows, and in addition to this he will also find it necessary to remove more than half the amount of side branches on each tree, as smaller twigs and branches, although not actually growing out sideways into his line, will nevertheless very frequently protrude and must be cut off if the passage is to be clear.

This in effect will mean that brashing the sides of two rows is actually brashing sixty to sixty-five per cent. of the crop and *not* fifty per cent as was at first intended. When setting a piecework rate it will be very necessary to bear this in mind.

[Mr. Jennings' article shows the difficulties encountered in North Wales in our efforts to reduce brashing costs. At high elevations Douglas fir is extremely coarse-branched, and when spruces have checked during early growth the whorls are close together and branches very numerous ; brashing is therefore very costly and complete brashing may exceed £6 per acre. Unfortunately our efforts to reduce the cost by adopting partial measures have usually resulted in increased costs per tree brashed, and the reduction in cost per acre has therefore not always been as great as had been expected. F. C. BEST, *Conservator, North Wales.*]

RECORDING OF THINNING YIELDS IN PLANTATIONS

(*SILVICULTURAL CIRCULAR No. 22*)

THERE IS A great need for more precise information as to the actual yield per acre from first, second, third, etc., thinnings made in those Forestry Commission plantations which have got to the thinning stage. Data are wanted both as to out-turn in cubic feet (quarter girth, over bark) and in terms of produce classes—timber, pitprops, pulpwood, etc., and these figures must be related to the height and average quarter girth of the stands concerned. If such data were collected systematically, they would not only be a valuable guide to Conservators in estimating their yields from future thinning, but will also enable us to improve our Yield Tables, which are defective especially as regards the thinning yields between twenty and thirty years of age.

The desired information could be provided, without excessive demands on the time of the local staff, by laying out small circular plots in blocks or compartments which have been marked for thinning, before the thinnings have actually been cut. The plots should be selected at random, but more or less evenly spaced over the area.

In blocks of from 1 to 10 acres, select 2 plots.
 „ „ „ „ 10 to 20 acres, select 4 plots.
 „ „ „ „ 20 acres and over, select 6 plots.

If there are obvious differences in rate of growth or stocking within a block, each type would need to be sampled separately.

The plot or plots are to be selected and laid out in areas which have previously been marked for thinning by the Conservancy staff, but it is not necessary to wait for the whole of a stand to be marked before selecting plots: this would clearly be impracticable where the felling follows close behind the marking of the thinning. The chief points to note are: (1) that the selection is random, i.e., no attempt should be made to select what is regarded as a typical sample of the plantation; (2) that the plots are not laid out until the marking for thinning has been actually done in that portion of the stand; (3) there is no necessity for all the plots in any one stand to be measured on the same day.

It is realised that the number of plots which can be laid out in any given year in a Forest will depend on local conditions, and especially upon the staff available, but it is hoped that District Officers and Foresters will do their best to collect the desired information.

In young stands, e.g., first and second thinnings, the size suggested for the plot is one-twentieth of an acre: a plot this size will have a radius of 26 feet 4 inches (a one-tenth acre plot has a radius of 37 feet 3 inches). The centre of the plot should be a well-formed dominant-class tree, and this tree should be marked with a broad band of white, and given a number for permanent record, e.g., 1/C. 27, indicating that this marks the centre tree of Plot No. 1 in Compartment No. 27. The boundary trees of the plot should also be marked with white paint.

The Plots as a Basis for Increment Records

By marking with white paint the centre tree and boundary trees, it will be possible to return to the same spot after a period of years, to remeasure the same trees, and so obtain a fairly accurate record of increment in girth and

height. Such data would be of general as well as of local interest and value. The approximate position of the centre trees should be marked if possible on a six-inch map, and also described in sufficient detail to enable each of the plots to be located in future. The outline plan prepared in connection with the thinning programme would seem a convenient map for the purpose of indicating the sites of the plots. A rough sketch on the back of the Summary Sheet, showing the shape of the Compartment and the approximate site of the plot or plots, would be useful.

The information to be recorded for each plot is indicated on the attached specimen forms, which are designed to produce the essential information as concisely as possible. It is proposed to provide books of these forms for convenient use in the field. Individual points to note in completing the forms :

Description Sheet : One description sheet (Form T.Y.1.) is required for all the plots within a uniform compartment or subcompartment, and the same sheet will serve for several remeasurements until the space for remarks is full up, when a new sheet will have to be added.

Girthing Sheet : One sheet (Form T.Y.2.) for each plot.

- (i) The whole inches, quarter girth, are to be inserted in the girth column, starting at the top of the page with the smallest girth that is likely to be encountered. If the girth range is very large, two sheets may be necessary to cover the whole range.
- (ii) The determination of mean quarter girth by the 40 per cent. rule ; if there are 100 trees in a plot the mean tree is the 40th in descending order of girth ; with 65 trees the mean tree would be the 26th from the top girth :

$$\frac{(65 \times 40 = 26)}{100} \quad \text{or} \quad (65 \times 0.4 = 26).$$

Thinning Sheet :—One or more thinning sheets (Form T.Y.3.) for each plot.

- (i) Produce to be classed as timber only if there is a minimum length of 10 feet of 9-inch top diameter over bark or more.
- (ii) Pitwood includes all reasonably straight lengths below timber size, measured down to 3-inch diameter over bark.
- (iii) Pulpwood runs from 3 to 1½ inches top diameter over bark.
- (iv) Firewood is any wood that owing to bad shape or for other reasons is unsuitable for other use.

Summary Sheet : One summary sheet (Form T.Y.4.) for each group of plots within a compartment or subcompartment, as for description sheet.

Equipment

Apart from the tools for converting the thinnings the following equipment is required for establishing the plots :

Tape or chain—for measuring radius of plot. It will be useful to mark conspicuously the point at 26 feet, 4 inches or 37 feet, 3 inches, depending on whether one-twentieth or one-tenth acre plots will be used.

Girthing tape—marked in quarter inches of quarter girth.

Paint and brush—for marking centre and boundary trees. White Titanium paint as used for the Forestry Commission permanent sampleplots is suitable. (Suppliers :—Montgomery, Stobo and Co., Rogart Street, Bridgeton, Glasgow).

Chalk—each tree when girthed should be marked with chalk at the girthing point, i.e., at 4 feet 3 inches above ground, to avoid measuring the same trees twice or missing out trees.

Supply of Thinning Yield Forms.

Pencil and rubber.

A stick, four feet, three inches long, as a guide for correct determination of the breast height point. On a slope always measure from above.

Fixed calipers for diameters of $1\frac{1}{2}$, 3 and 9 inches, would be a help, but are not essential.

Procedure

Work to be done by two men.

1. Select well shaped dominant as centre tree, paint on it the plot and compartment number, e.g., 1/C.27.
2. Fill in description sheet, if this has not already been done for a previous plot in the same compartment.
3. Run out tape and mark with paint the boundary trees. Trees right on the boundary should be *excluded* if the centre of the stem is outside at ground level ; and *included* if the centre is within the specified radius.
4. Girth the plot. One man records, the other girths, and calls out the girth, adding whether main crop tree or thinning. Each tree as it is girthed is chalk-marked to prevent confusion.
5. Fell, measure and record thinnings. Include all trees with a quarter girth at breast height of $1\frac{1}{2}$ inches or over ; where there is no measurable volume enter "No Volume" in the Remarks column.
6. Complete forms locally, or send to District or Conservancy Office for completion according to instructions. Conservator will have copies of the Summary Sheet typed and sent to local District Officer and Forester ; one copy, together with the original field book forms, to be sent to the Chief Research Officer, Alice Holt, Wrecclesham, Farnham, Surrey.

W. L. TAYLOR

Director-General

The forms which follow present the data for a plot measured in a Corsican pine plantation in the New Forest. It will be noted that the volumes of the thinnings are given in Hoppus feet and inches using the Forestry Commission Hoppus Tables, supplemented by an extra table for quarter girths below two inches. In some Conservancies Dr. Wilson's decimal Hoppus Tables are used, these are equally suitable for the purpose.

The table below gives volumes in decimals, and Hoppus feet and inches, for quarter girths below two inches.

VOLUMES FOR QUARTER-GIRTHS BELOW TWO INCHES

Feet Long	Cubic feet, quarter girth		Cubic feet, quarter girth			
	1½ inch q.g.	1¾ inch q.g.	1½ inch q.g.		1¾ inch q.g.	
	Decimals	Decimals	Feet	Inches	Feet	Inches
1	.02	.02	0.	0	0.	0
2	.03	.04	0.	0	0.	1
3	.05	.06	0.	1	0.	1
4	.06	.09	0.	1	0.	1
5	.08	.11	0.	1	0.	1
6	.09	.13	0.	1	0.	2
7	.11	.15	0.	1	0.	2
8	.13	.17	0.	2	0.	2
9	.14	.19	0.	2	0.	2
10	.16	.21	0.	2	0.	3
11	.17	.23	0.	2	0.	3
12	.19	.26	0.	2	0.	3
13	.20	.28	0.	2	0.	3
14	.22	.30	0.	3	0.	4
15	.23	.32	0.	3	0.	4
16	.25	.34	0.	3	0.	4
17	.27	.36	0.	3	0.	4
18	.28	.38	0.	3	0.	5
19	.30	.40	0.	4	0.	5
20	.31	.43	0.	4	0.	5
21	.33	.45	0.	4	0.	5
22	.34	.47	0.	4	0.	6
23	.36	.49	0.	4	0.	6
24	.38	.51	0.	5	0.	6
25	.39	.53	0.	5	0.	6
26	.41	.55	0.	5	0.	7
27	.42	.57	0.	5	0.	7
28	.44	.60	0.	5	0.	7
29	.45	.62	0.	5	0.	7
30	.47	.64	0.	6	0.	8
31	.48	.66	0.	6	0.	8
32	.50	.68	0.	6	0.	8
33	.52	.70	0.	6	0.	8
34	.53	.72	0.	6	0.	9
35	.55	.74	0.	7	0.	9
36	.56	.77	0.	7	0.	9
37	.58	.79	0.	7	0.	9
38	.59	.81	0.	7	0.	10
39	.61	.83	0.	7	0.	10
40	.63	.85	0.	8	0.	10

Form T.Y.1

Description Sheet

THINNING YIELDS

Conservancy : *New Forest.* Forest : *New, Wilverley Inclosure.* Compt. No. : 21. Species : *Corsican pine with a few Scots pine.* Planting year : 1921. Approximate area of stand : *Five acres.* Number of plots measured : *One.* Size of plot : *One-twentieth acre.* Serial Number of thinning (1st, 2nd, 3rd, etc.) : *Stand had had several previous light thinnings.*

Remarks : (e.g., whether a normal type of thinning or mainly for removal of wolf trees, or for some other special reason).

A normal type of medium thinning. A high proportion of malformed dominants in the crop, but now too late to get them all out.

If stand was previously thinned, how long ago ?

Elevation : 200 feet. Aspect : *South-West.* Slope : *Almost level.*

Initials : *G.D.R.* Rank : *Divisional Officer.* Date : 30 . 12 . 47.

On reverse side of this form make a rough sketch of the Compartment, showing approximate position of plot or plots. Add a north point.

Form T.Y.2.

GIRTHING SHEET

Conservancy : *New*

Forest : *New, Wilverley* Compt. No. : 21
Inclosure

Species : *Corsican pine*

P.Yr. : 1921

Size of plot : 1/20 ac.

Plot No. : 1

Quarter Girth at b. ht., ins.	Main Crop. Number of Trees (Tallies)	Thinnings. Number of Trees (Tallies)	Total Main Crop	Total Thinnings	Total Crop before Thinning
1 1 1 1 1 1 1 1	.	X X X X X*		5	5
2 1 1 1 1 1 1 1	X X X X X X X	X X X X X X X	4 2 1	1 2 4	1 6 2 5
3 1 1 1 1 1 1 1	X X X X X X X X	X X X X X X	2 2 3 1	1 1 1 1 2	3 3 1 4 3
4 1 1 1 1 1 1 1	X X X	X	2 1	1	3 1
5 1 1 1 1 1 1 1	X X X X X X X X X	X X	2 2 3 2	2	4 2 3 2
6 1 1 1 1 1 1 1	X X X		1 2		1 2
7 1 1 1 1 1 1 1	X X		1 1		1 1
8	X		1		1
Total ...	33	21	33	21	54

**Mean quarter girth before thinning (by 40 per cent. rule) : 4 in.

†Mean quarter girth after thinning (by 40 per cent. rule) : 5½ in.

Upper height of dominant trees : 38 ft.

(estimated from measured length of taller thinnings).

Initials : *G.D.R.*

Rank : *Divisional Officer*

Date : *30th December, 1947*

* For ease of printing the letter X has been used in place of the usual stroke.

** (0.4 x 54 = 22). The 22nd tree counting from the foot of the last column has a quarter girth of 4 inches

† (0.4 x 33 = 13). The 13th tree counting from the foot of the Main Crop column has a quarter girth of 5½ inches.

Form T.Y.3.

THINNING SHEET

Conservancy : *New*

Forest : *New, Wilverley Inclosure*

Compt. No. : 21

Species : *Corsican pine*

P.Yr. 1921

Size of plot : 1/20 ac.

Plot No. : 1

PRODUCE FROM FELLED TREES														
Q.G. b.ht. ins.	Length to tip feet	TIMBER over 9 in. diameter			PITWOOD 3 in. to 9 in. diameter			PULPWOOD 1 1/4 in. to 3 in. diameter			FIREWOOD			Remarks
		L. ft.	Mid. Q.G. o.b.	Vol. cu. ft. and ins.*	L. ft.	Mid. Q.G. o.b.	Vol. cu. ft. and ins.*	L. ft.	Mid. Q.G. o.b.	Vol. cu. ft. and ins.*	L. ft.	Mid. Q.G. o.b.	Vol. cu. ft. and ins.*	
2 1/2	29	6	3	.5	8	2 1/2	.3						No volume	
4 1/2	35	20	4	2.3									No volume	
1 1/2	18												No volume	
1 1/2	17													
1 1/2	22													
2 1/2	27													
1 1/2	21													
1 1/2	23													
2 1/2	28													
2	29													
5	37	24	4 1/2	3.0									Scots pine	
2 1/2	30													
5	37	24	4 1/2	3.0										
3 1/2	33	11	3 1/2	.10										
2 1/2	31													
3 1/2	32													
4	39	14	3 1/2	1.0										
2 1/2	30	25	3 1/2	2.5										
3	35	6	2 1/2	.4										
3	35	6	3	.5										
3 1/2	30	13	3 1/2	.11										
3 1/2	36	10	3 1/2	.9										
Totals Trees	619			15.4			6.9							

NOTES :—(i) Produce to be classed as Timber, only if there is a minimum length of 10 ft. of 9 in. top diameter over bark or more.
 (ii) Pitwood includes all reasonably straight lengths below timber size, measured down to 3 in. diameter over bark.
 (iii) Pulpwood runs from 3 in. to 1 1/4 in. top diameter over bark (Minimum length with mid Q.G. of 1 1/4 in. to be 6 ft.)
 (iv) Firewood is any wood that owing to bad shape is unsuitable for other use. (Minimum

Average length of thinnings to tip : 30 ft.

Total volume of thinnings : 22 cu. ft., one inch Hoppus measure (over bark)

Initials : G.D.R.

Rank : *Divisional Officer*

Date : *30th December, 1947*

Form T.Y.4.

SUMMARY RECORD OF THINNING YIELDS—PER ACRE

Conservancy : *New* Forest : *New, Wilverley Inclosure* Compt. No : 21
 Species : *Corsican pine* Planting Year : 1921
 Aged 27 years at Date of Measurement, 30th *December*, 1947
 Serial Number of thinning (1st, 2nd, 3rd, etc.) : *3rd or 4th*
 (Volumes to be given to the nearest 0 or 5 cubic feet)

STANDING CROP

Plot No.	BEFORE THINNING			AFTER THINNING	
	No. of Trees per Acre	Av. Q.G. at b.h. ins.	Upper Ht. ft.	No. of Trees per Acre	Av. Q.G. at b.h. ins.
1	1,080	4	38	660	5½
2					
3					
4					
5					
6					
Total	1,080	4	38	660	5½
Av.	1,080	4	38	660	5½

THINNINGS

Plot No.	No. of Trees per Acre	Av. tot. ht. ft.	Volume in cu. ft. Q.G. over bark per acre				
			Timber	Pitwood	Pulpwood	Firewood	Total
1	420	30	—	305	135	—	440
2							
3							
4							
5							
6							
Total	420	30	—	305	135	—	440
Av.	420	30	—	305	135	—	440

Initials : *G.D.R.*Rank : *Divisional Officer*Date : *30th December, 1947*

AVERAGE YIELDS FROM THINNINGS

BY J. W. IRVINE

Forester, Research Branch

FOR THE PAST thirty years detailed records of growth and yield for the major coniferous species grown in Britain have been accumulating in the Sample Plot files. In response to a recent query as to the average yield per acre from thinnings, all recorded thinning yields from permanent sample plots were totalled and average yields per species and per age class determined.

All thinning grades were included, viz :

B grade—Light low thinning

C „ —Moderate low thinning

D „ —Heavy low thinning

C/D „ —Mod./Heavy low thinning (single plots)

L.C. „ —Light crown thinning

The results representing 1,091 measurements are tabulated in Table 1. Figures are cubic feet quarter girth over bark, and represent volumes measured to a timber height of three inches diameter (over bark). These averages

AVERAGE THINNING YIELDS PER ACRE : DATA FROM ALL PERMANENT SAMPLE PLOTS

TABLE 1

Species	Average yield per thinning O.B. vol. cu. ft. Q.G. (Number of measurements in brackets)							Mean for each species
	—20 years	21—30 years	31—40 years	41—50 years	51—60 years	61—70 years	71+ years	
Scots pine	150 (16)	140 (18)	225 (28)	345 (31)	365 (34)	165 (20)	240 (14)	<i>all ages</i> 255 (161)
Corsican pine	250 (8)	245 (28)	415 (29)	525 (13)	540 (4)	1,080 (1)	975 (4)	400 (87)
European larch	115 (23)	215 (65)	300 (72)	335 (58)	465 (21)	400 (4)	145 (5)	280 (248)
Japanese larch	205 (34)	350 (62)	595 (51)	555 (9)	—	—	—	405 (156)
Douglas fir	300 (22)	490 (54)	600 (40)	605 (16)	540 (6)	660 (3)	900 (1)	515 (142)
Norway spruce	310 (4)	245 (31)	420 (34)	385 (24)	705 (8)	—	—	375 (101)
Sitka spruce	460 (23)	385 (39)	685 (21)	615 (7)	1,155 (1)	440 (1)	—	500 (92)
Other conifers	265 (19)	365 (40)	765 (34)	805 (11)	—	—	—	525 (104)
Mean of all conifers by age classes	250 (149)	325 (337)	480 (309)	440 (169)	465 (74)	290 (29)	370 (24)	385 (1,091)
Hardwoods	190 (16)	120 (12)	140 (12)	180 (11)	240 (16)	195 (13)	220 (5)	185 (85)

represent the yield *per thinning* within the ten-year period, *not* the total thinning yield for the period. Thus it may be assumed that a thinning in European larch at 33 years of age would yield approximately 300 cubic feet, with a further 300 cubic feet from another thinning in four years time at 37 years of age. It must be emphasised that, except where the figures are based on a large number of measurements, the averages may tend to be misleading owing to the wide range of quality classes, thinning grades, etc., involved.

In addition, average yields for C grade plots only—as being the grade of thinning most likely to be applied in general practice—were also obtained. These yields, based on 326 measurements, are given in Table 2.

AVERAGE THINNING YIELDS PER ACRE : DATA FROM C GRADE SAMPLE PLOTS ONLY

TABLE 2

Species	Average yield per thinning O.B. vol. cu. ft. Q.G. (Number of measurements in brackets)							Mean for each species
	—20 years	21—30 years	31—40 years	41—50 years	51—60 years	61—70 years	71 years	
Scots pine	30 (4)	110 (4)	290 (8)	365 (9)	315 (8)	320 (5)	205 (2)	<i>all ages</i> 270 (40)
Corsican pine	300 (1)	285 (4)	485 (11)	510 (6)	730 (2)	—	—	470 (24)
European larch	15 (2)	200 (23)	270 (20)	315 (12)	180 (1)	545 (1)	—	245 (59)
Japanese larch	155 (11)	315 (26)	485 (20)	625 (2)	—	—	—	355 (59)
Douglas fir	325 (7)	535 (22)	755 (14)	930 (2)	—	—	—	590 (45)
Norway spruce	330 (1)	215 (10)	450 (11)	300 (7)	730 (3)	—	—	365 (32)
Sitka spruce	430 (8)	425 (11)	750 (8)	1,115 (2)	—	—	—	565 (29)
Other conifers	110 (3)	450 (15)	910 (15)	745 (5)	—	—	—	645 (38)
Mean of all conifers by age classes	230 (37)	345 (115)	540 (107)	475 (45)	450 (14)	360 (6)	205 (2)	420 (326)

The bulk of the measurements used to compile these two tables are from sample plots on private estates. Table 3 summarises the returns received to-date at the Research Station of one-tenth acre plots measured in accordance with the procedure laid down in Silvicultural Circular No. 22. These figures are from twenty-two forests in seven Conservancies. Pulpwood was excluded in arriving at the averages, thus volumes are to a three-inch diameter (over bark) top as before. It should be noted that none of these plots exceeds thirty years in age.

AVERAGE THINNING YIELDS PER ACRE : DATA FROM 1/10TH ACRE THINNING PLOTS

TABLE 3

Species	Average yield per thinning O.B. Vol. cu. ft. Q.G. (Number of measurements in brackets)		
	20 years	21—30 years	Mean for species, all ages up to 30 years
Scots pine	10 (1)	100 (79)	100 (80)
Corsican pine	165 (5)	230 (45)	225 (50)
European larch	180 (7)	275 (8)	230 (15)
Japanese larch	220 (62)	325 (5)	230 (67)
Douglas fir	525 (1)	195 (17)	210 (18)
Norway spruce	—	30 (2)	30 (2)
Sitka spruce	—	445 (8)	445 (8)
Other conifers	115 (1)	195 (1)	155 (2)
Mean of all conifers by age classes	215 (77)	175 (165)	190 (242)

For two reasons the thinning yields in Tables 1 and 2 are probably higher than what we may expect in Forestry Commission plantations. Firstly, sample plots do not usually include any understocked patches such as occur in nearly all stands, and secondly many of our sample plots had been thinned only very lightly, if at all, prior to being established as sample plots, with the result that the first few thinnings after establishment yielded a larger volume of produce than they would have done in plantations thinned systematically from the start.

ESTIMATION OF VOLUME OF MAIN CROP FROM THINNINGS IN ONE-TENTH ACRE PLOTS

BY J. N. R. JEFFERS

Forester, Research Branch

IN JUNE, 1948, the Southern Sample Plot Party established a series of one-tenth acre thinning plots in the New Forest, in co-operation with Mr. Rouse, the Divisional Officer. As the main purpose of the series was to investigate and compare the various methods which had been suggested for estimating the volume of the main crop, the plots were established in as many species and age groups as were available for thinning.

The procedure laid down in Silvicultural Circular No. 22 was followed in measuring the plots. But, in addition, three standing sample trees at the mean girth of the main crop were climbed and measured, timber height being taken to $1\frac{1}{2}$ inches diameter over bark. From these standing sample trees an estimate of the main crop volume was obtained by using Hartig's formula, viz :—

$$\text{Volume of Main Crop} = \frac{\text{Volume of sample trees} \times \text{Basal area of main crop}}{\text{Basal area of sample trees}}$$

This is the method which is usually employed in measuring temporary sample plots, and the volumes obtained from this direct measurement of standing sample trees have been used as a standard of comparison for the volumes obtained by the other methods—for the purposes of this experiment they have been termed the "Standard" volumes. In practice it has been found that this method gives an unbiased estimate of the true crop volume, and is usually within three to four per cent. of the correct volume.

To apply the method of standing sample trees to the large number of plots which it is hoped will be established, is too laborious, and the estimate must therefore be derived from trees felled in thinnings. There are several ways in which this can be done, as is shown below :—

Method 1a. Calculate the mean volume of all those thinnings with a breast-height girth equal to the mean breast-height girth of the main crop, and multiply this volume by the number of trees in the main crop. If there are less than five thinnings of that girth, add trees chosen at random (the first appearing in the list would do), in equal proportions from the girth classes immediately above and below the mean. If there are no such trees method (2) must be used.

Method 1b. Using the same sample thinnings as in (1a), calculate the volume of the main crop by means of Hartig's formula, instead of by direct multiplication.

Method 2. In forty per cent. of the plots measured for the purposes of this experiment, there were no thinnings of the girth classes at or above the mean girth of the main crop. To overcome this difficulty, the volume contained by the three largest thinnings was calculated and Hartig's formula again used :—

$$\text{Volume of Main Crop} = \frac{\text{Volume of 3 largest thinnings} \times \text{basal area main crop}}{\text{Basal area of 3 largest thinnings}}$$

Method 3. Calculate total basal area of the main crop and of the thinnings and take the main crop volume=

$$\frac{\text{Volume of all thinnings} \times \text{basal area main crop}}{\text{Basal area of thinnings}}$$

Method 4. Plot a volume/basal area graph based on the thinning data, and from this graph obtain a volume corresponding to the mean girth of the main crop (the line being extended beyond the range of the plotted points, if necessary). The volume so obtained is multiplied by the number of trees in the plot, to give the volume of the main crop.

The volumes for all the methods were calculated, and the data obtained are summarised in the following table. The differences in volume between the "Standard" volumes, as obtained from standing sample trees, and the thinning volumes, were analysed statistically.

DIFFERENCES BETWEEN STANDARD VOLUME AND VOLUMES CALCULATED BY VARIOUS METHODS

Species	Locality	Age, years	Top Ht. feet	Standard Volume (cu. ft.)		Method 1			Method 2	Method 3	Method 4
				per acre	per plot	(a) By Direct multiplication	(b) By Hartig's formula				
Scots pine	Hawkhill	24 & 28	42½	1,760	176.0	57.0	55.8	—	52.6	21.2	
"	Busketts	85	84½	3,838	383.8	—	—	30.6	30.6	—	
"	Wilverley	52	70	3,832	383.2	—	—	6.1	19.1	-50.8	
"	Bramshaw	46	73½	2,837	283.7	1.5	24.6	—	27.7	36.2	
Corsican pine	Knightwood	30	52	2,511	251.1	—	—	36.6	39.9	28.5	
"	Wilverley	28	40½	2,083	208.3	18.2	15.1	—	37.6	10.3	
European larch	Bramshaw	33	67	3,333	333.3	17.7	3.7	—	15.6	-8.3	
"	Woonsons Hill	—	55½	2,078	207.8	—	-21.6	—	-7.6	-22.3	
"	Wilverley	26	50	2,134	213.4	—	—	-4.8	28.9	-24.6	
Douglas fir	Denny Lodge	19	47½	1,938 + 72.6	193.8 + 7.26	1.0	8.8	—	69.4 + 0.3	33.4 + 1.1	
"	Holiday's Hill	23	57	1,883	188.3	—	2.4	—	40.5	16.7	
"	Wilverley	30	51½	2,240	224.0	—	—	20.3	53.9	22.2	
Sitka spruce	Hawkhill	27	53	1,128 + 290	112.8 + 29.0	5.0	35.7	—	32.8 + (-2.2)	32.5 + (-0.9)	
"	Kings Garn	29	61	2,672	267.2	5.0	—	—	11.1	-12.1	
"	Knightwood	28	80	3,982	398.2	-26.0	-56.8	—	71.5	11.7	
Thuja plicata	Wilverley	30	44½	1,502	150.2	—	—	54.9	79.8	20.2	
Oak	Salisbury Trench	38	32½	604	60.4	—	—	11.5	47.1	-0.2	
				Mean difference from Standard Volume, cubic feet per plot		5.14	5.73	22.2	—	34.14	6.62
				Standard Error, cubic feet per plot		±5.94	±8.12	(not calculated)	—	±5.70	±5.52

Note.—Volumes are cubic feet quarter girth over bark, measured down to a diameter of 1½ inches over bark.

Results of Analysis :

Method 1a. Mean volume of thinnings of a breast-height girth equal to the mean breast-height girth of main crop \times number of trees in the main crop.

For 40 per cent. of the plots, this method was not applicable, as there were no thinnings of the requisite size. In the remaining 60 per cent., the mean difference between the "Standard" volumes and the volumes calculated from the thinnings was 5.14 cubic feet (or 2.6 per cent. of the mean volume), with a standard deviation of ± 20.59 cubic feet (10.3 per cent.) and a standard error of ± 5.94 cubic feet (3.0 per cent.). With a "t" value of 0.86 for 11 degrees of freedom, the slight bias towards a lower volume was obviously not significant.

Method 1b. Hartig's formula applied to thinnings of a breast-height girth equal to the mean breast-height girth of the main crop.

Again this method was not applicable for 40 per cent. of the plots. The mean difference between the "Standard" volumes and the volumes obtained by this method was 5.73 cubic feet (or 2.9 per cent. of the mean volume) with a standard deviation of ± 28.12 cubic feet (14.0 per cent.), and a standard error of ± 8.12 cubic feet (4.1 per cent.). The value of 0.71 for "t" at 11 degrees of freedom was again not significant.

Method 2. Volume of 3 largest thinnings used in conjunction with Hartig's formula.

This method was applied to the 40 per cent. of plots for which there were no thinnings with a breast height girth equal to, or larger than, the mean breast height girth of the main crop. With only 6 degrees of freedom no full analysis of the volumes was advisable, but all but one of the volumes were lower than the corresponding "Standard" volumes. Thus, what little evidence is available shows that there is a tendency towards a negative bias in using this method.

Method 3. Volume of all thinnings, used in conjunction with Hartig's formula.

For this method, the mean difference between the "Standard" volume and the thinning volume was 34.14 cubic feet (15.9 per cent.), with a standard deviation of ± 24.81 cubic feet (11.6 per cent.), and a standard error of ± 5.70 cubic feet (2.7 per cent.). The bias towards a lower volume is here highly significant. Examination of the individual plot volumes shows that it is in the plots which have a large number of trees at a very low girth, i.e., first thinnings, that the bias is most pronounced, possibly because the introduction of so many stems with little or no volume upsets the proportion on which Hartig's formula is based.

Method 4. Graphical method.

Tested on 18 plots, the mean difference between the "Standard" volume and the volume obtained from the volume/basal area graph was 6.62 cubic feet (3.1 per cent.), with a standard deviation of 23.43 cubic feet (10.9 per cent.), and a standard error of 5.52 cubic feet (2.6 per cent.). There was thus no significant bias over the whole range of plots.

Further examination of the data, however, shows that, for those plots in which there are thinnings of larger girth than the mean girth of the main crop, Method 4 gives an unbiased estimate with a large standard

deviation, while, for those plots in which all thinnings were smaller than the mean girth of the main crop, the method gives a distinct bias towards lower volumes (mean difference 9.96 cubic feet (4.6 per cent.) and a standard error of 3.49 cubic feet (1.8 per cent.)).

Discussion

Methods 1a and 1b are obviously superior to the other three methods, and as 1a is simpler than 1b, of these two it is the method to be preferred. Both these methods, however, are only applicable where there are thinnings with a breast-height girth equal to, or larger than, the mean breast-height girth of the main crop. In plots where this condition is not fulfilled, Method 2 appears to be preferable to Method 3, which introduces a larger negative bias than Method 2.

Method 4, which is applicable to all plots, has no advantage over 1a or 1b where these are applicable, as it gives a large standard deviation, and the plotting of large numbers of thinnings is laborious. Applied to plots where there are no thinnings equal to, or greater than, the mean girth of the main crop, the method gives a significant negative bias, but not such a large one as for Method 2 or 3.

The obvious advantages, both in accuracy and simplicity, of using thinnings with a girth equal to the mean girth of the main crop, suggest the desirability of obtaining thinnings of this size immediately outside the plot, when they are not obtainable in the plot itself; provided that the part of the stand in which the sample thinnings are measured does not differ essentially from the plot. It should, however, be stressed that serious errors may result if conditions are not closely comparable.

The only very poor results obtained in Methods 1a and 1b were for the Scots pine at Hawkhill, where one of the sample thinnings was obviously unrepresentative. The rejection of such obviously unrepresentative sample trees, though it will probably increase the accuracy of volume estimate in the individual plots, should not be carried too far. The arbitrary selection of sample trees, in contrast with random selection, may lead to the introduction of a bias, the measurer unconsciously selecting, systematically, better or worse trees—generally better!—than the true average for the plot.

Recommendations

To obtain estimates of the volume of the main crop in one-tenth acre thinning yield plots, the mean volume of 3 to 5 thinnings, with breast-height girths equal to the mean breast-height girth of the main crop, should be calculated, and multiplied by the number of trees in the main crop. Where there are less than 5 thinnings at this girth, trees chosen from the girth classes above and below the mean girth, in equal proportions, should be included. Where there are no, or insufficient, thinnings of the requisite size, sample thinnings should be chosen from outside the plot, care being taken that the trees are not chosen from unrepresentative parts of the crop. Where this is not possible, the total volume of the 3 largest thinnings may be calculated, and the volume of the main crop obtained from the formula:—

Volume main crop = $\frac{\text{Volume of 3 largest thinnings} \times \text{basal area of main crop}}{\text{Basal area of 3 largest thinnings}}$

Basal area of 3 largest thinnings

But this method may give under-estimates up to about —20 per cent., while Method 1 gives a less biased estimate, which may usually be expected to be within ± 10 per cent. of the true volume of the plot.

CROWN THINNING

CROWN THINNING, as the name implies, differs in principle from the low thinning of normal practice. A low thinning consists of the removal of all dead and suppressed trees, most sub-dominants, and a percentage of the co-dominants and dominants which may vary according to the heaviness of the thinning. In a crown thinning, however, elite trees are selected from the dominant and co-dominant classes. All other dominants and co-dominants competing with those selected elites are then removed, although not necessarily in one thinning. Gaps in the canopy are usually covered over by the sub-dominants which have so far been ignored, or by trees previously suppressed. All dead, dying, or whip trees should, of course, be removed. Because of their extra freedom, the selected elites have all become dominant after one or two thinnings, and the forest assumes the appearance of a two-storey wood. The number of trees which die in the lower storey varies according to the species and number of dominants removed. Unless the crown thinning has been exceptionally heavy, however, even with extreme shade bearers, the survivors among the lower classes, some fifteen to twenty years after the initial thinning, usually become drawn up and whippy. These have then to be removed, but as the best of them will have grown into ladder poles, building poles, or pit props, their retention until then will have been fully justified financially, as well as from silvicultural considerations. Thuya, tsuga, Sitka spruce and Norway spruce can all be successfully thinned in this way.

Some advantages of this grade of thinning are :—

1. Elite trees can be high pruned early, and the thinning, if properly carried out, will ensure the presence of those trees in the final crop.
2. Every tree removed, except a few of the dead ones, is of marketable size, even from the first thinning.
3. After initial selection and pruning of elite trees by a forester, marking of thinnings can be carried out by a comparatively unskilled man.
4. When the stand reaches the later thinning stages, both heavy timber and material at pitprop size should be available for cutting.

One disadvantage, however, concerns extraction, which is made more difficult by the presence of so many small trees.

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THE USE OF STAND DENSITY INDICES FOR DESCRIBING THINNINGS

BY F. C. HUMMEL

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THINNINGS ARE COMMONLY described as "light," "moderate" or "heavy," but these terms are necessarily vague, and what one forester may consider "moderate," another might call "heavy," or "light," depending on the general standards to which he is accustomed. These standards change not only from Conservancy to Conservancy, but they change also with time. Plantations which most of us now consider moderately thinned, would have been considered heavily thinned some twenty or thirty years ago. The issue is further obscured by the fact that in using these adjectives some foresters think more of the number of trees they cut out, and others more of the growing stock that is left. For research purposes, where precise definitions are of special importance, trees have been classified according to their position in the canopy (dominance), stem form and crown development, and the tree classes that must or must not be cut out in each thinning grade have been laid down in the code of Sample Plot Procedure (2). This method, however, in itself does not achieve the object for which it was designed, because in a stand where stem form is bad a thinning of a given grade will tend to be heavier than in a stand where stem form is good. This applies particularly to the C grade (moderate low thinning) in which dominants are removed only if they are badly shaped.

It may well be asked whether, apart from research, there is a real need for a precise definition of thinnings. There are several good reasons for answering this question in the affirmative, but the most immediate and the least controversial, although not the most important, is that foresters do in fact talk about the severity of thinnings, and are interested in how their own thinnings compare with those of others, and quite clearly such discussions and comparisons are facilitated if thinnings can be described with some precision. It is rather like speaking in terms of cubic feet instead, merely, of large or small trees. To what extent, if at all, precise description should be followed by precise prescription, is quite another matter, and there is no space to consider this point here in detail. It may, however, be pointed out that thinning instructions, like most other instructions, should be clear and concise. They should not discourage initiative and judgment, but should on the contrary stimulate the exercise of these invaluable faculties by directing them towards the attainment of a definite goal.

A thinning regime is determined in the first place by the density of the growing stock after thinning, because it is on this that the future development of a stand will mainly depend, but the density before thinning also affects the issue, because a given density after thinning may be achieved either by frequent light thinnings or by less frequent and more heavy thinnings.

The problem is therefore to define the term "density" of stocking. In even-aged uniform stands with the same mean girth and mean height (i.e., the girth and height corresponding to the mean basal area), the density is clearly proportional to the number of trees per unit area. In stands with an equal number of trees, and the same mean girth, density is proportional to height; and finally, in stands where the numbers and mean heights are the same, but the mean girths differ, the stand with the greater mean girth gives the appearance of being the denser. In addition to these three factors there are others, but they can safely be left out of consideration; crown spread, for instance, which undoubtedly influences the density, is closely correlated with girth, and other factors such as colour and density of foliage are of minor importance, and are, in any case, fairly constant for any one species. The three important factors are, therefore, the number of stems per acre, the height, and the girth.

Lexen (1), working on North American conifers, found that by multiplying the number of stems per acre by mean girth by mean height, he obtained a product which in fully-stocked stands remained more or less constant above a certain age. Tests on several British and Continental yield tables, as well as on our permanent Forestry Commission sample plots, have confirmed that this is more or less correct up to the age when stands start to deteriorate, and tests have also shown that this applies not only to fully-stocked lightly-thinned stands, but also to more heavy thinning regimes. It has, however, been found preferable to substitute "top height" for mean height; "top height" being the average height of the 100 largest trees (in point of girth) per acre. When a stand is subjected to heavy thinnings from an early age, the constant value of this *stand density index* is reached at a top height of about thirty feet, and, if thinnings are lighter, between forty and fifty feet. Where growth is fast, the constant value is reached at an earlier age than where it is slow. Why this stand density index should in fact vary so little with age is not quite understood, but it is perhaps worth noting that it is a measure of the cambial surface, or bole area of a stand.

In practice, height is measured in feet, and multiplied by breast-height true girth in inches. The product is then multiplied by the number of stems per acre, and it is necessary to divide the resulting product by 1,000,000 because a convenient range of values is then obtained ranging from about .25 for very heavily thinned stands of young larch to about 1.2 in lightly thinned stands of shade bearers such as the spruces. Maximum values up to 1.6 have been encountered in exceptional plantations, such as the B grade *Abies grandis* plot at Novar in Ross-shire.

Table 1 gives the stand densities after thinning certain of our more important conifers according to the Forestry Commission yield tables and, in the case of Scots pine, also according to two Continental yield tables.

EXAMPLES OF STAND DENSITY INDICES FROM YIELD TABLES

TABLE 1

Species	Yield Table	Quality class	Age class (years)							
			20	30	40	50	60	70	80	100
Douglas fir	Forestry Commission Bulletin 10, 1928	I	.90	.99	1.0	.97				
		III	.76	.86	.90	.85				
		IV	.72	.83	.84	.82				
Norway spruce	Forestry Commission Bulletin 10, 1928	I		.90	.94	.98	1.0			
		III		.85	.88	.87	.87			
		V			.71	.74	.75			
Sitka spruce	Forestry Commission Yield Tables (1948 revision, unpublished)	I	.79	.77	.74	.75				
		III	.66	.78	.80	.76				
		V		.68	.77	.76				
Scots pine (England)	Forestry Commission Bulletin 10, 1928	I		.64	.75	.73	.71	.70	.70	.69
		II		.53	.65	.70	.67	.67	.65	.63
		III			.53	.61	.62	.63	.60	.59
European larch	Forestry Commission Bulletin 10, 1928	I	.63	.75	.77	.77	.74	.74	.74	
		III		.59	.63	.66	.67	.65	.66	
		V			.51	.55	.54	.54	.53	
Japanese larch (moderate thinnings)	Forestry Commission Yield Table (1948 revision, unpublished)	I	.52	.50	.46					
		II	.43	.48	.47					
		III	.32	.43	.46					
Japanese larch (heavy thinnings)		I	.37	.38	.39					
Scots pine	Gehrhart (Germany, 1921)	I		.75	.80	.76	.73	.74	.71	.68
		III		.58	.63	.62	.60	.60	.59	.57
		V		.41	.44	.48	.48	.48	.49	.48
Scots pine	Ilvessalo (Finland, 1920)	O.M.*	.37	.45	.53	.62	.70	.73	.76	.75
		M	.35	.45	.55	.62	.70	.75	.79	.78
		V	.23	.41	.52	.55	.57	.62	.64	.64
		C		.34	.39	.38	.43	.48	.56	.55

* Quality classes based on forest types

The Japanese larch and Sitka spruce tables are of very recent origin, but all the others were prepared long before this concept of stand density had been evolved, so that there can be no question of the tables having been made to fit the concept. The same applies to the stand density figures from some of our older comparative thinning plots, which are reproduced in Table 2 in order to give some idea of the range of values encountered in practice, and also in order to demonstrate within what wide limits stand density may vary within any one of the standard thinning grades, as defined by the tree classification alone.

EXAMPLES OF STAND DENSITY INDICES FROM FORESTRY COMMISSION SAMPLE PLOTS

TABLE 2

Species and Locality	Age years	Thinning grade	Stand density	Thinning grade	Stand density	Thinning grade	Stand density	Thinning grade	Stand density
Douglas fir (Beaufort Invernesshire)	15	Plot B	S.38	Plot C	S.37				
	20		1.0		.51				
	26		1.2	Plot D	.77				
	32	1.2	.68						
	38	1.2	.62		.69				
Norway spruce (Bowmont, Roxburgh)	20	Plot B	S.85	Plot C	S.86	Plot D	S.87	Plot L.C.	S.88
	25		.72		.64		.52		.63
	30		.91	.75	.45	.71			
	35	.98	.87	.46	.73				
			1.1	.78	.40	.69			
Sitka spruce (Haggerston, Northumberland)	16	Plot B	E.70	Plot C	E.69				
	21		.70		.67				
	31	1.0	.82						
Sitka spruce (Glendye Estate, Kincardine)	34	Plot B	S.15	Plot C	S.16				
	44		.76		.68				
	54		.93	.65					
	60	1.1	.66	.65					
Sitka spruce (Benmore, Argyll)	50	Plot B	S.84						
	56		1.0						
	61		.93						
	66	C/D	.95						
Scots pine (Windsor Estate, Surrey)	35	Plot A	E.35	Plot C	E.39	Plot D	E.38	Plot L.C.	E.37
	45		.67		.54		.53		.55
	55	(un-thinned)	.82	.50	.36	.60			
Japanese larch (Stourhead, Wiltshire)	22	Plot B	E.55	Plot C	E.56	Plot D	E.54		
	32		.91		.64		.47		
	42		.86	.60	.36				
European larch (Murthly, Perthshire)	29	Plot B	S.45			Plot D	S.46	Plot L.C.	S.44
	39		.62	.44	.61				
	48		.73	.43	.55				
			.73	.39	.48				

NOTE.—A = removal of dead and dying trees only

B = light low thinning

C = moderate low thinning

D = heavy low thinning

L.C. = light crown thinning

It is perhaps worth mentioning that in sample plot work stand density has not superseded the stem classification as a means of defining thinning grades, but is used in conjunction with it in order to ensure that plots of the same grade are as closely comparable with one another as possible.

Present day thinnings in this country are on the whole heavier than indicated in the older British yield tables, and the following figures are given as a very rough estimate of what may be considered as average present day practice.

AVERAGE STAND DENSITIES ACCORDING TO PRESENT THINNING PRACTICE IN GREAT BRITAIN

TABLE 3

Species	Stand density, after thinning, at top height of :	
	30 feet	40 feet and over
Douglas fir } Sitka spruce } Norway spruce }	.5 —.7	.7 —.8
Corsican pine	.45—.55	.55—.65
Scots pine	.4 —.5	.5 —.6
Japanese larch } European larch }	.25—.35	.4 —.5

This is not the place to discuss the relative merits of heavy and light thinnings, the time when they should commence and their frequency. There are undoubtedly instances where the objects of management and local conditions call for much heavier or much lighter thinnings than indicated by the above figures, which are given, not as a precept to be followed, but rather as a standard of comparison in the hope that some readers may consider it worth while to find out to what densities they are thinning, and to test for themselves the value of this concept.

There are various ways of determining stand density in the field, depending on the degree of accuracy desired. The simplest and roughest method is by ocular estimate of the number of stems per acre, top height, and mean girth, and the most accurate is by using the measurements obtained from one-tenth acre circular thinning yield plots. Between these extremes there are various possibilities of compromise, e.g., only one or two height measurements, the girthing of a few trees that appear to be near the mean and the counting of stems on a one-tenth-acre plot. If in thinning a plantation it is desired to reduce the stand density by a given amount, it must be remembered that the mean girth of the trees removed in thinnings is usually less than that of the main crop, so that in a plantation with a stand density of .8 the removal of one-quarter of the trees is not likely to give a stand density of .6, but rather more, probably about .65.

The stand density index described, which was evolved by Lexen (1) is not the only one that has been tried. Mulloy (3) in Canada uses Reineke's stand density index (4) which is based on girth and number of stems alone; work on stand density has also started in various European countries, but it is not possible to explain here why we have come to prefer the product of N.G.H. (Number, Girth, Height) to the other methods that have been proposed.

In conclusion it must again be emphasized that stand density is a measure of quantity, and not of quality. Thinning to a specified stand density will ensure the removal of the desired proportion of the growing stock, but not the right choice of trees. The right choice requires skill and experience, and these are only acquired by practice and the habit of keen observation which springs from a genuine love of the forest. Those who are opposed to the concept of stand density because they fear its misuse, have found an eloquent exponent of their sentiments in the Scottish bard whose verse follows this article as its epilogue, or, as he might wish—its epitaph.

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O TEMPORA ! O MORES !

Langsyne by learned precept I'd been taught
 The *Hoch* and *Nieder* way to thin a wood.
 But now, the grade for acre and for rod
 By factor fixed sets hard-won skill at naught.
 Methinks, by Loreli figures we've been caught !
 "Experience teaches" holds no longer good,
 Statistics pair the craftsman and the crude
 In woodland's numbered day—they're all distraught !
 Can any hand with brush that's dipped in paint
 Make living canvas such as Raeburn did ?
 Or can a sinner come to be a saint
 Just reading what the ten commandments bid ?
 Heaven says No ! No more can "S.D.I."
 Of thinning teach the wherefore and the why.

A. M. MACKENZIE,
District Officer, Research Branch

TREATMENT OF SCOTS PINE PLANTATIONS IN THE BLACK ISLE

BY J. A. DICKSON

District Officer, North Scotland

THE FOLLOWING NOTES refer in particular to the forests of the Black Isle, but may have a wider application to forests on the Old Red Sandstone formation elsewhere. Doubtless, as is the case in most forestry operations, many theories can be advanced, and these notes are offered only as a personal opinion. Generally speaking, the old woods on the Black Isle fall into two fairly distinct age classes, the first 70—80 years old, and the second 40—50 years old. These will be dealt with separately, as there is a distinct difference in their quality.

In the development of all forests, the soil formation is an important factor, and this is no exception. Although there are many local variations, the soil is generally of an inferior type, and consists mainly of a shallow layer of peat, four to six inches in depth, overlying a shallow layer of wash lying directly on the hard packed drift. This layer of drift, which consists largely of compact sand and clay with boulders, is non-porous, and will not permit of the free flow of water and air through the soil, which is so essential to plant life. One also finds traces of non-continuous iron pan at the junction of the wash and drift. The really important factor is the drift layer.

To refer again to the two age classes mentioned above, one finds a difference in planting technique between them, probably due to the finances of the times. The difference in the planting technique means that to-day we have two different types of Scots pine plantations.

The 70—80 Year Class

The technique here was rather similar to present-day methods, and one can see that our predecessors appreciated the difficulty of growing a commercial crop on this type of soil. Intensive hand drainage was done, obviously for the purposes of soil aeration, as the drainage was done in a mechanical manner without attention to the contours of the soil surface. These drains were placed at seven to ten yard intervals. It is quite apparent now that the good trees and, in some cases, the only trees remaining, are those on the sides of the drains. One can realise that as a consequence the crop is unevenly distributed over the ground and that, although the trees on the sides of the drains are fairly evenly spaced due to recent thinnings, there is a blank or practically blank area between the drains. In addition, as is frequently found in old Scots pine woods, squirrel damage is extensive and the number of malformed stems is exceptionally high.

Two methods of treatment of these woods have been tried, and both so far have yielded reasonable results. One method is the heavy thinning of the wood, leaving about eighty trees per acre, the area being left for natural regeneration. The second method is the removal of the worst stems in the form of a fairly heavy thinning and the underplanting of *Tsuga* under the overcrop of old Scots pine.

Various methods of thinning can be carried out, principally clearing of groups or thinning so as to leave the best stems in the overcrop. Group clearing is advantageous when it comes to the further thinning of the old crop,

as less damage to the natural regeneration or underplanting results, but it does not of necessity preserve the best stems of the overcrop. Straight-forward thinning, although leaving the best of the overcrop, results in some damage to the undercrop. It is probable that the best results can be obtained by leaving a very sparse overcrop of about eighty to one hundred trees per acre, these being the best formed stems, to be retained to grow on with the undercrop for about forty to fifty years, when they can be removed without much fear of damage to the undercrop. *Tsuga* is not so great a shade bearer as some people think, and the best growth results when it is fairly free from overhead cover.

As to the undercrop, a combination of natural regeneration and underplanting would, where necessary, probably be the best solution. If a little more attention were paid to good seed years, which can normally be foreseen the better part of a year ahead, and thinning done accordingly, there is little doubt that natural regeneration would result, especially with the soil cultivation given during the extraction operations. One cannot always, in this part of the country, rely on good seed years every few years, but with the advent of the disc plough, soil cultivation even amongst standing trees is a reasonably easy matter. If natural regeneration fails, one can always resort to underplanting.

The 40—50 Year Class

Little drainage has been done in these woods, and one finds that the Scots pine on the knolls, where the drift layer is deeper below the surface, have succeeded reasonably well, while in the flats and hollows they have failed, and have either disappeared or have grown only a few feet and stayed in check since. It is doubtful whether any manurial treatment would result in marked improvement. More drastic measures have to be taken, and these are largely dependent on mechanical equipment and its manoeuvrability. One can get results by hand drainage, but unless the failed areas are small, this method is too costly. The alternative method of treatment is ploughing, and the ease with which this can be done is largely dependent on the size of the area. Ploughing can be done by one of two methods; the first is to plough completely the failed area; the second to leave, in so far as possible, rows of the failed trees standing, and plough two or three furrows between each row of trees. No definite information is available as to the success of this latter method, although examples can be found where ploughing has taken the original crop out of check, and information is available to show that the good effects of ploughing do not extend beyond four to five feet from the channel cut by the plough. It is fairly certain that one cannot, with reasonable prospects of success, leave more than a single row of trees standing.

Although to date it has been the practice to plant up the ploughed area, there is little doubt that these areas could be naturally regenerated. One can commonly see on open moorland areas, with odd mother trees standing, numbers of natural seedlings a year or two after ploughing has taken place.

With regard to these flats and hollows, the theory could be advanced that Scots pine is not the proper species for such wet areas. This is not the case as, when the drift layer is broken by ploughing, the soil becomes quite dry. The wetness is merely due to the hard drift layer not allowing percolation of water into the lower soil strata.

With the acquisition of new areas which include plantations of Scots pine, the treatment of these is of considerable importance and yields an extensive field for experimentation.

LARCH PLANTATIONS AT GLENTRESS FOREST

BY T. A. ROBBIE, *Forest Officer Instructor,*
AND C. R. DICK, *Foreman ;*
Glentress Forest School

GLENTRESS FOREST is situated at the southern end of the Leithen Plateau and lies on that broad belt of Silurian rocks which stretches across the Southern uplands of Scotland from the Mull of Galloway to St. Abb's Head in Berwickshire. The underlying strata consist principally of siliceous material such as grits, shales and greywacke, but these do not determine the quality of the forest soil, as glaciation has resulted in the deposition of a thick layer of Boulder Till over the entire forest area. This naturally varies in thickness, due to differences in topography, and gives way in a few places to colluvial deposits of clay and silt, but it is on soil derived from the weathering of the Boulder Till that the larch plantations are found. A rough mechanical analysis shows the soil is a clay loam, and, except for slight variations in water content due to differences in drainage and water supply, it varies but little over the entire area. Leaching appears to be absent, or, at the most, only very slightly advanced, and tests carried out in the surface layers by the colorimetric method of pH determination yields a result of 5.0 to 5.5

A typical profile shows :—

- 0.1 inches : Mat of grass roots.
- 1.2 inches : Black friable layer of well decomposed humus.
- 2.18 inches : Grey-brown, or brown layer of clay loam, with small angular and sub-angular rock fragments throughout.
- 18.48 inches : Red-brown or buff layer of sub-soil with a high clay fraction, containing larger angular stones.
- 48.60 inches : Well defined loose layer of broken shale and angular greywacke fragments of from three to six inches in size.
- Below 60 inches : Parent material.

In parts of the area there is some evidence of the precipitation of iron salts, but these do not appear to have been laid down in definite bands, and "pan" formation has not taken place.

Ground vegetation is indicative of soil suitable for the growth of larch. Good hill grasses predominate, with *Holcus mollis* in abundance, accompanied by scattered tufts and small clumps of *Agrostis canina*, *Festuca ovina* and *Deschampsia flexuosa* ; but these give way in many places to flushes of pure bracken, and this latter is fairly well scattered throughout the whole of the plantations. In the ground layer *Hypnum schreberi* and *Hylocomium squarrosus* are the dominant mosses.

Elevation ranges through some 800 feet, a small proportion of the underplanted larch being situated below the 700 feet contour, but for the most part the plantations concerned lie along the 1,000-foot mark, although the upper limit is just on 1,500 feet. Aspect varies from south, south-east, south-west to west and north-west, and exposure generally verges on severe, especially as regards plantations on the west, north-west and south-west aspects ; but it can hardly be assumed that the extremely poor quality of the larch is due to the severity of the exposure alone, as canker and die-back occur at lower elevations, and in sheltered situations within the same forest area.

The climate is representative of the whole of that area of the county of Peebles which lies north of the River Tweed and which may be termed "the dry north-eastern part."

As regards temperature, which determines the growing season, meteorological records for the county reveal the remarkable fact that the growing season in this area is almost two months shorter than that of a neighbouring county lying twenty odd miles to the north, and six weeks shorter than that experienced in the lower Tweed valley. Growing days (i.e., days in which the mean temperature is in excess of 42 degrees Fahrenheit), do not occur until about the 20th of April, and by the middle of September the period of continued growth is virtually over. This should be a decided asset to the forester in the growing of larch, as the short growing season approximates to the optimum conditions under which the European species grows in its natural environment, but there are other important climatic and topographical factors which play no small part in nullifying this advantage.

As regards rainfall, the area lies within the 35-inch isohyetal line, but, in order to understand the full effect of precipitation on the growing crop, it is not only necessary to know and understand this fact but, in addition, to ascertain the seasonable distribution of rainfall, and, if possible, to summarise the effect of seasonal evaporation. An examination of the rainfall records reveals that the winter season, extending from October to March, is only from three to six inches wetter than the summer season, April to September. The latter is of the greater importance as it covers the growing season, and it is interesting to note that April, May, June and September are the driest months of the year. Thus the commencement of vegetative growth of the larch in spring coincides with the driest period of the year, and not only with the period of minimum precipitation, but also with the seasonable occurrence of dry easterly winds which lower the relative humidity of the air and increase the incidence of evaporation. In adjacent areas to the north and east, the spring of the year is characterised by the occurrence of "haars" brought in from the North Sea, but it is significant to note that the Peebles area is singularly free from these mists and does not therefore participate in their beneficial effect on the relative humidity of the atmosphere in its relation to tree growth. Again, the local topography is such that any water which may drain from the melting snows in the spring is concentrated away from the forest area, and does not constitute an available source of supply.

To sum up, it is reasonable to assume that the climatic and topographical factors discussed above, together with the fact that the larch areas here are situated on a very freely draining subsoil, all combine to bring about a condition of physical drought at the time when the larch urgently requires much wetter and moister conditions of soil and atmosphere.

The larch plantations at Glentress were planted by a previous owner between 1892 and 1903. The exact spacing cannot be determined, but it appears to have been from three to four feet apart. Generally, at the time when the Forestry Commission foresters and officers decided to underplant, the result appears to have been a fairly poor quality, slow growing irregular crop of larch, whose rate of growth did not indicate that it justified retention for a period of more than ten to fifteen years. In some places the crop may have been so open that the underplanting was undertaken to get a full crop on the area, but the main reason for underplanting appears to have been to use the shelter of the larch, and the improvement of soil conditions brought about by the larch crop, in order to establish a second forest crop. The plan was to remove the larch by a series of thinnings as the undercrop required more light, until eventually the whole of the larch overcrop was removed when the undercrop was established.

We come, therefore, to the treatment carried out on some individual compartments, and in this short summary "S" indicates series number, and "C" compartment number.

S.1/C.9. The larch were planted in 1892. This was thinned in 1938 and underplanted with grand fir, *Abies grandis*. At the time of underplanting there appear to have been about 300 to 350 stems of larch per acre, with a total height of 45 feet and a crown percentage of 25 to 30. 1,250 grand fir were planted per acre. This area was thinned in 1944, and again in 1948, and we now have 140 larch stems per acre with a total height of 62 feet, a breast-height quarter-girth of $9\frac{1}{2}$ inches, timber height of 52 feet, giving a volume per acre of 1,740 cubic feet. There is now a canopy percentage of 20. The undercrop has now almost completed canopy, and has an average height of 7 feet 2 inches. The height growth during the last year was 15 inches and that of the previous year 12 inches.

A section of the same compartment was underplanted in 1943 with 1,500 Norway spruce per acre. The larch here were not of such good height, due to higher elevation and thus more exposure. This section now carries 140 stems per acre, with a total height of 58 feet, a timber height of 47 feet and a breast-height quarter-girth of $7\frac{3}{4}$ inches, giving a volume of timber per acre of 1,250 cubic feet. The canopy percentage is approximately 25. The spruce now average 21 inches in height, and made an average growth of 2 inches during the past year and $1\frac{1}{4}$ inches in the previous year.

It appears that in this compartment the larch have recovered since thinning, and that underplanting was carried out too soon after thinning for the effects of the thinning to show on the larch. In the Norway spruce section there has been too great a shade from the larch. Measurements were taken where there was no sign of damage to the underplanting from rabbits, as has occurred over one or two other portions. Weeding of the underplanting appears to have been too light in its early years, and it has suffered slightly from this.

S.2/C.6. The larch appear to have been planted about 1903. Records of thinnings are very incomplete for this compartment, but it appears to have carried in one section about 360 stems per acre with a total height of approximately 30 feet. Underplanting was carried out in P.27 with 800 Norway spruce per acre. The overcrop was thinned in 1936, 1942, and 1944; it now carries 150 stems per acre with a total height of 41 feet and timber height of 36 feet, a breast-height quarter-girth of $6\frac{1}{2}$ inches, and a timber volume of 1,150 cubic feet. The canopy percentage is now approximately 30. The average height of the undercrop is now $8\frac{1}{2}$ feet, and the average height growth in this past year is 14.1 inches, and 13 inches in the previous year. Ground cover is approximately 50 per cent. mainly due to the smaller number of underplanted trees per acre.

Another section of this compartment was underplanted in 1943 with 1,300 plants per acre. There appears to have been over 400 stems per acre on this section at the time of underplanting. There are now 300 stems per acre, with an average height of 38 feet, an average timber height of 33 feet, a breast-height quarter-girth $5\frac{3}{4}$ inches, and a volume per acre of 2,275 cubic feet. Canopy percentage of the overcrop now is approximately 50. The average height of the underplanted trees is 18 inches, the average height growth of this past year being 3.6 inches and of the previous year 2.1 inches.

This compartment is on the 1,200 feet contour, but is in the centre of the forest block. It is evident that if it were necessary to underplant this

compartment, underplanting should have been delayed until more light was allowed through after thinning. This compartment is scheduled for thinning during this coming year.

S.2/C.7. The larch was planted in 1903. It was underplanted in 1928—29 with Norway spruce. There are no records to indicate the condition of the larch crop at the time of underplanting. Records show that the overcrop was thinned in 1936, 1938, 1940, 1942 and 1944 ; the overcrop was completely removed in 1946.

The condition of the spruce now shows 1,250 stems per acre, with an average height of 10 feet 3 inches, and a canopy percentage or ground cover percentage of 75. The average height growth last year was 14 inches, and in the previous year 13 inches, hence the overcrop was completely removed when the undercrop was about 8 feet in height.

There are many more compartments where underplanting has been carried out, but the above samples are representative. In view of the dying off of larch on several areas, we have summarised the work done at Glentress to indicate the number of stems per acre, and the height of the canopy, at the time of underplanting, which may be of interest where underplanting is considered elsewhere. We have also given the rate of growth of the undercrop in comparison with the percentage of canopy and the rate of removal of the overcrop. We may add that felling of the overcrop was done by the best forest squad, conversion was done before extraction, which was done by horse to the rides, and although a little damage was done to the undercrop, this has all disappeared in the last two years. In some cases underplanting has been carried out when the overcrop canopy was too dense, and where the overcrop had just been thinned prior to underplanting. The underplanting should have been delayed in order to see the effects of thinning of the overcrop. Rabbits and other animals likely to damage the underplanting must be exterminated before underplanting, and all underplanting must be carefully weeded until established. If natural regeneration is not possible on all our areas, perhaps new crops may be established by underplanting more extensively, where soil conditions and other locality factors permit.

RAPID GROWTH OF JAPANESE LARCH IN CORNWALL

MENTION WAS MADE in the 1948 issue of this Journal of an area of retarded growth at Wilsey Down in Cornwall. Where conditions are favourable, however, tree growth in this county can be exceptional, and one's ideas of thinning in connection with age require considerable adjustment. It may be of interest to consider briefly one such area at Bodmin Forest, where a few acres of P.37 Japanese larch, within a larger block, produced such growth that it was necessary to carry out a second thinning in F.Y.48, a year after the first thinning.

The area is on a steep slope of brashy clay loam, elevation 150 feet, well sheltered from the south and west, about eight miles from the north Cornish coast. The ground previously carried a good oak coppice crop which when felled was immediately followed by the larch. The two-plus-one plants used were of such a poor branching type that it was necessary to prune them before planting. Beating up was a normal operation and no check occurred in establishment, indeed growth was so fast (and straight despite the poor plants used) that a first thinning was carried out in F.Y. 47. A fairly heavy thinning was done, leaving 980 trees per acre.

An inspection in the succeeding spring of this particular area showed that the response had been so great that a second thinning was now necessary. This was done in the early summer of F.Y. 48, when one-third of the crop was removed, leaving 680 trees per acre. The average total height of the thinnings was 32 feet, one of the better poles had a maximum growth of five feet four inches during F.Y. 43 ; and the best trees in the remaining crop were estimated to be 42 feet in total height.

In favourable situations in other parts of this district, Japanese larch planted in P.47 had reached a height of eight feet by 1948. There is no doubt that the sheltered valleys in the extreme south-west will produce some phenomenal growth, and a new technique will be required to deal with them if and when such areas are acquired.

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WHAT IS HYBRID LARCH?

BY M. V. LAURIE

Chief Research Officer

HYBRID LARCH FREQUENTLY figures as an item in seed demands and in lists of stocks of plants in Conservancy nurseries. I have the impression, however, that there may be some misapprehension regarding what this hybrid larch stock really is, and that in some cases it is fondly imagined by the recipients of such stock or seed that they are getting the original Dunkeld hybrid, or something like it. This, in fact, may be very far from the case.

The original Dunkeld hybrid larch was first recognised in 1905 among seedlings raised from the ten Japanese mother trees growing in an avenue on the Dunkeld Estate, which were cross-pollinated by European larches in the vicinity. It was first described by Henry, and was given the specific name of *Larix eurolepis* A. Henry. This first generation hybrid, which has been described in greater detail by Laing (1) is, relatively speaking, fairly consistent in its characteristics. In the general colour of its twigs it resembles the European larch more closely than the Japanese larch, and there are a number of other characters which are sometimes the same as those for the Japanese larch and sometimes the same as the European larch, and sometimes intermediate. By using a combination of these characters, which include the papillae on the epidermis of the leaf, the number of cells in the epidermis, the colour of the female flowers, the shape of the male flowers, the colour of the roots in older trees, and certain anatomical details of the wood, it is possible to determine the first generation hybrid larch fairly definitely. There is, of course, a certain amount of variation in it which is due to the variation in the European and the Japanese parent trees themselves, but the range of this variation is, as already mentioned, relatively restricted.

This first generation hybrid has been investigated by various continental workers who have established that it is heterotic—that is to say that it has hybrid vigour, growing more strongly than either of its parents. It is further claimed that it is heterotic in its resistance to diseases and pests, and in winter hardiness and drought resistance (Ashton (2)). For instance, Albensky (3) found that 55.2 per cent. of first generation hybrid trees, five years old, reached between 150 and 200 centimetres height, and 10.4 per cent. exceeded 200 centimetres height, while the tallest pure European plants in the same trial only reached 176 centimetres. Dengler (4) in a comparative trial obtained 2.66 metres height growth in five years for first generation hybrid stock, as compared with 1.64 for pure European stock and 1.80 metres for pure Japanese stock from the same parent trees. He found, moreover, that it was immaterial whether the hybrid seed was collected from European mother trees cross-pollinated by Japanese male parents or *vice versa*. In this country many trials have been done with hybrid larch seed, and this hybrid vigour has been noticed in some cases; but the tests have rarely been critical, as the source of the pollination of the mother trees has usually been uncontrolled, and in many cases it could not be guaranteed that the hybrids were genuine first generation crosses. It is striking, however, when looking round European larch provenance experiments how, in seed origins collected in this country, one frequently comes across individual accidental hybrids showing all the signs of hybrid vigour. They can be picked out at a distance by their much larger diameter and taller growth.

So convinced are the Swedes and the Danes of the merits of first generation hybrid larch that special plantations for the production of seed in considerable quantity under conditions of controlled pollination from parents of elite stock have been established, and we may shortly be able to buy from them seed of the true "Dunkeld hybrid," only of a superior type owing to the careful selection of the parent material.

The hybrid larch seed which is commonly used in the Forestry Commission for raising stocks for plantation purposes and for sale to the public is not obtained under any controlled conditions. Sometimes it may be collected from Japanese or European parent trees which are in proximity to trees of the opposite species, and the hybrid seedlings picked out in the nursery from those of the pure parent lineage; but more commonly seed is collected from existing hybrid larch plantations which have reached a sufficient age to produce fertile cones. In the latter case the result is entirely different from the first generation cross. Instead of getting a stock with relatively consistent characteristics which can be described, this second generation hybrid segregates out into a very wide range of forms, varying from plants looking almost like pure Japanese larch to plants resembling pure European larch, and all varying very widely in the vigour of their growth, an undescrivable conglomeration of types. The important point, however, is that hybrid vigour, if it has not vanished altogether, will be greatly reduced, and the range of variation in vigour of this mixture of types, though wider than the range of variation of the parents, will usually centre about nearly the same mean value as the parents, and plants as vigorous as the heterotic first generation hybrid will, if they occur at all, be comparatively rare.

Professor Ashby (5), in his most intriguing article on "Hybrid Vigour" in *New Biology*, describes the genetical theory behind heterosis, as developed by the distinguished American geneticist, D. F. Jones. He points out that if, as seems likely, all the chromosomes in a plant contribute to its growth, in a plant such as tobacco which has 24 pairs of chromosomes the probability of heterosis turning up in the second generation from self-pollinated heterotic first generation hybrids might be, according to theories based on pure Mendelian inheritance, about one in seventeen million individuals. On the other hand, if only four chromosomes were involved, 6.5 per cent. of the second generation might be heterotic. Larch has twelve pairs of chromosomes, and here the probability of heterosis occurring in the second generation would, theoretically, be negligible if all the chromosomes were involved in producing heterosis in the first generation. Actually, as Ashby points out, none of the theories entirely explain the facts of heterosis, and there are conflicting views on this fascinating subject. In practice, in most crops hybrid vigour is greatly reduced in the second generation, and is usually insignificant in extent by the fourth generation, if not earlier. The results in a number of experiments in this country suggest that in larch, very little, if any, hybrid vigour is left in the second generation, but, as mentioned, these experiments are not very reliable. Cook (6) in America, who was supplied with "Dunkeld hybrid larch" seed, as well as European larch seed of Sudeten origin and pure Japanese larch seed, found that the range in form and colour of the five-year-old hybrid plants varied very widely, ranging from almost pure European to almost pure Japanese types, and the average height of the plants was intermediate between that of the pure European and the pure Japanese lots. This is what one would expect to happen on the genetical theories of heterosis, as the seed supplied was not the true "Dunkeld larch" seed at all, though sent under that name, but was second generation hybrid larch seed collected from the original hybrid larch plantations at Dunkeld. There was no apparent

evidence of heterosis in this second generation. More work is, however, required to establish whether any hybrid vigour is retained in the second hybrid generation, and if so, how much.

My main object is to emphasize that the first generation hybrid, the true Dunkeld larch, is a distinct form, with marked hybrid vigour, and to suggest that the name "Dunkeld larch" and the latin name "*Larix eurolepis* A. Henry" should be reserved for the first generation hybrid only. It appears quite unjustifiable to use this name for the mixture of types that appears in the second generation, which has no constancy and little, if any, of the merits of the Dunkeld hybrid, either as regards rate of growth or any other of its properties which may be heterotic.

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The high elevation experiment at
Beddgelert Forest, North Wales,
described in the article by R. D.
Pinchin

Lord Robinson, Chairman of the Forestry Commission, felling the first tree to be removed in thinnings at Kieldor Forest, July 2nd, 1948





Sir William Taylor, C.B.E., with the desk presented to him by the staff on March 23rd, 1949



**SAWFLY LARVAE ON
SCOTS PINE**

The winning picture in the 1948 Photographic Competition, taken by A. D. S. Macpherson, Forest Worker, South Laugan, Inverness-shire.

A HEIGHT AND GIRTH ASSESSMENT OF THE PARENTS OF THE DUNKELD HYBRID LARCH

AT THE REQUEST of the Chief Research Officer the parents of the Dunkeld hybrid larch were measured in October, 1948, by the Northern Sample Plot Party.

These larches are located in the Kennel Bank area of the Dunkeld House Estate, Dunkeld, Perthshire. The Japanese larch grow in a row alongside the main drive, whilst on a bank, immediately adjoining to the west, the European larch are found. The European larch, because of their situation and greater height, tower above the Japanese larch and stand in an excellent position to effect fertilisation.

The European larch are approximately 199 years old (1). They grow in a mixture which consists mainly of larch and beech, and this association has no doubt helped to produce the fine branch-free stems of the larch. They are clean for forty to sixty feet ; this, together with their lack of taper, gives them an appearance of great strength and considerable beauty.

The Japanese larch are sixty-four years old (2). They are of coarse habit and there is little or no branch suppression. The branches growing out into the drive are particularly long—the lower ones often spanning thirty feet. Detailed measurements are tabulated below.

	European larch	Japanese larch
Approximate age ...	199 years	64 years
Average height ...	123 feet	81½ feet
Height range ...	116-135½ feet	73-91 feet
Average quarter girth at Breast height ...	27 inches	19 inches
Quarter girth range	21-39 inches	16-22 inches

REFERENCES

- (1) *Report of the Conifer Conference, 1931.*
- (2) *Transactions of the Royal English Arboricultural Society IV, 1898, p. 273.*

D. B. CRAWFORD

Forester, Sample Plots, Research Branch

OBSERVATIONS ON ICE-DAMAGED DOUGLAS FIR AT KERRY FOREST

IN JANUARY, 1940, an ice storm caused severe damage to plantations of Douglas fir, then sixteen years old, on the Sarn area of Kerry Forest, Montgomeryshire. The following observations on these damaged plantations were made in 1946, at which time they were marked for their first thinning.

The area examined lies in Compartment 1, P.24, on a steeply sloping area with a north-east aspect, ranging from 1,150 feet to 1,320 feet in elevation. The proportion of stems damaged by the ice varied over different parts of the plantation from one tree in four, to one tree in fifteen, with one tree in six as an average figure. This damage now takes varied forms, such as forked leading shoots, malformed stems and crowns, and secondary leaders arising from side branches after the original terminal shoot had been broken off. Some trees now have several "leaders," whilst on others crown development has completely ceased, following breakage of the main stem. Damage appeared to be most severe on those trees that had been dominant at the time of the ice storm, with the result that many of them had since assumed the form of wolves. When marking the thinning such trees were selected for removal where possible, in order to favour the better formed sub-dominants which had escaped severe ice damage.

D. L. SHAW

Foreman, North Wales

METASEQUOIA GLYPTOSTROBOIDES

BY C. A. CARPENTER

Clerical Officer, Dean

THE UNFORTUNATE BEARER of this rather formidable nomenclature has made a somewhat recent and phenomenal appearance in botanical circles but, contrary to what might be supposed in such an instance, this member of the Coniferae is by no means new. The story surrounding its discovery and introduction is one packed with romance, and savours strongly of H. Rider Haggard.

It had hitherto been supposed that in some remote corner of the globe, untrodden by the foot of man for generations, there might exist the undiscovered relics of a bygone era in the botanical sense, and, shortly after the first world war, there existed in certain circles a very strong rumour to the effect that somewhere in the sub-arctic regions of Canada, and sheltered by high hills, there lay hidden a valley which, warmed by natural heat generated underground, provided a perfect environment for the shelter of what might prove to be the survival of an ancient tropical flora. The rumour may have received some consideration from certain sources, but never had sufficient support to merit attention by practical thinking botanists, and so eventually died a natural death.

Much later, in fact only three years ago, another rumour started, that in China, somewhere near the Hupeh border, a region that has so generously provided for our aboretums in the past, a large tree had been discovered which, so far as could be ascertained at that time, bore no resemblance to any other tree classified in modern botanical circles, and could only be assumed to be the survivor of an era possibly commensurate in time with that in which the coal measures were laid down.

Lord Aberconway of the Royal Horticultural Society was sufficiently convinced of its existence to state to the Fellows of the Society that a tree recently discovered in China was a survival from the Cretaceous period, and great interest was immediately awakened. The story of its discovery was originally told by Dr. E. D. Merrill in *Arnoldiana*, a publication of the Arnold Arboretum—Part I, Vol. 8, dated March 5th, 1948.

The discovery was made by Mr. T. Wang in 1945, and in the following year sufficient evidence was obtained to establish that the tree was a living species of a genus known only from paleobotanic records and named *Metasequoia* by the botanists. It is not quite so old perhaps as *Ginkgo biloba*, which member of the Coniferae is known to be the oldest survivor of the known plant world of today, having persisted through millions of years.

Sufficient interest was aroused for an expedition, financed by the National Central University, Nanking, and led by Mr. C. J. Hsueh, to set out in search of further evidence and, if possible, to secure botanical specimens. This was successful and the specimens so collected were dispatched to the Arnold Arboretum, where they aroused so much interest that a further expedition arranged between Dr. Merrill and Dr. H. H. Hu, and financed by the Arnold Arboretum, was sent to Szechuan, near the Hupeh border. It was organised by Professor Wan-Chun Cheng and led by Mr. Hsueh, who found

large numbers of mature specimens and later, in the Shin-sa-pa valley in Hupeh Province, succeeded in collecting seed which was dispatched to the Arnold Arboretum.

The Arboretum in turn generously arranged for the distribution of seed to the botanic gardens at Wisley, Kew, Bodnant and Edinburgh ; and the first results of sowings were seen in the form of a pan of seedlings raised at Wisley and exhibited at one of the recent shows of the Royal Horticultural Society.

Morphologically, *Metasequoia* bears a resemblance to *Glyptostrobus*, the likeness to which has furnished its specific name. The branches assume the same habit, the foliage suggesting a likeness to *Taxodium distichum*, both in general appearance and in the fact that the tree is deciduous.

It has, so far, only aroused the interest of plant collectors and arboriculturists. From the forestry point of view it may yet be viewed with a certain amount of conservative opinion. The tree, however, appears to have possibilities from the amount of timber it produces—specimens of 110 feet in height and 7 feet trunk diameter are by no means uncommon, and place it in size well within the class of *Sequoia sempervirens*.

It may of course very well prove that the quality of the timber produced would not meet the demands of timber required in commercial circles, when grown outside its natural habitat. So far as is yet known it is indigenous to Hupeh only, and if introduced to other localities, it cannot be assumed that the site factors which obtain in its new abode would be conducive to its well being or the production of a sound and durable timber. It may prove to be, at best, only a valuable amenity tree or an interesting acquisition to the arboriculturist.

A ROUGH-BARKED BEECH

VISITORS TO SAVERNAKE Forest have shown considerable interest in a large beech here which has a very rough bark. Not only is the bark of the trunk thick and scaly, but the same characteristic extends even to the small branches of the tree. The leaves appear to be the same as any other beech, and during a recent visit a Research Branch party were satisfied, on a superficial examination, that the main characteristics, apart from the bark, conformed to the normal *Fagus sylvatica*. As far as I know there is no other beech here anything approaching this specimen with the same aberration. The tree is perfectly healthy and shows no sign of disease of any kind.

J. T. WILDASH

Forester, South-West England

HIGHLAND BIRCH

BY J. S. R. CHARD

District Officer, Census of Woodlands

BIRCH IN THE Scottish Highlands, as elsewhere, is a very variable tree, with different forms often occurring in adjacent glens and sometimes on different aspects of the same hillside. In general there is a tendency for *Betula pubescens* Ehrh., to predominate on the western watersheds and *B. alba* L. on the east, but neither agrees very closely in character with these types as they are found in the southern parts of Britain, while in the north-west and north *B. pubescens* appears in a rounder-leaved form which may have some affinities with *B. nana* L.

Of greater interest to the forester is an elite and apparently distinct type which occurs in the Central Highlands. This is an erect straight growing tree of medium height (fifty to seventy feet), with a cylindrical smooth-barked bole and very long and pendulous secondary branches. Leaves are small, acuminate, bi-serrate, and markedly angular in appearance, glabrous, and with numerous glands when young. Twigs are extremely fine and wiry, and in all the material examined are neither tuberculate nor pubescent, but develop numerous and very prominent lenticels on the second and third-year growth of the main branches. The latter are shiny, of a dark mahogany colour, becoming ruddy in transition to the white bark of the older stem. The catkin scales, in the shape of a fleur-de-lys in *B. pubescens* and with a less prominent central lobe in *B. alba*, are in this form scarcely trifid at all, the middle part being reduced to a small tooth at the junction of spreading side lobes.

The largest and best stands of this truly Highland birch are found in the upper sections of the main river valleys, notably on the Tummel (Kinloch Rannoch) and on the Spey (Loch Insh). Both the latter sites are characterised by broad alluvial tracts at relatively high elevations, with an inland mountain climate of cool summers and of long winters with considerable snowfall, and it is suggested that in such situations, where the growing season is too short for oak to ripen its seed, and the soil conditions, favouring grass vegetation, are too fertile for pine, birch may originally have formed the natural climax forest over fairly wide areas, and so have acquired more permanent adaptation to locality factors than is normally open to it in the role of a pioneer species.

In this connection Thomas Pennant, visiting Strath Tummel in 1774, recorded that apart from the pines at Dall, the natural woods of that district were entirely of birch; and in 1830 Elizabeth Grant of Rothiemurchus recalled that in her childhood the tracts beside the Spey were covered in a similar manner. The present stands at Loch Rannoch are definitely of second growth, but the floristically rich composition of many areas in Strath Spey, with a dense undergrowth of juniper (resistant to grazing but highly susceptible to fire damage) and frequent co-dominance of aspen (highly susceptible to grazing), suggests that the latter have been little interfered with by man.

Indeed, although the minor products of the birch played an important part in the domestic economy of the Highlander, it is known that, in the general absence of roads and owing to its unsuitability for fletation, there was no commercial exploitation of the tree in this district until well into the nineteenth century. This came after the last remaining large tracts of native pinewoods had been cut over, and was brought about by the demand for boxes and casks

for the herring industry, which enjoyed its greatest boom (under government bounty) in the aftermath of the Napoleonic wars. The supply was exhausted soon after the completion of the Highland Railway in 1863, but the virgin character of the stands being cut during that period can be judged from the fact that the trade was for logs of fifteen inches diameter and up, and John Grigor, writing in 1868, states that the better specimens were over two feet in diameter.

Hardly any trees of this size are to be found at the present day, but Pennant described a birch sixteen feet in *circumference* which he saw at Rannoch, and going back to a more remote period of history, a mediaeval crannog excavated in Loch Treig in 1933 contained two straight clean-grown birch logs, thirty feet in length and twenty and twenty-one inches respectively in top diameter, the smaller of which showed 118 annual rings.

Seeing that at most only some three or four generations separate the existing birch woods of this part of the Highlands from a parent stock of such quality, it is surprising to find, not that some good stands survive, but that such large areas now amount to little better than scrub. Allowance must be made for some deterioration of conditions due to dissipation of the original forest soil, and it is possible that the better types of tree have tended to be eliminated by selective felling, or that inferior types may have been more successful in re-establishing themselves after the initial clearances. It appears probable, however, that the conditions now observed can be attributed mainly to fundamental changes of land use.

At the time of Elizabeth Grant, the only stock carried in the forest areas were black Highland cattle, which would give little hindrance to regeneration, particularly as they were moved up to hill sheilings during the summer months when young growth is most susceptible to damage. The wholesale fellings of that period finally left insufficient shelter for cattle to be wintered in large numbers; their value fell in competition with more quickly-maturing lowland breeds, which were developed on the extension of enclosures and the introduction of the turnip; and soon the growing industrialisation of the woollen industry made sheep more profitable. Although much of the land in the Central Highlands very soon became sheep-sick or failed to establish stocks, and in turn went over to deer forest, the original birch wood areas, with their natural grass swards, have been kept under sheep ever since.

The result has been that every seedling is nibbled back many times before it is strong enough to shoot away, and frequently when more vigorous patches are able to form thicket they are deliberately cut and burnt to clear the pasture. The effect of this grazing pressure is also to maintain over longer periods, and perhaps to accelerate, the sequence of rising water table, water-logging, surface run-off, leaching and peat formation, which is always associated with the clearance or degradation of forest cover under the Scottish type of climate; in many cases, of course, it altogether prevents the eventual reversal of this process.

Trees which do succeed in establishing themselves under these conditions are inevitably distorted, weakened, and stunted, and are quite unrepresentative of their inherent type, or of the possibilities of the locality. Such better stands as occur have clearly originated in the absence of, or during some temporary relaxation of, this grazing; but very few of these have any prospect of making big trees, as the current use is for bobbin wood and furniture squares, neither of which require large dimensions, and with demand exceeding supply, the usual cutting size is down to seven or eight inches in

diameter. In consequence, even where growth is good, the impression given to a casual observer by the small size of the trees, and the interspersed areas of a scrubby character, is that Highland birch has little potential value as a timber crop.

The historical and other evidence which has been given above does not support such a view, and it is suggested that it would be well worth while to both the forester and the farmer if steps were taken to cultivate it in a rational manner, instead of treating it as a weed.

The forester does not need reminding of the increasing economic value of well-grown birch for plywood and for many other uses, but in this country he has hitherto been precluded from devoting to its growth any land of sufficient quality or extent to support an industry of this nature. Here is his opportunity, for by co-operation with the Highland farmer he could have the use of all the land that could be needed for this purpose, at no other expense than that of fencing, preparation of ground, and thinning.

The benefits would be mutual. The successive clearing of about an eighth of the farmer's scrub at a time for the purpose of regeneration, would not deprive him of more pasture than he loses at present by persistent and haphazard coppicing, or by the encroachment of peat following upon the dying out of overmature stands; while after about ten years the better trees could be singled out and the sheep let in to graze beneath them, without hindrance for the remainder of the rotation. Not only would the farmer's wintering be assured in perpetuity, but, owing to the soil being fully protected, fertility would build up again instead of being dissipated, and the stock-carrying capacity correspondingly increased rather than decreased. There would be no detraction of amenity, and useful by-products in the form of firewood and temporary fencing stakes would be available for the taking. Birch may not be an ideal firewood, but it has the one great advantage over peat that it can be cut in winter when farm work is at a minimum, and can be carried without dependence on the weather. It makes useful stakes and even posts if properly creosoted.

The technique of management on such a basis admittedly requires an experimental approach. In the writer's view it is an experiment which cannot fail to be of some benefit to any farmer, and which, particularly if based on the recognition and encouragement of elite strains of tree, carries prospects of a large measure of success for the forester also. As there are in the Highlands at the present time some 150,000 acres of moribund and untended birch scrub, producing neither timber nor satisfactory grazing, and a further 50,000 acres from which birch has died out in the past fifty years owing to complete suppression of regeneration, it is an experiment which should be started without delay.

THREE FINE SPECIMENS OF OAK IN THE FOREST OF DEAN

BY W. T. WATERS

Forester, Research Branch

THREE OAK TREES of special interest were recently selected and felled in the Highmeadow section of the Forest of Dean. Their trunks are to be converted into panelling for the new Imperial Forestry Institute now being built at Oxford. Various countries of the Commonwealth are contributing representative timbers from their forests for decorative indoor furnishing, and these trees will show what fine timber can be grown in our British woodlands. The actual conversion of the timber is being carried out at the Forest Products Research Laboratory, Princes Risborough, Bucks.

The three trees were cut in different compartments of the Highmeadow Woods. The soil on which they grew was derived from Devonian Old Red Sandstone rocks, and consisted of some six inches of top soil with a light covering of humus. The stocking of the woods was satisfactory, although tree No. 2 had in earlier life developed wide annual rings on its southern side; this was probably due to a small area being felled on that side, which had enabled more light to reach the tree's crown, so encouraging girth increment.

The first tree grew on a slight slope inclined towards the west, the second low down in a side valley running down towards a larger valley running south-west, and the third on a steep south-facing slope. So steep was this slope, having a gradient of about 40 degrees, that in order to prevent damage through splitting, it was found necessary to fell this particular tree by cutting a "key" in its bole. A small amount of rot was observed in the trunks of the first and second trees, but the third was completely sound and had a clean straight bole.

The timber dimensions of the trees, together with some details of their early height growth and volume increment obtained by stem analysis, are set out below. Unfortunately the total heights of the trees at the time of felling could not be obtained, because the branchwood and tops had been cleared away before the measurements were taken.

FINAL DIMENSIONS OF THE THREE TREES

TABLE 1

	Tree No. 1	Tree No. 2	Tree No. 3
Age, years ...	190	194	140
Quarter girth at breast height (4 ft. 3 in.) in inches	33	34	19½
Log. 1. Length in feet ...	25	17	18
Mid quarter-girth, inches ...	26½	31½	17½

	Tree No. 1	Tree No. 2	Tree No. 3
Volume, cubic feet, q.g. ...	121.9	119.0	37.2
Log. 2. Length, feet ...	15	15	18
Mid quarter-girth, inches ...	25½	30	14
Volume, cubic feet, q.g. ...	67.7	93.8	24.5
Log. 3. Length in feet ...	16	8	18
Mid quarter-girth, inches ...	16½	23	13½
Volume, cubic feet, q.g. ...	30.3	29.4	22.8
Log. 4. Length, feet ...		12	
Mid quarter-girth, inches ...		22½	
Volume, cubic feet, q.g. ...		42.2	
Total volume, cubic feet ...	219.9	284.4	84.5

Note.—Girths and volumes are "over bark."

EARLY HEIGHT GROWTH OF THE THREE OAK TREES

TABLE 2

Age, years	Height in feet		
	Tree No. 1	Tree No. 2	Tree No. 3
11	—	17	—
15	—	—	18
19	25	—	—
27	—	—	36
37	31	—	—
39	—	35	—
42	—	—	54
50	—	52	—
56	56	—	—

VOLUME INCREMENT OF THREE OAK TREES IN HIGHMEADOW WOOD AS CALCULATED FROM STEM ANALYSES
 Hoppus cubic feet, over bark measure

TABLE 3

Age (years)	Tree No. 1			Tree No. 2			Tree No. 3					
	Volume, cu. ft.	Annual increment		Volume, cu. ft.	Annual increment		Volume, cu. ft.	Annual increment				
		cu. ft.	Periodic		cu. ft.	Periodic		cu. ft.	Periodic			
50	---	---	---	---	---	---	---	---	---	---	---	---
70	41.5	1.13	2.14	11.3	.95	4.57	15.8	.65	2.90	.32	.41	.53
90	64.1	1.47	1.87	30.2	1.16	2.78	28.7	.94	2.47	.41	.53	.52
110	93.5	1.43	1.33	53.4	1.55	2.25	47.5	.48	.92	.53	.52	.50
130	122.0	1.26	.94	84.3	2.04	1.95	57.1	.40	.66	.52	.50	.50
150	147.2	1.06	.67	125.1	2.16	1.47	65.0	---	---	---	---	---
170	168.3	1.56	.85	168.2	1.63	.88	---	---	---	---	---	---
190	199.5	---	---	200.7	.79	.38	---	---	---	---	---	---
				216.5	1.1	1.1						

THE WALNUT

BY J. S. R. CHARD

District Officer, Census Branch

IT IS NOT GENERALLY realised that the common walnut is naturalised over a great deal of the chalk down areas of south and south-east England ; this is probably because the trees are widely scattered and, to a casual observer, particularly in winter but also in some circumstances in summer, they have a fairly close resemblance to ash. Trees of all ages up to maturity can be discovered in situations where it may be assumed that they have definitely not been planted, but there is always an apparent preponderance of saplings up to about seven years old, suggesting the incidence of factors which may limit survival beyond that stage.

The typical sites are along fence lines, on uncultivated banks or lynchets, at the sides of low hedges and in the larger openings amongst downland scrub. Occasionally seedlings establish themselves in young plantations, or on recently felled areas, but they never invade closed scrub, established woodland, or even large hedgerows, and where larger trees are found in such places it is usually evident that they are much older than any surrounding growth.

The planting of walnut as an orchard crop has long been out of fashion, and as the demand for, and felling of, mature timber has always been heavy, potential parent trees are relatively scarce. The wide dispersal of regeneration to what is obviously a restricted choice of sites is therefore remarkable ; in some cases it has been noted as far as five miles from any known or ascertainable source of seed.

Although many creatures feed on the nuts, observation over a number of years has confirmed my belief that rooks are by far the most important agents of distribution. They clear whole trees of nuts in a few hours, just as the hulls begin to split, and by flying to the open and deliberately dropping their booty in an attempt to break the shells, they scatter seed over a wide area. Moreover they choose stretches of bare ground or short turf for this purpose, and it is just in these situations that unretrieved nuts have the best chance of escaping the attentions of mice in the interval before germination.

The young seedlings also flourish best in short herbage and under full exposure ; they dwindle at once under shade, while the shelter afforded by any form of side cover stimulates unseasonable growth, and, by impeding the drainage of cold air during radiation frosts, soon leads to numerous casualties. It would appear that once the maiden stem has been cut back, whether by frost, by rabbit damage, or by the hedger's bill hook, the plant has little hope of survival, since the resulting sprouts fail to cease growth and to harden off before the onset of autumn frosts.

The seven-year period already noted is perhaps the usual time taken by trees which have been crippled in this way to succumb. It is also a period of considerable extension of the main root system, and, if there is any hindrance to the development of this, walnut goes into check in the same manner as ash and several other hardwoods, and is soon overgrown by weeds. Shallowness of soil and poor drainage appear to be the main limiting factors, for walnut will not thrive where chalk comes very near the surface, nor on the heavier

clay-with-flints cappings of the hill summits. In fact, although some seedlings come up almost anywhere, it is remarkable that vigorous growth and all the larger trees are restricted to deep dry loams, such as are commonly accumulated by downwash along lynchets and enclosure terraces.

Thus the lower and outside edges of hanging woods, on south-facing slopes above the level of valley frosts, are perhaps the ideal sites for this very exacting tree ; and it may not be a coincidence that the common box, associated with walnut in its native habitat, favours a similar situation in the few places in this country to which it is considered to be indigenous. Certainly an understory of box is an excellent addition to a grove of mature walnut, shading and protecting the soil and preventing the establishment of aggressive weeds, and affording valuable cover and flushing points for game.

It may be added that attempts to grow walnut as an ordinary plantation tree, in the interior of woods, appear to be equally misguided on technological as on silvicultural grounds. The value of walnut as an ornamental timber or veneer lies first in its butt, which must have as large a diameter as possible but need not be above six to seven feet in length, and is with advantage fluted or burred ; secondly in its root spurs, which are always severed below ground when the tree is felled ; and thirdly, in its numerous, large, spreading and much crooked limbs. None of these characters can be obtained by silvicultural methods of close spacing, but require the old technique of widely spaced standards given full freedom to make their maximum rate of growth on carefully selected sites.

DISTRIBUTION OF THE MOSS *THUIDIUM TAMARISCINUM* IN BRITISH HARDWOOD STANDS

THE FOLLOWING NOTES were compiled from data collected on various areas in connection with the collection of stem analysis data for hardwoods. As a general rule the moss seems to favour clays, loams and soils containing alluvial deposits.

The most luxurious and abundant growth of *Thuidium* was found in North Wales, near Trawsfynydd, Merionethshire, in a stand of pure oak situated on a hillside with a western aspect ; the soil, although shallow, had a reasonably good covering of humus (accumulated from a larch plantation further up the slope), together with deeper pockets of alluvial soil, all with a high moisture content.

In Radnorshire some excellent hardwoods including oak, sycamore and ash, were being felled on an area similar to the oak site in Merioneth, i.e., a hillside with a western aspect and damp conditions, but the soil texture differed from the other site in that the first twelve inches of top soil consisted of a clay loam, and *Thuidium* was found to be growing freely with *Hylocomium squarrosum* and *Hylocomium splendens*.

In Somerset (Stoke St. Mary) in a mixture of oak, ash and sweet chestnut, where the ash was doing well, *Thuidium* was found to be growing with *Hylocomium splendens* on a slight slope inclined towards the south-west.

In several wooded areas in Hampshire, including parts of the New Forest, Alton, and in the surrounding district of Alice Holt, *Thuidium* was found quite frequently growing under coppice with standards, and it seemed to be particularly attracted to decayed stumps.

The following selected woods in different parts of the British Isles are typical of *Thuidium* sites :—Parts of the Forest of Dean (Acorn Patch was noticeable), Bessingham in Norfolk where some fine oak are growing on clay, some good specimens of ash and oak on loam at Gargrave in Yorkshire, several woods in Argyllshire, including Benmore, Innellan, Tarbet, and a birch-sycamore-poplar mixture at Kingussie in Inverness-shire.

From these brief notes it can be concluded that *Thuidium* selects a well drained clay loam or alluvial soil, which can support some of the better hardwoods. Generally speaking, regarding the country as a whole, the moss seems to prefer the wetter parts, i.e., West Scotland, North Wales, West and South-West England, but *Thuidium* may be found to a lesser extent in the East and South-East.

W. T. WATERS

Forester, Mensuration Section, Research Branch

THE GREAT FIRE OF HATTLICH-EUPEN, SEPTEMBER, 1947

BY C. TERWAGNE

Translated by A. A. ZUKOWSKY
District Officer, Research Branch

THIS ARTICLE IS a summary of an account of the great fire in the Eupen Forest District in September, 1947, by Monsieur C. Terwagne, who was in charge of the District and actually conducted the fighting of the fire.

The Eupen Forest District is an area of about 30,000 acres situated on a fully exposed plateau at an altitude of 2,000 feet, in the north-eastern part of Belgium, close to the German border.

The forests of the Eupen District seem to be permanently under the menace of fire. This menace arises from the nature, age and distribution of the stands, from the vegetation being bracken and *Molinia*, from the presence of a deep layer of peat, and from heath land in the neighbourhood. To this should be added numerous visitors and campers, abandoned war material, and smugglers who use the forest to avoid Customs Officers, and do not trouble to extinguish a fire lit on a chilly morning. The particular cause of the disaster of September, 1947, which led to 15 per cent. of the forest area—about 4,000 acres, being swept by fire, was the unusually dry and hot summer of that year. There was no rain recorded after 20th July, from which date the weather was extremely hot, temperatures usually ranging above 90°F., winds blowing from the south and south-east. By 15th August the birch, as well as edge trees among the oak and beech, started to shed their leaves; springs, streams and herbage dried up; and the peat became powdery. Coniferous plantations reminded one of gunpowder dumps!

The fire which actually led to the disaster started on 4th September. It was, however, preceded by smaller ones. One of these was signalled on 16th August in a 40-45 year-old spruce plantation with a thick layer of peat. It was only extinguished by 10th September, and this merely because two Zeppelin bomb craters, dating from the 1914-1918 war, being in the vicinity and containing about 8,000 gallons of water, had served to localise the fire.

The great fire which, as has been said, began on 4th September, was first signalled in the Hattlich beat in the south-western part of the big State-owned heath "Torf Mist." The ling and the herbage, as well as the peat, were on fire, the flames rapidly passing into an adjoining spruce plantation. Though the wind was moderate it kept changing its direction. The task of the thirty forest workers brought to the spot was made extremely difficult owing to the heat and dense smoke. Water was not available and the fire had already penetrated into the ground. The usual methods for fighting fires were applied, but fire-besoms and beating-forks proved far from effective; flames stifled with difficulty sprang up again, forcing the fire fighters to retreat. Then a crown fire started, fed by slash (dating from 1942) left lying by the Germans. A stretch in front of the fire was therefore immediately cleared of slash and several fire-breaks established. This slowed down the advance of the fire, and when the wind died out it was possible to extinguish the last flames; workmen then started cutting a fire-trace twenty-five feet wide in the young spruce, and digging a fire-ditch intended to encircle the fire zone. Though only fifteen acres of heath and five acres of 10-20-year-old spruce were destroyed, the danger still persisted, the peat continuing to smoulder.

Next morning (5th September), the wind rekindled the flames, and sparks set fire to the herbage beyond the fire-ditch and the fire trace. The whole day was spent in beating down the reviving flames, in localising smaller fires, in keeping clear and extending the fire traces, and starting on new ones when the fire crossed the original traces. From 6 p.m. the evening became calm again. The fire, though now covering about twenty acres of heath and ten acres of spruce, was comparatively well localised.

In the afternoon of September 6th a strong wind started the fire again, and dense smoke drove away the fire fighters. A heavy storm with sudden gusts of wind pushed the flames forward by leaps and bounds. One gust of wind would make the flames leap ten to twelve feet high and sweep forward 300 yards in a few seconds. This led to the fire entering P.1896 and P.1906 spruce plantations, littered with snowbreak and recent thinnings left lying. A crown fire started, with flames leaping thirty feet above the spruce tops; the fire roared like an approaching locomotive. This put to flight Italian workmen who had come to assist in fighting the flames. Suddenly the storm ceased, and the crown fire gradually died out. A drizzle which followed was hardly enough to moisten the herbage of the heath.

At 6 p.m. the usual night calm was restored. By that time the fire zone had spread over a hundred acres of heath and fifteen acres of spruce, and had entered into the woods and heathlands belonging to a German Commune but administered by the State Forest Service. Next day (7th September), the wind was from the north-west and the fire extended eastwards into the Elsenborn Forest District, where it swept over sixty acres of spruce plantation and 150 acres of heath. The workmen being exhausted, a hundred soldiers and a gang of Italian navvies were brought in as reinforcements.

During the following three days (8th—10th September), the wind moderated, and so advantage was taken to prevent the fire from gaining ground, and also to complete fire-ditches, to brash and remove loppings and slash.

On 11th September a strong southern wind carried sparks over the line of protection, which had to be abandoned as numerous fires had started in its rear. In view of the growing danger, a request was made to have 200 soldiers instead of the 100 sent daily.

On the following day, 12th September, the fires entered a 40-year-old spruce plantation. The burning peat undermined and charred the roots of the spruce, which the slightest gust of wind succeeded in uprooting; the crowns of the fallen trees got ignited from the burning peat, and their flames started a crown fire among the still standing spruce. At this stage, the whole fire control work was reduced to throwing flaming brands, projected far beyond the limits of the fire, back into the fire. By 10 p.m. the fire reached the Hattlich-Mutzenich main road, rendering it unusable, and the ammunition left abandoned along the road began to explode. The fire, pushed by gusts of wind, advanced at the speed of a galloping horse, and passed into the woods beyond the road. The explosions rendered the workmen cautious, and as a last measure, a counter-fire was lit on a stretch of 400 yards, based only on a fire-trace the herbage of which had been trampled by the passage of fire-fighters. This measure of despair had only a temporary effect. By 5 p.m. the fire died down.

It was calm during the next three days, which allowed the digging of fire ditches, brashing up and the establishing of fire-breaks to be continued. Water being close at hand, a motor pump was installed by the fire-brigade and the northern outskirts of the fire zone were watered.

On 16th September a strong southern wind again rekindled the flames over the whole fire zone, and the defence had to be brought back to a line previously cleared. Meantime on the Northern sector, at the very moment when the German workmen succeeded in completing a ditch around the whole of the fire zone, sparks flying at a height of more than 100 yards, set on fire a 10-20-year-old spruce plantation. Owing to an incredibly strong wind, the fire advanced by leaps and bounds, and 250 acres of spruce were destroyed in the Northern sector before the end of the day. At this stage it was realized that on account of the size of the perimeter of the fire the force of 500 men was inadequate to deal with it, and the National Rescue Corps was summoned.

The extinguishing of the fire by water began on 17th September, and was continued on 18th September; both days were calm. Unfortunately there were far too few motor tanks (of a capacity of 600—1,800 gallons) for ensuring a regular supply of water, especially as the pumps were very powerful, using 160 gallons per minute. Furthermore, the most crucial point, where the fire-line was close to a heath and to a young spruce plantation, was inaccessible to motor vehicles.

The 19th September was the day on which the disaster reached its peak. The wind was from the south-east, first moderate then strong. Sparks flew over the fire ditches, and the line of defence had to be brought back. By 4 p.m. the fire had crossed the bed of the dried-up Getz stream, and sparks began to fly over the "Naziweg." In spite of the late hour, the wind continued to be strong, and the flames advanced at an incredible speed. In the night the picture was very threatening; an enormous blaze illuminated the horizon to the north-east, the spruce burning as torches in a sea of flames. It was only on the next morning at 6 a.m. that the conflagration was over, 2,500 acres of coniferous plantations having been destroyed in the course of 14 hours. But the danger still persisted, for everywhere the peat was smouldering and there still remained the danger of sparks.

On 20th September a bulldozer came into action and cut a fire trace eight feet wide. The Rescue Corps workers, now numbering 800, remained at their posts. In the evening the wind was from the west, and after two heavy showers during the next day the risk was not so great. On 23rd September half of the workmen were released, and after 27th September only a few of them had been left to watch the fire. Though the peat continued to smoulder the fire showed no progress. It was, however, only on 27th November that, after a snowfall of sixteen inches, the last fire died out.

4,000 acres had been set on fire, of which 1,700 acres were heath, 300 acres shelter belts (birch and alder) and 2,000 acres young spruce, aged from one to thirty years. The total damage was estimated at 15 million francs, and the cost of extinguishing the fire at one million francs.

The cause of the disaster

The real causes have not been established; it is, however, probable that the fire might have started through a smuggler throwing down a lighted cigarette.

The spread of the fire

Though climatic conditions were the chief factors favouring the spread of the fire, the influence of the following factors also needs to be stressed:—

- (a) Vast stretches of heath, at an altitude of 2,000 feet where there was a constant wind.

- (b) Great depth of peat, up to twenty feet, average eight to twenty inches.
- (c) Distribution of plantations ; young stands separated by heath.
- (d) Explosion of munitions.

Fighting the fire

Intense heat, dense smoke, absence of water, remoteness from any habitation, the long duration of the fire, a difficult liaison, and fire fighters being scattered over a vast and almost roadless area, rendered the fighting of the fire exceedingly strenuous. In spite of this, the firefighters showed great courage and endurance. The German workers, although on short food rations, rendered efficient and valuable service. Although it needs to be noted that the soldiers arrived without delay, they lacked experience and their equipment was seldom suitable for the job. The personnel of the Forest Service showed great initiative, zeal, endurance and devotion. Not one part of the forest was abandoned without a struggle.

Means used for fighting the fire and their efficiency

- (a) Fire-besoms, which were used for fighting surface fires, were of limited efficiency because the surface and ground fire kept practically in pace. Flames beaten down revived almost immediately.
- (b) Beating forks (shovels composed of multiple flexible metal blades on long handles) had about the same efficiency as fire-besoms.
- (c) Fire-traces : useful against surface fire but take a long time to cut.
- (d) Fire-ditches : absolutely efficient against ground fire. There is no need for ditches to be too wide or too deep or to reach the mineral soil. At Hattlich the only ditches crossed by the fire were those where sparks carried the fire beyond them.
- (e) Brushing : fully efficient as a prevention against the starting and spreading of crown-fires.
- (f) Fire-breaks : for breaking the contact of branches and for stopping crown-fires.
- (g) Water : proved of great efficiency against surface fire, thus preventing the fire from penetrating into the soil, but as a rule water is not available, and if available has to be brought by motor tanks from far away. It should be remembered that enormous amounts of water are needed to extinguish a fire which has penetrated into the soil. Even a plentiful watering moistens the burning peat to a small depth only ; a hard crust is usually formed under which the fire continues to burn. Water can be very efficient against the danger of sparks. According to the amount which is available water would have to be limited to a more or less abundant watering of the boundaries of the fire. The equipment of the National Rescue Corps is excellent, but too powerful for the majority of forest fires, as it is only exceptionally that large quantities of water are available.
- (h) Bulldozers seem to be very efficient for rapidly cutting a fire trace.

It should be noted that in general the efficiency of these various means depends on how rapidly they are applied ; it is of importance that a fire should be fought and stifled at the very outset. A few hand-pumps and a

small quantity of water would have been quite sufficient on the day when the fire broke out at Hattlich, but many months, many showers and a sixteen-inch layer of snow in November, were needed to extinguish the last remnants of the fire.

Precautionary measures

After each great fire, precautionary measures which should have been taken beforehand are usually discussed. During the fighting of this fire it struck the author that the following measures would have been of special importance :

- (1) Rapid warning of the fire. The fire-watcher on the tower, after having caught sight of an outbreak, loses too much precious time in reaching a call box to give the alarm to his chief and colleagues, and summon help to start fighting the fire. Portable radio sets would ensure a constant contact. (*Surely it would be simpler to instal a telephone in the tower—Editor*).
- The personnel on watch need to be provided with rapid means of locomotion.
- (2) Stocks of hoes, axes, spades, shovels, buckets, etc., in forest lodges need to be more plentiful, and should be reserved for fighting fires only. They need to be inspected often and handles renewed whenever necessary.
- (3) Arrangements should be made in advance for the rapid dispatch of bulldozers in case of a great fire.
- (4) Water reservoirs of a capacity from 4,000 to 12,000 gallons should be dug, for preference in impervious soils, in the most vulnerable but accessible parts of the forests. Hand-pumps of two to three gallons capacity seem to extinguish fire as efficiently and even more rapidly than the motor ones ; they also require less water, a point of cardinal importance.
- (5) Fire compartment ditches should be kept in order and all the turf removed.
- (6) In conifer plantations all trees should be brashed up to a height of six feet as soon as the lower branches die off. A stretch of from thirty to sixty feet wide along the borders of plantations should be kept clear of pruned branches. When a plantation adjoins a heath, drooping branches should be pruned or shortened to prevent the fire from passing from the herbage to the crowns.
- (7) When planting or replanting, sufficiently wide stretches should be reserved for shelter belts of alder, birch and maple into which shade bearers such as beech should subsequently be introduced.

EDITOR'S NOTE.—The above account originally appeared in the *Bulletin de la Société Centrale Forestière de Belgique* (No. 10, October, 1948, p. 370) under the title of "Le Grand Incendie de Hattlich-Eupen, par C. Terwagne." The translation is printed by kind permission of that Society.

THE CHIRDON FIRE

BY G. J. L. BATTERS

Conservator, North-East England

THERE HAVE BEEN many investigations and official reports on the Chirdon fire at Kielder Forest, but it may be of general interest to the Commission staff outside the North-East England Conservancy to have some details. Before dealing with the actual fire it would be as well to get a general picture of the forest ; it is typical of most of the Border country, rolling hills covered for the most part with *Molinia* and a certain amount of heather. The general slope of the forest is to the east and south, fairly gradual except where it drops suddenly and steeply to the Chirdon Burn.

The whole area had been surveyed on the regular rectangular system, each compartment being twenty-five acres. Minor rides running at right angles to the prevailing wind are twenty-five feet wide, and majors running parallel to the prevailing wind are thirty-five feet. There was one minor side ride which was supposed to be a fire line, but no actual work had been done on it. Roads are practically non-existent within the forest itself, but a fairly poor and narrow road leads to the edge of the forest. Apart from the rides, and occasional road alignments, the whole area has been planted without leaving any open ground.

The area of the forest is 3,500 acres, and planting started in P.38. The species chosen was Sitka spruce, with Norway spruce on some of the better ground (turf planted) and a few Scots pine on chosen sites. The greater part of the area was growing vigorously, but the ground vegetation had not been killed out ; in fact it was in a thoroughly dangerous state.

The weather during April was dry with strong east winds. (It was ironical that when Sir Harold Glover came up on April 30th to conduct an independent enquiry, we set out in a snow storm and the burnt area was completely white.)

The fire started at 12.55 p.m. on Monday, April 26th, 1947, and was finally put out and considered safe at 6.30 p.m. on the same day, during which time 702 acres were completely burnt.

The actual origin of the fire is still an unsolved mystery ; three men were planting up a small area of boggy ground, they were on piece work, and having run out of trees they had their lunch earlier than usual, before twelve o'clock, and had finished and re-started work about 12.15.

As there was a very strong wind blowing from the west, the men did not eat their lunch where they had a sheugh of trees, but went some three chains along a ride to a place where the trees were dense and provided some shelter. Having had their lunch and cigarettes, two put their cigarettes out in the drain, the other on the sole of his boot ; they then picked up their belongings and returned to the ride near the sheugh, where they piled their coats, haversacks, etc., and returned to work. Three-quarters of an hour later one of the men smelt burning, looked up, and saw that smoke was coming from the bundle of clothes, he gave the alarm and all the men ran at once to the spot and tried to beat out the fire. However, just as they arrived there was a sudden gust of wind which blew the flames across the ride and into the

trees. The men saw at once that the situation was out of control, and one man ran to the nearest point of the field telephones some three-quarters of a mile away (Chirdon Head) and gave the alarm.

The forester was some distance away in another part of the forest, talking to a shepherd who happened to be on horseback ; he jumped on the horse and made for the field telephone where he met the workman, who had arrived there immediately before him. Both forester and workmen then made off in the direction of the fire as fast as possible and the workman gave his account of the outbreak to the forester on the way. There was no time for the three men to concoct the story, and there was no opportunity subsequently for the man who went to the telephone and the two who remained at the fire to discuss the outbreak. The forester got the same story from the three men ; moreover, knowing the Border type I am quite certain that these men were telling the truth, and that if they had accidentally set fire to the forest they would have said so.

If the men had not been working at that particular place then it is almost certain that the fire would not have occurred, but there seems to be no reasonable explanation why the fire started. The cigarettes were extinguished, and anyway the fire started fifty or sixty yards away. There was a very strong wind blowing, and even if a cigarette had not been completely extinguished but had fallen into one of the haversacks it is very doubtful if it would have smouldered for three-quarters of an hour ; it would either have burnt itself out in a few minutes, or been fanned into flames by the wind almost at once.

The alarm having been given over the field telephone to all the Border area, and also by G.P.O. telephone to the military and the fire services, there were soon a large number of local farmers and helpers on the spot.

From a very early stage, it was obvious to everyone that no effective action on the fire front could be taken ; the fire was travelling at great speed and with terrific smoke and heat. Some, but very little, lateral control was possible, and, as there was no safe base line, back firing was impossible even if people could have travelled fast enough to get far enough in front of the fire.

Although there were 170 men fighting this fire, and although there were sufficient beaters, it is doubtful whether much more of the forest would have been burnt if there had been nobody there. The fire burnt itself out at the river on the south side, at agricultural land on the east and at a large drain and boggy ground on the north. The man power did prove very useful in controlling that part of the fire which started burning back into the wind ; they were also able to effect a little control on the northern flank.

Several lessons were learned as a result of the fire. Firstly, it is obvious that we are sorely lacking in access. It is essential that an efficient system of internal forest roads be constructed as quickly as possible, not merely from the point of view of enabling fire-fighters to get about quickly in some kind of vehicle but also because, in themselves, the roads will be a permanent fire ride and a safe line to start back firing.

It is quite clear that by establishing very large areas of forest of the same (or almost the same) age, without any wide breaks, either grazed belts, leanly stocked with sheep and cattle, or by ploughed and harrowed fire lines, we are running a great risk of another major fire ; and, in future, it is proposed to restrict the size of an inflammable block to not more than 500 acres, and less if possible.

It is very gratifying to know that the precautions which had been taken were satisfactory. The field telephone was invaluable, and the District Officer was notified of the fire very quickly through this field line and the G.P.O. The various squads of men from the forests were able to follow their directions without trouble or loss of time. The establishment of the Fire Headquarters at the end of the road, from which various instructions could be issued, worked well.

Should smoking be prohibited in the forests, and if it were prohibited could we enforce the prohibition? If smoking is prohibited, would it not tend to drive people into the thicker parts of our plantations for a surreptitious smoke, and by doing so create an even greater danger? Our forests are not like factories or mines where all employees are thoroughly supervised; our men must, on occasions, work in isolated groups or even singly, and it would seem that all our employees must be made completely fire conscious so that they NEVER TAKE RISKS.

RAILWAY FIRES AND PREVENTIVE MEASURES

BY J. T. FITZHERBERT

Divisional Officer, North Scotland

I HAVE BEEN asked to collate and summarise details obtained from Canada on the use of spark arresters on locomotives using solid fuel. For this information our thanks are due to the office of the High Commissioner of Canada.

The problem has arisen as a result of numerous railway fires at Leanachan Forest, Inverness-shire. The vegetation is almost entirely *Molinia*, and the Glasgow—Fort William railway line runs along the northern march of the forest for a distance of about nine miles. There is an inconvenient gradient just outside Fort William, which necessitates heavy stoking by the fireman and much puffing by the engine. At times I am told the scene resembles the fifth of November.

The initial questions asked were :

- (1) Have the Canadian Railways been successful in obtaining a good spark arrester ?
- (2) Is there any form of compulsory fitting either in the provinces or on a national scale ?

The information was most enlightening. We have learnt that all the railways in Canada run under Federal Charter and are therefore under the jurisdiction of the Board of Transport Commissioners. In the Board's rules and regulations there is a section dealing with prevention of fire. It is interesting to note some of the items.

(a) Spark arresters

Not only have the railways got to fit these but the type to be used is prescribed by the Board. The most useful one is known as the "Master Mechanic Front End type." In this the netting is of No. 10 gauge and the mesh approximately one-third to one-half of an inch. The mere fitting of the arrester is not the final act. Inspection of fire preventing devices has to be made periodically and recorded by the railway.

Experiments in the use of new types of arresters by the railways is not forbidden, but the patterns have to be approved by the Board before they are put into general use. The tests and specifications are very severe.

Many years ago, and occasionally even now, enginemmen apparently get the notion that the protective devices hamper the steaming of the locomotive. However, on investigation it appears that some other cause has always been discovered. The two main causes which encourage complaints from engine drivers have been due to moisture. In the first instance moisture on the netting collected the soot which caused a blocking of the mesh. This does not occur in modern engines with superheated steam, which are the type in use nowadays.

The other moisture trouble was due to condensation in the forced draft pipe. This has been overcome by installation of drain cocks on the pipe outside the smoke box.

Generally it is found that the spark arrester works perfectly.

(b) Other Engine Regulations

The Board have rules dealing with the condition of the various engine parts from which inflammable material might escape. They prescribe the type of coal to be used, and forbid depositing of live coals on rail tracks.

(c) General Regulations

Use of wooden bridges is restricted, and fire precautions are laid down where these exist. This includes clearance of inflammable material from wooden bridges.

Clearance of the margins of the track is the liability of the railway company, who must also maintain fire fighting signals.

Warning notices against fire risks must be provided in all carriages. Each year the railway companies are informed of the fire protection measures to be undertaken, and finally the company and company employees are liable to fines for the infringement of the order.

No doubt by now most readers have noticed a coincidental similarity between the Canadian Board of Transport Commissioners and the British Railway Executive ; also between the Commission plantations and the State forests of Canada. Is there any reason why many of the precautions mentioned above should not be incorporated into the regulations of British Railways ? I believe common law compels one to muzzle a vicious dog to protect the crowd.

I should in fairness point out that as a result of a meeting between the Commission and the Directors of the London and North-Eastern Railway Company (before nationalisation), several engines on the Fort William run were fitted with spark arresters. However for some reason or other the results are not encouraging.

In 1948 the railway embankment fires at Leanachan started on October 18th, and before Christmas 34 fires had been recorded. Altogether there was a total of 187 embankment fires during the year ; of these 34 were started by engines fitted with arresters.

PREVENTION OF FIRES CAUSED BY COMMISSION EMPLOYEES

(DIRECTOR-GENERAL'S CIRCULAR)

1. Records for 1948 disclose a most serious state of affairs, inasmuch as twenty-nine fires were caused by Commission employees, involving a loss of £21,570, which is 48 per cent. of the total. This is a loss, the remedy for which lies largely in our own hands, and it is up to all staff to do everything possible to stop it.

2. The origin of the fires due to Commission employees can be divided into three main heads :

- (a) Controlled burning of fire lines, safety belts, etc., getting out of hand.
- (b) Smoking at unauthorised times and places.
- (c) Fires believed to be out or under control, subsequently breaking away.

The following memorandum deals with a number of relevant points which experience shows need particular attention.

3. **Controlled burning**

Burning under control is often a valuable and important item in the plan for protecting a forest. It is action which necessarily involves an element of risk : the problem is to assess the risk accurately, and to take adequate precautions to meet it. There are three main decisions to be taken in each case :

- (a) *Whether protective burning is to form part of the Fire Plan or not.* This should, of course, be stated in the Annual Fire Plan. The District Officer is responsible for the recommendation, the Conservator for final approval. The decision must be based on a careful analysis of the circumstances of each case. Recklessness must be avoided at all costs, but it is also wise to guard against undue nervousness. The failure to burn when it ought to be done results in accumulation of herbage. Subsequent controlled burning becomes more dangerous, and if an outbreak does occur from any other source, the risk of its getting completely out of hand is gravely increased.
- (b) *How the burning is to be undertaken.*

In every case where a decision has been reached to burn in accordance with (a) above, equipment, staff and organisation to be employed should be laid down in detail. Too often this is left vaguely to the decision of the Forester. This should be worked out by the District Officer in consultation with the Forester, and recorded in writing. The requirements will vary according to the circumstances, but certain minima can be laid down :

- (i) A Forester, or an experienced Foreman, must be in charge and present throughout the operation.
- (ii) The squad must not be less than six men. Additional help should be quickly available on call, and precise arrangements made for its use in case of need.

- (iii) Equipment must include at least nine beaters suitable for the type of vegetation, and three knapsack sprayers (or, if not available, bantam sprayers). Additional beaters and a reserve of water for the sprayers must be close at hand.
- (iv) The length of the line of fire allowed to be alight at any one time *must not exceed* five yards per man, subject to an over-riding maximum of fifty yards, however many extra men may be on the ground.
- (v) The squad must be trained to work as a team, each man knowing exactly what his job is. It is quite clear we should place much more emphasis on training than we have done in the past.
- (vi) Burning should always take place against the wind. There are other points which can be settled in advance (e.g., whether an existing trace along the edge of the belt to be burned is adequate, etc., etc.), for each individual case. The essence is to plan the operation carefully and not leave loose ends.

(c) *When the burning is to be undertaken*

The actual day and time must be left to the decision of the man on the spot—the Forester. Obviously there are two main factors :—

- (i) The vegetation must be dry enough to burn properly, but not so dry that the risk becomes excessive.
- (ii) There must not be more than a very light wind, and it must be from a safe direction.

Experiments are proceeding to find means of assessing these factors and classifying the risk into degrees—mild, serious, extreme, etc.—but at present we cannot do better than rely on our judgment based on experience. It can at least be said that no one ought to have any doubt when conditions are bad, and when they are bad, burning must never be attempted. Difficulties arise when conditions change. A common explanation of why a fire broke away is that “the wind changed” or “there was a sudden swirl.” This explanation is not satisfactory because it shows unpreparedness for conditions which it should have been realised might easily arise. Frequently, at the time of year that burning is undertaken, there is a period in the morning when conditions are suitable for burning. As the day gets warmer, the wind rises and becomes very variable, and by afternoon conditions are really bad. By evening, safer conditions again prevail. This happens so often that we ought to take it for granted. It follows that the sound course is usually to do the work towards evening, when safer conditions are steadily developing. When morning burning is undertaken, it must always be stopped in plenty of time.

4. **Smoking at unauthorised times and places**

Several very serious fires were caused in this way in 1948. If we could prohibit smoking within a forest and adopt measures to enforce it such as is done, for example, in a dangerous coal mine, that would no doubt be the safest course to adopt. But that is not considered practicable at present, and we must continue the existing practice of permitting smoking, during danger periods, at specific times and specific places only. The times and places must be clearly and repeatedly made known to the men. Experience shows that a more or less casual warning at the beginning of a danger period is not enough.

The accidents that happen are due more to thoughtlessness than anything else, and only constant and repeated efforts by the foresters to get the full co-operation of the workmen in this matter will eliminate this danger. The ganger (or foreman if present) in charge of each squad should be given definite instructions to see that smoking regulations are strictly followed. Anyone disobeying them should be dismissed at once. The risk of fires due to smoking is greatest when men are employed alone or in twos or threes away from the main squad. Therefore, in danger periods, men should be concentrated where they are under constant supervision ; in no case (except e.g., thoroughly responsible trappers) should less than three men be employed on any job, and then only men selected for their reliability. The rule that there is safety in numbers is especially applicable in this case.

5. **Fires believed to be out or under control subsequently breaking away**

It is such a well known truism that a fire must never be left until it is out, that it is disappointing to find that this is still sometimes overlooked and loss occurs in consequence. In this connection just as much care must be taken regarding threatening fires on adjacent property as on our own land, and we should not hesitate to take appropriate action. The points which recent experience shows need emphasis are :—

- (i) Burning of brushwood, etc., must not be undertaken when conditions are not safe. Such fires continue to burn a long time and are difficult to put out without a large supply of water. Similarly, meal-time fires must be prohibited when conditions are not absolutely safe.
- (ii) Men engaged in patrolling a fire which has been brought under control should have knapsack or stirrup pumps. Water is indispensable for extinguishing smouldering peat, and even a small amount of water is invaluable in putting out smouldering embers. etc., which will from time to time show up.
- (iii) If there is any doubt as to whether a fire is completely out or not, it should be assumed that it is *not* out and precautions taken accordingly. This is a matter in which nothing should be left to chance.

A. H. GOSLING

Director General

January, 1949

FIRE BROOMS

The forester knows he must, in early spring, prepare and set out his stands of fire-beaters along the boundary fences and at known danger points for the protection of his forest. But is this their only use? With a thought to the method of erection, they can be a means of bringing the risk of fire to the notice of the visitor. People to-day give little thought to any notice telling them not to do this or that, but their attention is attracted by the novel or unusual, such as a stand to hold four or six brooms, made in any design you fancy, and painted in bright colours. Perhaps you would prefer six-inch bands of red and white, or a spiral effect; it does not matter, provided it is sufficiently attractive to arrest the attention of people who otherwise would not be bothered to look at an ordinary notice.

S. WATKINS

Forester, New Forest

(Fire beater stands, painted red and white, are already in use in parts of the country—*Editor*).

GREY SQUIRRELS AT SAVERNAKE

BY J. T. WILDASH

Forester, South-West England

I SHOULD THINK that Savernake Forest supplies all the amenities to a grey squirrel which he is likely to want. The area is plentifully supplied with nesting sites in the form of decrepit oak and beech. Food is plentiful in the forest itself in a good mast year, and failing that the hawthorn bushes over large areas are always well patronised when the beech and oak seed fails. It is quite definitely a fact that there is an annual migration from the old forest at harvest time and at the time of the hazel nuts, to the outlying woods where food is more plentiful, and as soon as this source dries up they return again to the old forest. This is quite obvious to one who is always in the area. In July or August it is unusual to see a squirrel in any part of the old forest, but the warreners also migrate to the outliers and take their toll there. I was once told by a member of the Agricultural Committee that he saw a squirrel on the downs beyond Marlborough where there were literally no trees in sight. There seems no doubt that they will go to ground freely, and the warreners have several times reported to me killing a squirrel when ferreting a rabbit earth. I have seen them go to ground myself in a hazel area in which there were some standard trees which might have served as a safe sanctuary.

An interesting theory was put to me one day by an old keeper who has known Savernake all his life. He told me that before the advent of the grey squirrel the jackdaws were particularly numerous, and there used to be an annual shoot to keep their numbers within bounds. Since the grey squirrel became established the jackdaws have steadily declined in numbers, and his theory, which seems perfectly reasonable, was that jackdaws were ousted from their nesting sites by the squirrels. This is particularly interesting, as in 1947, which I believe to be a peak year in the squirrel population, the jackdaw population was low. In 1948, however, the squirrels are quite definitely on the decline, and the jackdaws have been here in thousands and a nuisance to farmers and gardeners alike. I have kept records of the numbers of squirrels killed by the warreners and of the numbers of tails handed in to me, and from their observations and my own I believe that the population per acre is on the decline. The hard winter of 1947 had an effect on the numbers, and although I have no actual proof of disease in the summer of 1947, I believe that there was an epidemic of some kind, as I found dead squirrels and had many reports of other people doing so. The number of squirrels caught per month, since January 1946, has never been less than 20, and in July and September, 1947, it exceeded 200.

VOLE DAMAGE IN THE BORDER FORESTS

BY J. D. MACNAB

District Officer, South Scotland

MUCH HAS BEEN written about the incidence of voles in the Border Counties of Scotland, especially of the two great vole plagues of 1875-76 and 1890-92, and it is unnecessary to give any fresh details of these. Anyone who wishes to have this information is recommended to read Charles Elton's excellent book *Voles, Mice and Lemmings*, which gives in great detail the observations of many people and bodies who were interested in this phenomenon, for these plague years could only be described as such.

The vole population seems always to be present, and it is only the combination of various favourable factors, such as an open winter or a scarcity of their predators, which permits it to reach plague proportions. Some authorities state that plague proportions appear suddenly and disappear as quickly again; but I am inclined to think from my observations, that there is always a certain number of voles present, and that it is only when two or three open winters follow in succession that plagues become apparent. It has also come about in the last 150 years that many of their natural predators, both animals and birds, have been consistently destroyed by man, to protect either flocks or game birds. The natural control of the vole population by these agencies has thus been upset in the voles' favour. Although parasitic insects and organisms may still exercise some control, to what extent these operate has not yet been assessed.

With the advent of the Forestry Commission and large areas of grass and heath land becoming enclosed against grazing, and protected from periodic muirburning, conditions for progressive increase in the vole population have again become more favourable. In these afforestation areas, until the tree crop canopy closes, there are ideal conditions for voles to lead an unrestricted life, as the rank growth of vegetation gives them ideal cover from predators, such as hawks, owls, foxes, weasels and stoats. It is only in the more open parts, on the rides, roads and high ground that these animals and birds can catch them in great numbers. It has been observed also that when voles are present in any area in large numbers there is a great influx of these natural predators. Whether these animals and birds are present in the surrounding countryside or come from greater distances, I am not sure, but it is a positive fact that with the increase of vole population in any particular area, there is also a corresponding increase of their predators.

During the past two years, 1946-48, I have noticed sporadic vole damage to young plantations, which has increased greatly in parts during the winter of 1947-48, especially at Cardrona, Edgarhope and Wauchope Forests. In the spring of 1948, when ploughing was commenced at our new forest at Craik, the plough frequently disturbed as many as five voles in the course of 200 yards of ploughing. At Craik, the vole plagues of 1875-76 and 1890-92 were particularly severe, and it is to be hoped that with enclosure for afforestation and planting up, the vole population will not increase as it did then. At Wauchope Forest the damage caused to young spruce and larch was not severe, and appears to have been limited to the trees on immediate sides of streams and drains, although voles appear to be distributed all over the area. At Edgarhope Forest the damage, though more severe, is much more limited in area, extending to only one hundred acres, where the voles have attacked

all species indiscriminately. The damage for the most part has been around the collar and lower branches, and in many cases complete girdling has taken place, especially with ash and sycamore, and to a lesser extent with oak, Scots pine, Sitka and Norway spruces, and European larch.

At Cardrona Forest the picture is entirely different. Planting began there in 1933, and voles became noticeable in small numbers in 1934, but damage to plants was negligible, and from then on until 1945, although some slight damage was seen, it was at no time severe. By 1946 the vole population had increased greatly, especially in the heather areas in Kirkburn Glen above Highlandshiel. By 1947 it was apparent that vole damage to Scots pine was serious in parts, especially on the thick heather-clad slopes on the east side of the Kirkburn. These slopes are at 900 to 1,000 feet elevation, and carried a thick growth of heather, up to eighteen inches high, which provided a dense cover for the voles against their enemies. The number of holes, burrows and runways on the grassy areas on the opposite side of the burn was exceptional. Here the species were Norway and Sitka spruce and no vole damage was seen at all, all the damage being on the Scots pine (P.39, 40 and 41 ; Compartments 30, 31, 32). The damage had begun on the banks of the stream, and had gradually worked up the slopes to the higher elevations ; by the spring of this year damage was seen up to the 1,250 feet limit. Not all trees were attacked, but the majority have some damage, although not fatal. The damage is generally apparent at the collar, and may extend six inches up the stem, the bark being completely eaten off and the stem almost gnawed through, leaving only a very small core of heartwood which bends or breaks under wind or snow. No damage to roots is apparent except where they have become exposed : there is no damage to branches except where trees have bent over, and then some of the larger branches have been attacked in a similar fashion. To the north of the Scots pine are European and Japanese larches which, like the spruces, apparently have not interested the voles. In the Scots pine the diameters of the trees attacked vary between one and three inches at the collar : in most cases it is the bigger trees which have been attacked worst.

A KEEPER'S DAY

BY J. WEBSTER

Divisional Estate Officer, West Scotland

IT WAS ONLY five o'clock on a morning in early spring when Alan the keeper left his cottage which nestled in the alders along the shore of the western sea loch. He crossed the hill burn by the slab-stone bridge which the local people say was built some centuries ago by order of the Kirk Session as a punishment to a man who had committed some misdemeanour. It certainly was a curious structure, consisting of two slabs of local stone with an end on either bank, supported in the centre by a third stone resting on a rock in mid-stream. Tradition has it he had to hew, drag and build the slabs unaided. The quarry where the stones were hewn is known, and to lend support to the story the holes for the ropes by which he dragged the stones from the quarry can still be seen. Be this as it may, Alan had no time for more than a passing glance at the bridge.

For days on end the wind had been in the south-west, and the rain had come down as only in the west it can : overnight, however, it had shifted to the east, there were only a few cirrus clouds in the sky, the swallows were flying high and all the signs gave promise of a fine day.

This morning he has a double mission—to inspect his fox traps, and also the hill ground which the farmer wished burned. He skirts the shore of the loch where his Border terrier flushes a sheldrake, which in turn disturbs some eider duck which edge off with their peculiar low croak. Just back from the loch lies a thriving Sitka spruce plantation full of decaying trunks of ring-barked oak and birch, and from it comes a sound as if someone were working block and tackle gear ; it is the call of the spotted woodpecker. He is an elusive customer, but to-day, as if in protest at being disturbed so early, he makes off to the far shore of the loch and on to the long peninsula where he knows he will be undisturbed.

The way now lies inland, past the kirk and old Peter's croft, who at eighty must have been the oldest member of the Home Guard, and on to the old hill road. He crosses the dry-stone dyke built in Galloway fashion, open in places to lessen wind resistance but every stone keyed in place. On his left is the tank which supplies water to both the manse and Peter's croft, and he could never pass it but it evoked a smile at the contraption Peter invented to ensure that in a dry spell he got all the water, and the minister none. He soon leaves the track and begins to climb ; in a fold of the hill lies the lochan, and after noting the rings on the surface, he makes up his mind to come back later and have a cast for a brown trout.

There is nothing for it now but to face the hill to get on to the higher ground and the screes where his traps are set. He climbs with the hillman's steady swing up and across the face of the hill on to an old morainic slope, then across again to a shoulder which provides a good look-out. By now the sun is well up ; he pauses for a short time to survey the scene ; below he can see the smoke beginning to rise from cottages in the valley. To the south, in a blue haze, lies the island to which the Vikings gave their name, and he can just discern the turrets of their keep. Due west lies Jura of the Bens and it is evident there must be a fair breeze in the Sound by the spume over Corrieveckan. A pair of buzzards wheel in lazy flight above him. On

again, and another half-hour's climbing brings him to the traps. They are unsprung, but he renews the bait, and makes for a rock face where there is a chance of getting a hoodie crow as she leaves the nest. On the way his terrier makes off down the hill on a line of scent ; it proves to be a false one, however, and she soon returns. The hoodie's abode is near the area which the farmer wishes burned, and, before dealing with the hoodie, he makes an examination of the ground so that he can report to the forester whether burning is safe. It lies in the angle of two hill burns which shut off from the young plantations on the lower slopes, and he decides that with a north-west wind there would be little risk. He is now near the fork of the burns and well below the hoodie's nest. He knocks a stone on the branch of a birch, the sound disturbs her, and she takes to flight down the bed of the burn, breaking cover almost overhead. He lets her get clear of the scrub and then down she comes—one robber less !

His terrier has been resting ever since she got on to the false scent, and again she breaks away. He hurries along a sheep track and is just in time to see her disappear into a clump of bracken : on a ledge there is a flurry of brown with a streak of white where the vixen has been sunning herself. Instinctively, hand, gun and eye work as one, two shots ring out, both of which find their mark. An examination shows the vixen to be suckling five cubs, so her den must be at hand. Betty, his terrier, again gets going and the trail takes him back over much of the ground he has already covered, and eventually lands him at a cairn below the old vitrified fort which still stands sentinel over the Viking's fort and the Culdee chapel in what was once the MacMillan country. He blocks the entrance and decides to return home for traps. By now it is well into the afternoon, and by the time he reaches home and has a meal there will just be time to get back here before dark. So he takes a short cut through the plantation. At the point where he strikes the boundary fence it crosses a small burn, the water gate on which has been damaged by the last flood ; he effects a temporary repair and crosses into the Sitka spruce plantation. He does not enter, as the going would be too difficult, but follows the fence until he reaches a cross ride running in the way he wishes to go. There is little bird life in a Sitka plantation, but on the edges of the ride there is sun and light, and here and there he notes a goldcrest or two.

The day has not belied its early promise ; the sun has been shining and he is grateful of the shade. There is a peculiar flat boulder on the northern side of the ride, and on it he pauses to rest for a while. It is well known to him, as on it are those curious lines and hollows known as " cup markings." Whilst reclining on the stone his eye travels to a damp patch just within the edge of the wood. On it are tell-tale foot-prints, among others those of Brock the badger, who was here before the small dark men who built the vitrified fort.

On again, and he at last strikes the old hill track, where a mountain hare is flushed, the only one seen in a long day's tramp where once they were plentiful. He clears a stream which is threatening to change its course, turns down a cross trail and in a short time comes in sight of his cottage. Arrived there he first shuts Betty in her run, cleans his gun and hangs it in the rack in the kitchen, then and only then he lets his good wife attend to his wants.

VERMIN TROUBLE

BY J. CRYSTALL

District Officer, West Scotland

THE PLANTING SEASON was almost over and the ganger was glad. The forester liked to have this operation completed by the end of April but, because of being held up earlier in the season by bad weather, it was now into the first week of May. He would manage it this week. These thoughts passed through his mind as he walked briskly along the hillside to investigate the report made to him this morning by one of the squad, that some of the Scots pine which had been planted earlier in the season below the Barr of Uillan were missing. If they were missing, then there must still be rabbits in the enclosure, even although the trapper had told him only yesterday that the last one had been destroyed. It seemed to the ganger that trappers were always destroying the last one ! With this thought in mind he arrived at the heather-covered knoll and proceeded to check up by walking up and down the lines. Sure enough there were twenty to thirty plants missing. Thank goodness he still had a few Scots pine left in the sheugh. He would plant them up himself as soon as possible, but first of all he must find the trapper and inform him very politely that the last rabbit was still to kill, and was having a high old time of it in the interval.

The trapper was most indignant, and repeated that there were no rabbits in the enclosure. The ganger had not expected such an emphatic denial, and would almost have believed him had he not the evidence of his own eyes to convince him that the trapper was wrong.

The trapper was energetic and a dogged hunter, and he would pursue this one until he got it—even although he knew the ground to be clear. Of course, one might have got in under the fence or through one of the water-gates, although he doubted this because he had checked his fence line only the other day.

Arriving on the area, the trapper could see where the plants were missing and now he, too, began to ponder the mystery of their disappearance. He would have his dogs hunt the area and spend some time at the top of the crags watching. The holes which he had closed weeks ago showed no signs of occupation or disturbance. He looked up at the sheer rocky cliff immediately above the affected area, sixty feet high if an inch. No rabbit could possibly find cover on that bald face of stone.

Having scoured the area, the trapper and his dogs arrived at the top of the crags, and he set himself to watch. It was a beautiful May day—the best this year he thought ; he could see the squad in the distance planting away steadily ; the Add in the foreground looked like a silver ribbon threading its way to the sea. It was very peaceful, but the day was spoiled for him. These missing plants were disturbing, and he was also feeling a little hurt because the ganger doubted his word about the last rabbit. All the time he was thinking, his eyes and ears were active. He had a perfect view of the heather knoll and not a mouse could have moved without him seeing it. His dogs were lying peacefully at his side which was further proof in his mind, if any were needed, that there was no animal life in the vicinity. A lapwing colony drew his attention. Their alarmed calls crescendoed ; someone crossing the field probably. He was wrong on this, for the cause of alarm

was a buzzard flying high in the air, hovering for a moment and then moving on in its quest for food. It was working up the river towards him, and he could now see it quite plainly. It was a pity buzzards were protected, he thought, as he sat perfectly still. It was on a level with him now and thirty yards out—a perfect shot. Suddenly it disappeared from his view, and he looked to his right where he next expected it to appear. It did not, so he returned to his vigil.

How long he had been watching he was not quite sure, but suddenly he sat up—something had moved, and then he saw it. It was the buzzard, and on the ground. It had probably found its tea. It stood perfectly still for a moment, and did not appear to have anything—on the contrary it seemed to be looking for something. The trapper was on the alert now, and his tenseness was communicated to his dogs for they too were watching.

The buzzard was moving around and seemed to devote all its attention to one particular spot. It was using a good deal of energy and was milling around. At last it seemed to be satisfied, and rising into the air flew towards the rocks immediately below him carrying with it a young Scots pine. The trapper was both amazed and relieved. Who would have thought this was the answer to the mystery! He was on his feet by this time, and walking rapidly along the cliff edge. After much scrambling and scanning, he found what he had by now expected—a buzzard's nest composed of Scots pine plants.

It was an elated trapper who met the ganger the following morning. He told him the whole story in the same polite manner in which the ganger had addressed him the day before.

In concluding, the feather the trapper wore in his cap that fine morning (not the metaphorical one) could surely not have originated in the tail of a protected bird—or could it?

FOREST ORNITHOLOGICAL RESEARCH IN BRITAIN

BY M. V. LAURIE

Chief Research Officer

THE PART PLAYED by birds in the ecology of forests has been much debated. There is a fairly wide belief that insectivorous birds must on the whole do some good in controlling insect pests in the forest, but this is by no means established. And even if they do, it is not known how great an effect they have, or whether the expense and trouble of erecting and maintaining nesting boxes in the forest is worth while.

For instance, it is known that although the number of caterpillars that a pair of tits will destroy when feeding their brood of ravenous youngsters is very large, this number is utterly insignificant compared with the total numbers of caterpillars present on a single oak tree during an epidemic defoliation by *Cheimatobia* caterpillars. It is fairly safe to say that when any insect epidemic has really got under way, the feeding of birds on the pests will rarely have an appreciable effect on it.

One question is, therefore, whether birds, by their winter and early spring feeding on the hibernating forms and on the eggs of insects, are likely to exercise a controlling effect on summer proliferation and reduce the damage of epidemic outbreaks. It is known that a major controlling factor is the presence of insect predators and of parasites attacking the pests. Insectivorous birds are just as likely to eat the eggs and winter forms of parasites and insect predators as they are to eat the harmful insects themselves, and at present we have no information whatsoever to tell us which way the presence of birds is likely to swing the balance.

J. M. D. Mackenzie, in a series of preliminary nesting box experiments carried out from 1945 to 1947, has shown that birds can be induced to breed in considerable numbers in boxes erected in broadleaved woodland, at any rate up to a rate of about two nesting pairs per acre. Subsequent experience indicates that in favourable conditions a still higher nesting rate per acre may sometimes be possible. In conifer plantations it was found to be much more difficult to get birds to nest. Occupation rates in boxes were low, and for the most part, only boxes on the edges of the plantations were readily accepted. Much useful incidental information was also collected by Mackenzie in such matters as the best height to hang nest boxes, the effect of aspect, exposure, and of the presence of nearby branches, etc. : and ringing of nestlings was done to see if they returned to the same forest to breed there in the following year.

In 1947 a committee was formed under the chairmanship of Mr. (now Sir William) Taylor to carry the investigations a stage further. The terms of reference of this committee were defined as :—

To investigate the part played by birds in the ecology of British woodlands and plantations with special reference to the control of the major forest insect pests by the encouragement of beneficial species of nesting insectivores.

It was obvious that this line of investigation was intimately connected with the work of the Edward Grey Institute for Field Ornithology on the food of birds, and we were fortunate in being able to get the Director, Dr. David

Lack, and also Mr. P. H. T. Hartley of the Institute, on the Committee. Hartley undertook to organise and direct the investigations according to the policy decided by the Committee. Dr. W. J. Hall, Director of the Imperial Institute of Entomology, was elected to advise on the entomological aspects of the work, and besides the Chairman, the Forestry Commission is represented by Mr. Guillebaud, Mr. J. Macdonald, Mr. M. V. Laurie, and Mr. Hanson, Forest Entomologist.

The objects of the work are :—

Firstly :—to demonstrate that birds can be attracted to forests and their populations permanently increased.

Secondly :—to show that they *do* influence the incidence of insect pests.

Thirdly :—to determine the magnitude of the effects of this control of insect damage, as reflected in the rate of growth and in timber form in our trees.

The first of these objects has been partly achieved. We know that we can increase the nesting population of birds, particularly in broadleaved forests, but how far this causes a permanent increase in the resident population outside the nesting season is not yet known, and will require further study.

The second object is more difficult to demonstrate. Early in 1948 large compact blocks of forest at Nagshead in the Forest of Dean, at Alice Holt, and at Thetford were filled with nesting boxes, and control areas in similar forests nearby have been kept without nesting boxes. High occupation rates were achieved in oak forest at Alice Holt and the Forest of Dean in the first season ; while at Thetford, in pines, the rate was much lower but promising for a start. This year, further areas at Gwydyr and at Glentress are being similarly treated. It is hoped that, after a few years, when the bird populations have built up in the nest box areas, we will be able to determine, by observation on the insect populations in each, whether any large or obvious differences have occurred which can be attributed to the presence of an increased bird population. The food actually eaten by the birds is being studied at the same time, and it is hoped that some information regarding the indirect effect of birds on insect pests, through the destruction of parasites, can be obtained by a study of the relative rates of parasitization of insect pests in the bird box and control areas.

As regards the third object, this will be very difficult to assess, and is a long term matter in any case. It will not be attempted until further results are obtained under the first two objects.

IPS SEXDENTATUS, AN INSECT PEST ATTACKING PINE PLANTATIONS

(SILVICULTURAL CIRCULAR No. 24)

FOR MANY YEARS *Ips sexdentatus* and other bark beetles have been entering South Wales in the bark of pitprops imported from France, and since the war the numbers from this source have greatly increased. During the latter period, large numbers of these insects have also been arriving in the bark of pine timber imported from Germany. The large stocks of pitprops in colliery dumps, and the stacks of imported timber lying in country saw-mill yards, have provided exceptionally favourable breeding facilities. Home-grown poles and logs, left lying unbarked either in the forest or in saw-mill yards, have also been used for breeding purposes. From such sources a very large population of *Ips sexdentatus* has developed in South Wales, and serious damage is being caused to pine plantations.

Present status of the Pest

Sporadic outbreaks have occurred in coniferous plantations in the following Forestry Commission forests: Rheola, Llantrisant, St. Gwynno, Margam, Pembrey, Michaelston and Brecon. Scots pine and Corsican pine are the trees chiefly affected, but a few larch and spruce trees have also been attacked, and it is recorded that in one case a few spruce trees have been killed. In the pine forests, the extent of the infestations varies from small groups of a few trees, to large patches of several hundred. Trees ranging in height from eight feet to forty feet have been attacked and killed.

Development and Spread of Infestations

Dumps of pitprops at collieries, and stacks of unbarked coniferous timber lying in country saw-mill yards, along with thinnings left lying in or near forests, form the chief breeding places and potential sources of infestation. There is little risk of the beetles spreading from these breeding places during the spring and early part of the summer, as at that time of the year they are concentrating on the bark of pitprops and logs for breeding purposes. The young beetles feed in the bark of this material until their reproductive organs are mature, or until the bark becomes exhausted or unsuitable for their requirements. Towards the end of July the young beetles begin to swarm in large numbers. At this stage they fly very actively, and may disperse into the surrounding forest to find fresh material. After a period of feeding in the bark of standing trees, these beetles overwinter in the forest, and in the spring form egg-galleries in the bark of growing trees. If allowed to develop, these colonies may give rise to a local outbreak.

Description of the Beetles

(See also F.C. Leaflet No. 26—The Spruce Bark Beetle).

Ips sexdentatus beetles average about one-third of an inch in length. In colour they vary from light brown to dark brown, and when fully mature they become almost black. The rear portion of the wing cases (elytra) ends abruptly in a steep angle known as the apical declivity. This has a ridge along each outer edge, bearing six "teeth," of which the fourth is the largest. The greater part of the elytra, and the front and sides of the pro-thorax, are densely clothed with yellow hairs.

An allied species, *Ips typographus*, closely resembles *Ips sexdentatus* in general appearance, but is smaller (average length rather less than one quarter of an inch), has only four teeth along each edge of the apical declivity, and of these the third tooth is the largest. This species prefers to breed in the bark of spruce, while *Ips sexdentatus* prefers the bark of pines.

Life Cycle and Breeding Habits

The *Ips* bark beetles are polygamous ; in the case of *Ips sexdentatus* the ratio is generally four or five females for each male, but up to seven females may be present in one gallery system. Each female excavates a separate egg-gallery ; the average length of this is about five to eight inches, but it may extend to one foot or more. These egg-galleries start from a central pairing chamber, and when few females are present the egg-galleries tend to follow the long axis of the stem ; but when the females are numerous the egg-galleries may radiate in all directions. The eggs are laid in niches formed at intervals along each side of these galleries. The niches are spaced at fairly wide intervals, generally from one third to half an inch apart.

Breeding commences early in the spring ; the first broods complete their development in two-and-a-half to three months, and a second brood may be formed during late summer. In other words, the same parent beetles may have two lots of offspring in the same year. This is bad enough, but it also happens that in hot summers the young beetles of the first brood may pair and produce offspring in the same year, so giving rise to a second generation.

The breeding habits of *Ips typographus* are similar to those of *Ips sexdentatus*, but the sex ratio is generally two or three females for each male. The egg galleries are much shorter, as a rule about four to five inches in length, and run in the direction of the long axis of the stem. The eggs are laid at much closer intervals, generally about ten or twelve to the inch. The young beetles of both species continue to feed in the bark until they : sexually mature. It is this habit of feeding in the bark in the beetle stage that causes these insects to become such dangerous pests as during this feeding process the entire cambium and inner bark of the stem of attacked trees may be completely destroyed.

Signs of the Presence of the Beetles in Standing Trees

The first sign, in the early part of the growing season, is the presence of boring meal in the crevices of the bark of the main stem, and on the ground round the base of the attacked trees. A little later on, the trees will be seen with wilted needles which eventually turn brown. When trees die from the attack, it usually means that beetles have completed two or more breeding seasons in the bark.

Infestations in Other Parts of the Country

All field officers and foresters are instructed to keep a close watch for signs of these beetles. The most likely place to find them is in the bark of felled thinnings or timber of Scots pine, Corsican pine, and other conifers ; but the possibility that the beetles may have got into the standing crop must not be overlooked. Any infestations discovered should be reported at once through the usual channels, and specimens of beetles and bark sent to the Chief Research Officer, Alice Holt Research Station, Wrecclesham, Farnham, Surrey.

A. H. GOSLING

Director General

July, 1948

NOTES ON THE DIE BACK OF EUROPEAN LARCH

BY JAMES MACDONALD

Director, Research and Education

THERE ARE THREE species of larch with which we foresters in Great Britain have to deal, the European larch, the Japanese larch and the Hybrid larch, the first introduced just over 200 years ago, the second in the last quarter of the nineteenth century, and the third discovered at Dunkeld as recently as 1905. We have thus only a brief experience of the Hybrid and Japanese larches behind us, yet there are few foresters to-day who would not prefer giving their opinions on these newer species to venturing a suggestion for the treatment of the European larch, although we have been working with this tree in Great Britain for about two centuries. In a paper in 1939, Anderson (1), who dealt very fully with the silvicultural requirements of the European larch, did not suggest that there was anything about the species which would make even experienced foresters diffident in its presence. Yet, to-day, we hesitate. The reason, of course, is well enough known to all of us. It is the widespread, and sometimes devastating, attack of disease which has struck plantations of European larch all over the country within the last few years. This "die-back" of larch is a complex thing, associated with frost damage, and canker, and with chermes (*Adelges*), *Argyresthia* and other insect pests. It is also capricious in its occurrence. It is often found, quite severe, in places which any experienced forester would have said were suitable sites for larch; on the other hand, it is not found at all in places where it might have been expected. A plantation of larch suffering severely from "die-back" gives a picture of a crop completely maladjusted to its surroundings. Which of the many enemies preying upon it in this condition is the most important, is for the experts in such matters to decide; to the forester, the important thing is that he has made a mistake either in the kind of larch he has chosen or a mistake in the selection of the site.

Die-back has occurred all over Great Britain, but it seems to be more severe in the west of England, and in South Wales, than it is elsewhere. A survey carried out in 1942 of 382 plantations in England and Wales and 266 in Scotland showed that 43 per cent. of the plantations surveyed in England or Wales were described as "very poor" or "hopeless" while the corresponding figure for Scotland was 9 per cent. In South Wales, out of 103 plantations investigated, no fewer than 84 were very poor or hopeless, in south-west England, 16 out of 26, while in eastern England only 7 out of 39 were so described. In Scotland, the incidence of the disease has been more even; there have been several moderately bad cases in the west and south-west, but the most spectacular example is at Clashindarroch near Huntly in the north-east. Most of the recorded cases of die-back are on afforestation areas, and it is interesting, in this connection, to note that the disease does not seem to have occurred with the same severity in the New Forest or the Forest of Dean where most of the planting is on old woodland soils. The European larch, which is exacting, we might almost say fussy, in its requirements, is not the easiest tree to use in afforesting new ground, and one would naturally expect more failures in these conditions, but we require more information about those cases of die-back which have occurred on old woodland.

The first thing which we must remember is that this is no new phenomenon. It has happened before. In 1832, there was published in the

Transactions of the Highland Society of Scotland an account of the Larch Plantations on the estates of Atholl and Dunkeld executed by the late John, Duke of Atholl, and in that paper the following statement was made :—

“ Previous to the year 1795, a blight (occasioned by an insect) affected the larch, and of those in low situations many died. At that time the frost was very severe, and heavy frosty fogs hung about the trees in spring. After this phenomenon the blight appeared. Trees above 30 feet in height and in high situations, escaped this affection, where the wind could shake them. This blight destroyed the flower of the larch, and prevented the formation of seed, and, consequently, the propagation of the plant. The first appearance of the blight was indicated by a substance on the larch resembling small balls, of a fine white matter like cotton. These balls or nidi enclosed small insects, a species of *Aphis*, the two sexes of very different appearance. They appeared to live upon the juices exuding from the bark of the tree, and not upon the leaves ; and they probably prevented the sap from ascending, at least no fresh shoots were thrown out by the tree that season. Many trees were much injured by this disease, and for a long time afterwards they presented a remarkable appearance, that of being completely covered over with lichens. The trees, however, shot up clean stems 20 to 25 feet above the fogged* part, and these stems were as healthy as those of the healthiest trees that had never been affected. On cutting the wood, the fogged part was no more injured than the wood of the healthiest trees, though the lichens had adhered to them for fifteen years. The effect of this blight, then, was only superficial. The existence of this disease for eight or ten years certainly retarded the growth of the trees, but it did not cause the Duke to relax in the least in his efforts to form large larch forests. On the contrary, it impressed upon him the necessity of planting the high ridge of the mountains, in order that the trees might be placed beyond the influence of the disease, which did not appear higher than 600 feet above the level of the sea.”

Loudon (5) in his *Arboretum* published in 1838 states :—

“ Early in the present century, the larch, both in England and Scotland, was, in many places, attacked in its foliage by a white woolly *Aphis*, commonly known as *Aphis laricis*.”

In 1848, there appeared the *New Statistical Account of Scotland*, the second of those great surveys which were carried out, parish by parish, by the ministers of the Church. Among the subjects on which reports were made was forestry, and, though this was not generally treated very well, there are, nevertheless, many valuable pieces of information scattered through the numerous volumes. The period of the Survey was apparently a time when larch was the fashionable tree to plant, the native Scots pine having fallen out of favour, and this is referred to over and over again. What about the larch

* The word “fog” appears to be used in two senses in this paragraph. Here it means : mosses or lichens. cf. J. Logie Robertson :

“ We fa’ as fell oor faithers,
 Into the narrow hame,
 An’ fog forgetfu’ gaithers
 Owre oor very name.”

disease? Well, listen first to the Reverend Robert McDonald, Minister of Blairgowrie, in Perthshire, who, after describing the woodlands in his parish goes on to say :—

“ The writer regrets to add, however, that a great proportion of the larch planted within the last fifteen or twenty years is already beginning to wither and decay but whether this is owing to the bad quality of the seed or to the nature of the soil, he cannot take it upon him to express an opinion.”

Or to the Minister of Kinclaven, also in Perthshire, the Reverend Henry Henderson.

“ It is to be regretted that the larch plantations that have been formed during the last twenty or twenty-five years have nearly all failed from the effects of that inexplicable disease which has appeared so generally to attack the larches planted about that period.”

Or to the Reverend Alexander Taylor, Minister of Leochel and Cushnie in Aberdeenshire :

“ Its advantages (i.e., of planting) are now fully understood, and about 1,500 acres, imperial, have been planted, mostly within the last twenty years All these late plantations consist almost exclusively of Scotch fir and larch. The former promises well, but the latter, after thriving very well for ten or fifteen years, is all but universally going to decay. The stem becomes covered with a greyish or whitish parasitic production like moss, the top shoots wither, and the plant, in a few seasons, perishes altogether. This prevails widely at present among the young plantations of larch all over the district.”

Other references to the poor condition of the larch may be found in books by Sir Henry Stewart (1848) (10) and John Grigor (1868) (3), and many more quotations of this kind could be made because, all through the nineteenth century, the minds of foresters were exercised by the larch disease which seemed to vary in intensity from period to period. The truth probably is that every great extension of planting has been followed by an outbreak of disease among the larch, and we are witnessing the greatest of these outbreaks now because the last quarter of a century has seen more activity in planting in this country than has ever been displayed before. Any great expansion of planting or any sudden enthusiasm for a particular species is accompanied by certain dangers. A sudden or a large demand for plants of an exotic species means that seed has to be collected in its native country, often hastily, and without regard to its suitability, and that the larger these collections are, the greater is the risk of the introduction of unsuitable types. The second danger is the temptation, hard to resist, to believe that a tree, which one fancies because it has done well on one site, will do well on all sites. The result of this is that a tree may be planted in all kinds of places, some suitable and some in which it has no hope of developing.

Therefore, in considering the problems arising out of the die-back of the larch, it appears to be necessary to deal with the matter in two ways, to consider the plants and to consider the sites on which they have found themselves.

On looking at larch plantations which are suffering from die-back one is frequently impressed by the variations in the resistance displayed by individual trees to the disease. There are cases in which all the trees are

killed, but they are many fewer than those in which only a proportion have succumbed, and in which the survivors appear to be shaking off the attack, re-asserting themselves and beginning to grow normally. In many woods of this kind, it will probably be difficult in, say, thirty years time, to tell whether the crop has or has not suffered from the die-back disease; the survivors, which now look so sparsely distributed over the ground, will have grown and formed canopy and, for their age, will not be abnormally thinly stocked. As we shall see later, it may well be important to know whether the trees have been exposed to die-back and, therefore, all foresters should keep careful records of their larch plantations so that their successors may know what has happened in the past.

What difference does the origin of the seed make in the reaction of the plants to the die-back disease? Here, fortunately, we have some information derived from experiments carried out by the Research Branch of the Forestry Commission over a period of years. In Wales and in the west of England it is clear that larch of Scottish origin is much more resistant to die-back than larch from the Alps or from Silesia. Experiments of the same kind in Scotland have yielded some rather confusing evidence, but the same tendency is apparent there also. It is also possible that the relatively milder attack which Scotland has suffered may be due to the use of a greater proportion of home-collected seed. The Scottish larch which was used in these experiments was not taken from one locality, but was drawn from a variety of sources mostly north of the Highland line. Some of them, like those from Loch Ordie and Ladywell, were no doubt in the direct line of descent from the original Atholl stock, and some of those from Moray may also have had the same ancestry, because we are told by Grigor, in his book, that "the plantations in my neighbourhood (Forres) are generally very healthy and probably are composed of the third, fourth and fifth generations from the Atholl larch forests." But there is no likelihood that a special Scottish "race" or "strain" of larch exists. There may have been one in the old Atholl trees, as Schotte (9) in Sweden suggested 31 years ago, but, if there were, it has been lost almost entirely. What we do seem to have, is not one race, for Laing's (4) researches have made it clear that Scottish larch is very variable, but a number of strains of larch, the progeny of which have proved to be more resistant to die-back than plants raised from Continental seed.

Some years ago, Munch (7) in Germany, working on the problem of larch canker, which was causing serious damage in that country, came to the conclusion that the answer lay in the origin of the seed. He argued that a healthy young plantation gave no guarantee that it would succeed and resist the attacks of the canker, and he considered that the best evidence was that provided by stands of about eighty years of age, which must have experienced and survived the canker which was so prevalent in Germany from 1870 onwards. He was able to find, on a private estate between Magdeburg and Brunswick, a series of stands which seemed to substantiate his theories. We may, I think, adopt Munch's method of arguing, and say that the reason why the larch of Scottish origin is better at resisting die-back is because the plants were the offspring of oldish trees which had been exposed in their youth to the die-back, had survived it and had transmitted to their posterity, in some measure, the capacity to resist it too. Therefore, we should raise as many as possible of our larch plants from seed collected from reasonably mature trees in this country, and reduce the import of seed from abroad. That I think, is the first lesson which this die-back has taught us. There would be, of course, difficulties, and some dangers in pursuing this course. The dangers are, first, that not all the home larch is of a good type, and secondly, that it may

not all have been exposed in the past to the die-back. There are places where, for reasons which are sometimes obvious and sometimes obscure, the larch has not been subjected to the disease. Seed collected from trees which had not been tested in this way in the past might well suffer from die-back if they were planted on a site in which die-back was likely to occur. The sorting out of the resistant and the susceptible individuals would have been deferred for one generation. It is in this connection that it is important to keep proper records of plantations. When they are both mature, it will generally be impossible to distinguish between a crop which has never been subjected to die-back, and a crop which has suffered from it but in which enough individual trees resisted it or recovered from it, and went on to make a stand. Only accurate records over a long period can provide the necessary information.

The first difficulty is that the number of trees and stands of European larch of anything like maturity has gravely lessened during the years of war. The needs of the country during the war made serious inroads into the already small areas of sizeable larch timber which we had in this country, and the scope for seed-collection is now relatively small. It should, however, be exploited to the full, and it might even be considered whether some restriction on the felling of suitable seed-bearing larch should not be imposed.

The second difficulty is that larch, and especially old larch, does not yield a heavy crop of good seeds, and the output in seedlings is often very low. In addition, there are years, and they are not infrequent, when there is almost no seed at all. These factors make the supply of home-grown larch seed a little uncertain, but it should be possible, even under present-day conditions, to get all that is required in a normal year, provided the collection is properly organised. In the experimental work, to which reference has been made, the home-grown larch which was used was all drawn from Scottish sources. There used to be good larch in England, particularly in the north and in some parts of the west ; if this has not all disappeared it would be advisable to test it as the Scottish larch has been tested.

The die-back disease has emphasised the importance of the origin of the planting stock in the silviculture of the European larch, but it has also taught another lesson, that a close study of the topography is vitally necessary if success is to be achieved and die-back avoided. There is obviously no doubt that frost plays one of the major parts in inducing this trouble, and the effect upon frost-damage of the topography and particularly the micro-topography is now well understood. The account which was given of the early damage in the Atholl plantations was the story of a severe frost which filled the valley of the Tay with cold air up to a level of 600 feet, and the old Duke's action in deciding to keep his larch above this level in the future was eminently sound. Any site where there is a risk of cold air collecting should be avoided wherever possible.

So far as soil is concerned, it has been agreed by all investigators that the European larch is a most exacting species, requiring a fertile soil, though not necessarily a soil of the highest fertility, and an abundance of free moisture early in the growing season. In the Highland district of Scotland it does remarkably well on the Mica Schist or on soils derived from it ; the Old Red Sandstone in the west of England has also grown some splendid larch. Dry sands and heavy clays are alike unsuitable, and highly calcareous soils usually give poor results. Any soil, though otherwise suitable, which is liable to dry out, should be avoided as it will cause trouble both in early youth and in middle age.

Much of the afforestation, in which European larch has been used, has been carried out on soils covered with what may broadly be called a grass-heath type of vegetation, a mixture of grasses with *Calluna*, *Erica cinerea*, *Vaccinium* and other species. Great care is needed in dealing with this type of land on which many failures have occurred, and it is advisable to plant much less of it with larch than we have done in the last thirty years. The more *Vaccinium* there is in the mixture the greater, as a rule, is the danger. This type of land passes quickly, and if it has been recently burned almost imperceptibly, into other types which are quite unsuitable for larch.

Within reasonable limits there is nothing in elevation itself to prevent the growth of larch, and we have had a recent record of a seedling larch growing, admittedly in a very stunted, almost a prostrate, form at 2,950 feet on the Glas Maol (8). Dier (2), in an unpublished report, has recorded a Quality Class II plantation of European larch at 1,730 feet in Glen Ey in the Mar district of Aberdeenshire and another in the same neighbourhood at 1,640 feet. J. A. B. Macdonald (6) in his interesting account of the plantations at Loch Ericht, now felled, gives details of areas of European larch among which was one at 2,000 feet, averaging forty feet in height at approximately fifty years of age, and carrying 1,772 cubic feet per acre. All these high-lying woods were growing on good soil. The Aberdeenshire lots were growing on unleached schistose loams, and the Loch Ericht plantations on a soil of glacial origin with a high mica-schist content. But elevation cannot very well be considered by itself because, as elevation rises, so does exposure tend to become more severe. European larch, largely because it is deciduous, withstands a moderate amount of exposure, often quite successfully, but on very exposed sites, especially at high elevations, it becomes stunted and misshapen. Nevertheless, there is no reason why larch should not be grown at higher elevations than we have lately been planting it, if the soil is good, the topography suitable, and the exposure not excessive.

The aspect is a feature about which much has been written in the past, and it is possible to theorise about it in a most convincing way. But, in practice, it is very difficult to draw any satisfactory conclusion because it is involved with so many other varying factors. A northerly aspect may be an advantage in places where there is a risk of frost, especially if use is made of Scottish larch, which as Laing has shown, is late in flushing. A southern aspect may be better because the European larch is a tree which, in its native habitat, is used to bright sunlight and a high light intensity. This may be of importance on the cloudy west coast where, in fact, there are examples of good larch plantations with a southerly aspect, but, on the other hand, soils with this aspect dry out more rapidly in times of drought.

Much of the best larch in this country has grown in areas where the annual rainfall is between thirty and forty-five inches, although good larch can be found outside those limits. But here again, the matter is complicated because in areas of very low and very high rainfall, soils suitable for larch are relatively scarce.

The conclusion is, that although the severe attacks of die-back have shown us that the larch must be treated with care, there is no need for panic. They will have done good if they have taught us to pay more attention to the fundamental needs of the species.

There is one immediate silvicultural problem left us by the attacks of die-back. That is, the treatment which must be given to the affected crops. In extreme cases, where all, or nearly all the trees have died, the procedure is clear enough; there is nothing to do but to replant with another species. What that species should be will depend on the nature of the site and the soil.

The difficulty arises in those plantations in which only a part of the crop has died and where, as is usually the case, the deaths are spread over a number of years. The decision which the forester must make in such cases is whether to maintain the crop as a larch plantation or whether, by interplanting or underplanting, to convert it into a plantation of some other species. On sites which are known to be capable of carrying larch, it is a mistake to decide too soon. Trees which look like dying often recover ; trees which are apparently healthy may succumb suddenly ; it is necessary to wait until, as always happens, some kind of stability is reached. If the result is an open crop of trees of good habit and reasonable growth, then this crop should be left to develop in the confidence that in ten or fifteen years time it will be more normally stocked. The forester should look ahead and think, not of the present open and irregular stocking, but of the condition which will be reached later on.

Generally speaking, therefore, I would say that on good sites, the crop should be retained as larch and not converted to another species.

On soils of moderate fertility, where a similar open crop of larch has been left, there is the danger, as Anderson pointed out, that the open stocking and the light shade may permit the development of plants like *Vaccinium* which form an acid humus. Here the forester is in some difficulty. He will find it necessary, at some stage, to introduce a shade-bearing species to kill off the acid-forming vegetation. If he does it too soon, by interplanting through the open larch, he will run the risk of losing a moderately good larch crop, and getting in its place a rough and irregularly-stocked crop of another species. If he waits, he will be able to get a larch crop big enough at least for fencing material, with a better crop of another species to follow. On the other hand, he may have more difficulty in establishing the second crop because of changes in the vegetation.

In other cases, where there is any doubt about the suitability of the soil or site for larch, it is better to start at once converting to another species.

Every plantation which is in need of repair after an attack of disease must be carefully considered. Hasty decisions should be avoided. One sees, sometimes, examples of want of thought, where a new species has been introduced because the forester abhorred what he believed to be a vacuum, and for no other apparent reason.

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CORYNEUM CANKER OF CYPRESS

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A RATHER SERIOUS disease of *Cupressus macrocarpa*, caused by the fungus *Coryneum cardinale*, has been present in California since at least as far back as 1915, though it was not properly described till 1928. In 1933 the same fungus was reported by Birch from the North Island of New Zealand, where it was said to be doing serious damage. In Kenya an exactly similar disease has been attributed by Nattrass to the fungus *Monochaetia unicornis*, which is closely related to *Coryneum*. In 1944 Barthelet and Vinot reported *Coryneum cardinale* on *Cupressus macrocarpa* at La Nartella, in the province of Var in the extreme south of France, but no details were given as to its severity. A somewhat similar disease is caused by the fungus *Coryneum berckmanii*, which was reported by Milbraith in 1940 attacking mainly *Thuja*, but also *Cupressus sempervirens*, in America; that disease, however, is confined to foliage and young stems, mature stems are not affected, whereas *Coryneum cardinale* often attacks quite large stems.

The first evidence of infection by the fungus is a browning of the live bark tissues around the point where the fungus has entered. This is commonly at a crotch, or around the base of a branchlet, though infection may occur through wounds. The infected bark swells slightly and resin exudation usually occurs. Later the brown bark dies and dries out, becoming somewhat shrivelled in the process. The fungus advances more rapidly up the stem than round it, so that cankers are usually three to four times as long as they are wide.

If the weather is not too dry, the small black pustules, in which the spores of *Coryneum* are produced, begin to appear on the surface of the dead bark after four to eight weeks. They resemble tiny black blisters or shallow craters, and are scattered irregularly over the bark surface. On older bark they develop mainly in the crevices.

Lesions increase more rapidly during the first month or two than later. This slowing down appears to be associated in part with defensive reactions on the part of the tree, such as the development of cork layers. Cankers, however, soon spread round small branches, girdling them. On larger stems a much longer time is required before girdling is complete. The growth of wound tissue, and the increased growth of the remaining cambium, may result on considerable deformation of the affected stem before girdling is complete. Large cracks are sometimes made in the dead bark of the cankers by the development of ridges of wound tissue round the margins.

By the time girdling occurs the foliage on the affected branches usually show signs of distress, such as the yellowing and shedding of the older leaves. Fading and death of all the foliage on the girdled stems, however, may not take place for several weeks after girdling is complete. The dying of these individual branches constitutes the chief symptom of the disease noticeable from a distance. On small trees, however, or occasionally on large trees, where the girdling canker is situated low on the main stem, the whole crown may die uniformly.

Trees of any size, age, or degree of vigour are liable to attack. Those of normal open-growth form appear to become infected more readily than those with closely pruned, dense foliage, such as trees used for hedges. On

young, fast-growing trees, with open crowns extending to the ground, stem infections are most common, especially when the disease first invades a plantation ; on older or more crowded trees branch cankers predominate. Neither spraying nor cutting out cankers have proved of any real value for control. The only means of checking the disease is the removal of diseased trees.

The only tree known to be very susceptible to this disease in California is *Cupressus macrocarpa*. Other cypresses of little importance in this country, including *C. sempervirens*, are listed as susceptible, or moderately susceptible. *Thuja plicata* is stated by Wägener to be slightly susceptible, and *Chamaecyparis lawsoniana* and *Cryptomeria japonica* to be not susceptible. In contradiction to this, however, Birch in New Zealand reports that the disease is serious on Lawson cypress as well as on *C. macrocarpa*. The *Monochaetia* disease in Kenya is most severe on *C. macrocarpa*, but there are differences between it and *Coryneum cardinale* with regard to its virulence on other North American cypresses. Nothing is known yet with regard to the susceptibility of that interesting and possibly useful hybrid between *Cupressus macrocarpa* and *Chamaecyparis nootkatensis*, *Cupresso-cyparis leylandii* ; nor with regard to its other parent *C. nootkatensis*.

In this country *C. macrocarpa* despite its value for seaside shelter can hardly be regarded as an important species, but if *Chamaecyparis lawsoniana* were to prove susceptible here, there would be more cause for concern.

The importation of decorative varieties of Lawson's cypress forms an important part of the nursery trade with the continent of Europe. It is possible that the fungus might be imported in this way, though it is not considered that the importance of the disease and the risk of thus introducing it would justify adding *Cupressus* to the list of conifers whose import, except as seed, is prohibited.

It is important, therefore, that any appearance of canker on *Cupressus*, particularly on *C. macrocarpa* or on related genera, should be reported promptly, bearing in mind the fact that *Thuja* in particular is frequently subject to frost canker on really frosty sites. The comparatively slow spread of the disease in California indicates that it is not extremely infectious. Early notification and removal of infected trees, therefore, might well hold it in check in this country, or even eradicate it, should it unfortunately gain entry.

DYING OF GROUPS OF SITKA SPRUCE

BY T. R. PEACE and H. L. LOUGHBOROUGH

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IN 1936, SEVERAL groups of dying P.12 Sitka spruce were found in a wood at Canonbie, Dumfries-shire. In the earliest stage that could be observed without root excavation, one or two of the major roots were dead up to the collar; but with this amount of root damage no discoloration of foliage or reduction of growth was visible. Only when nearly all the major roots were affected did the tree show any signs in the crown, when a slight yellowing of the foliage and a reduction in shoot length were visible. The trees made valiant attempts at recovery by producing fresh roots from the collar into the moist surface humus layers. Usually, however, when all the major roots were dead the top of the tree died also. Neither of the fungi usually associated with root disease in conifers, *Armillaria mellea* (Honey fungus) or *Fomes annosus*, were present. No fungus mycelium could be found between the dead bark and the wood, as is almost invariably the case with the two fungi mentioned above. The surface of the wood, when the bark was stripped from it, had a watersoaked appearance, and the dead tissue often extended a foot or eighteen inches up the stem above the dead root in the shape of a wedge, pointing upwards. The dead roots did not decay nearly so rapidly following death, as would be the case with *Armillaria* or *Fomes*. Culturing from diseased roots failed to yield any fungi likely to cause the death of roots.

In 1939, two similar groups of dying Sitka spruce were found in the Manchester Corporation forest at Thirlmere in the Lake District. The war then stopped further investigations of this disease. By the end of the war the position had altered considerably. The area at Canonbie had been felled, but the patches at Thirlmere had increased in size and number. In addition, Mr. W. R. Day, of Oxford, had been investigating the dying of groups of conifers at Llantrisant Forest in South Wales, and at Kerry Forest on the Welsh border. At Kerry, Sitka spruce was again involved, but at Llantrisant, in the first instance, the trouble was found only on Japanese larch and Corsican pine; later, however, two Sitka spruce groups were also found. The symptoms were generally similar on all species, and closely resembled those associated with the fungus *Phytophthora* on chestnut (Ink Disease) and on beech. Mr. Day was able to isolate a *Phytophthora* from some of the affected trees.

Since then a similar trouble has been found, always on Sitka spruce, on widely scattered and widely varied sites. A list of these is given below:

<i>Date noted</i>	<i>Locality</i>	<i>Age in years</i>
July, 1946	Old Warden Park, Biggleswade, Beds.	12
June, 1948	Ruardean, Forest of Dean	32
— —	Harryhill, Forest of Dean	27
— —	Dunster, Somerset	22
— —	Longleat, Wiltshire	40

Diseases of Sitka spruce, which sound very similar, were reported in 1946 from the Isle of Man, and in 1948 from Inverliever Forest, Barcaldine Forest and Crarae in Argyll. None of these areas has yet been visited.

Plots have been laid out at Thirlmere, Forest of Dean, Dunster and Longleat to study the progress of the disease. Root studies, which are mainly in the hands of Mr. Day, have been started in the Forest of Dean. So far it is too early to make any pronouncements about the cause of the disease. It certainly occurs on a wide range of sites and climates ; though of course the cause may not be the same in all cases. On the basis of its known extent, it cannot be ranked as a serious disease. Nevertheless its widespread occurrence makes it essential that it should be watched and studied. This work will be greatly assisted if foresters finding dying groups of conifers, especially Sitka spruce, will report them. When this is done, full details of age, site, etc., should be given, and a preliminary examination made to see if either of the obvious parasites, *Armillaria* or *Fomes*, is present.

A quite different disease, also of unknown cause, has been reported on Norway spruce, particularly at Comlongon in Dumfries-shire, but also at Patching in Sussex, and on an estate near Stafford. In this case, however, the top of the tree dies before any of the major roots. Very similar symptoms have also been observed on Norway spruce on heavy clay at Apethorpe (Rockingham Forest) and on a private estate near Bourne in Lincolnshire, but in these two places drought seemed a very probable cause. The dying Norway spruce do not occur in definite groups as do the Sitka spruce. However, further instances of their occurrence would be of great interest.

BARK STRIPPING IN THE FOREST OF DEAN

BY W. H. MARSTON

Forester, Dean School

I AM PLEASSED to say that the ancient custom of bark stripping is once again being revived after a period of stagnation of at least ten years. It offers excellent returns for a by-product, and this revenue is much too valuable to lose by making fellings and leaving the bark on the trees, especially as a deduction of 10 per cent. has to be made on the sale of oak timber which is measured over bark. Stripping, however, can only be done in the late spring and early summer, when the sap is running. Methods of preparing this valuable product have changed considerably in recent times. Years ago a worker who was a skilled axeman was selected by his fellow workmen to go around with the Forester and view areas in which it was proposed to make a stripping. He would then be asked to tender for a section of woodland. More than one tender would be asked for from the various units of men employed, and naturally the lowest terms would be accepted, based on a price per ton. When each unit was informed that their tender had been accepted, provision was made to get a hogshead or two of "zider" as near the work as possible. This was the incentive to work; and unskilled labour was recruited indirectly for the operation by the skilled employees.

The method employed was to strip the trees standing, starting with the top branch, and then working on the body of the tree. Only on very rare occasions were the trees felled and stripped on the ground. If the trees were heavily branched all was well, but if the branches were few and far between, the workers used a special iron which was driven into the tree for foot-hold.

Two types of stripping irons were used: a small stripper for the branches and a larger one with a longer handle for the trunk. When stripping standing trees, the worker carried a small hatchet on his belt for girdling, but when on the ground the normal felling axe was used. When the workers chose to strip felled trees, one man was detailed to strip the butt lengths before the tree was cut. The cost of felling was paid to the workers when the logs were dressed at the end of the barking season.

The older workmen contend that stripping on end is much simpler and faster than stripping on the ground, which is the present-day method. When stripping on end, the worker has the advantage of the bark falling away from his work, but with the log on the ground the worker has to keep moving the bark as he strips it off, thus slowing down his progress. Present day labour prefer stripping felled trees—not because the workers are less skilful—but because the sap is most injurious to their clothing, which until recently was rationed.

Having successfully stripped the tree, the bark is then carried to a dump and "railed" to dry. The smallest pieces are placed along the top and sides of the rail, about eighteen inches from the ground, or in the case of felled logs, along the trunk of the tree. The larger pieces are reserved for the outside of the rails, and the butt lengths, which are called "caps," are put across the top; stacking is at the rate of one hundredweight per yard.

The bark is then left to dry for a period varying from two weeks to a month—depending on the season. When the bark is considered ready for delivery, it is tested and, if found to be brittle, it is fit for despatch. It is

beneficial to harvest the bark as quickly as possible, as it tends to become mildewed if left in much rain. Merchants dislike accepting mildewed bark. A harvesting of three weeks is sufficient in a dry summer season.

Delivery is done at piece-work rates. If loaded carefully using dripples on the sides of the lorry, a load varying from three to five tons can be obtained on a lorry with a fourteen-foot bed.

The present-day cost of stripping and "railing" in the Forest of Dean is £5 per ton, and the sale price of harvested bark is £15 per ton delivered. There is thus a good profit to be made from stripping, and this operation is well worth reviving.

In a good season a worker can earn at least 40 per cent. over day money, but in a season of late frosts, which would slow down the flow of sap, and the ease of stripping, the worker might have difficulty in earning 25 per cent. over day money.

THE NEED FOR CARE WHEN FELLING TIMBER

BIG TIMBER IS now becoming very scarce, and it is not always realized how much damage can be done to a fine bole by lack of care when actually felling it. A serious split may reduce the value of a log that might have been worth ten or twelve pounds, to no more than its price as firewood.

When felling leaning trees, many of the older and more skilful cutters in the Dean Forest employed the device known as "cutting a key." A key is an opening cut in a spur of the tree, on the side *from* which it is likely to fall, wide enough to allow a saw blade to be inserted. The saw cut is then made in the usual way, but the tree cannot fall until the key is cut through. The saw is removed when only a small thickness of timber remains to be severed ; the key is then cut away with the axe, and the trunk falls without risk of splitting. The remains of such keys can occasionally be found on old tree stumps.

Trunks may also be split when large branches or forks strike the ground, and to avoid this risk such branches may be removed before the tree is brought down. If this is not practicable, they may be partially cut through, and then when they strike the ground the breakage will occur amongst the branches of the crown rather than in the more valuable bole.

G. LEES

Forester, Dean Forest

DRAGGING POLES

BY D. WATT

Student, Glentress Forest School

A CONTROVERSY APPEARS to go on between two schools concerning the operation of dragging thinnings. One school says drag points foremost, and the other school argues the very opposite, butt end foremost. From information gleaned from the learned of each opposing school I present the following facts for your appraisal.

The "butt end foremost" school places all its faith in the fact that the weight of the load is at the front, with the chain around it and where the horse can get a good pull at it, at the same time causing a certain amount of lift, and also that there is less danger of the chain slipping off.

This, when whispered in the ear of a member of the "thin end foremost" school, causes a glassy look to appear in his eye and a slow shake of the head. Then the following argument comes forth: Dragging thinnings point end foremost lifts the load a few inches clear of the ground where the chain goes round the logs. This to a very great extent keeps the points clear of obstructions and brushwood, and no earth accumulates in front of the load. Then the butt ends trailing behind lend themselves to easy dragging by "flowing," so that when the load comes between two stumps it does not jam, but the poles pile on top of each other and flow over, and generally the "drag" shapes itself to suit the objects which it must pass. You have no large frontal area which jams easily and takes along everything in its path. The adherents of this method also maintain it is easier on the horse, and that the load does not slip if the chain is put on properly.

Going deeper into the subject, I find that the southern part of Scotland goes in for "butt end foremost" dragging, while in the North-East they go in for dragging thin end foremost. This seems to me a case of district custom, and custom is often stronger than instructions.

**NOTES ON THE WEIGHT AND VOLUME
OF GREEN WOOD OF
SCOTS AND CORSICAN PINES**

IN FEBRUARY, 1948, the following enquiry was sent by the Conservator, East England, to the Director of the Forest Products Research Laboratory at Princes Risborough :—

We are selling a large amount of small Scots pine and Corsican pine poles on a weight basis, and have hitherto accepted a conversion figure of 30 cubic feet quarter girth per ton. Some doubt has been thrown on the correctness of this factor, and I would be glad if you would let me know what you consider to be the weight per cubic foot (quarter girth measure) of freshly felled Scots and Corsican poles, of three to five inches mean diameter and approximately 20 years old.

The reply received was as follows :

- (1) Forest Products Research Laboratory tests show that green Scots pine, largely sapwood, weighs about 60 lb. per true cubic foot at a moisture content of some 120 per cent. (Two actual results were 66 lb. at 143 per cent., and 60 lb. at 149 per cent. And from the accepted weight of 50 lb. at 85 per cent., the weight at 120 per cent. should be approximately 60 lb. The oven dry weight is approximately 27 lb. per true cubic foot).
- (2) 60 lb. per true cubic foot implies 76 lb. per Hoppus foot using the 0.785 factor to convert true to Hoppus. (1 cubit foot true = 0.785 Hoppus foot).
- (3) 76 lb. per Hoppus foot implies $29\frac{1}{2}$ Hoppus feet or say 30 Hoppus feet, approximately, per ton of 2,240 lb. This agrees with the figure used by the Forestry Commission, Eastern Conservancy.
- (4) The British Railways allow 37 Hoppus feet per ton for Scots pine. This implies a weight of 60 lb. per Hoppus foot, approximately, and a moisture content of about 75 per cent., compared with the 120 per cent. moisture content implied by the Forestry Commission's figure of 30 Hoppus feet per ton.
- (5) It is coincidence and nothing else that the Railway's figure of 37 Hoppus feet, when used as a divisor on 2,240 lb., gives approximately 60 lb., which is the weight of one true cubic foot of Scots pine at 120 per cent. moisture content (*not* of a Hoppus foot at the same moisture content) ; and that 60 lb. is the weight of one Hoppus foot at 75 per cent. moisture content. The references to Hoppus and true measures are apt to confuse the calculations.
- (6) What the average moisture contents are at time of sale or transport is a separate matter on which Forest Product Research Laboratory lacks data. Measurements would not be very difficult. It is clear, however, that freshly felled young Scots pine, largely sapwood, is likely to have a high moisture content ; and at 120 per cent. moisture content, would weigh about 60 lb. per true cubic foot and imply 30 Hoppus feet per ton.
- (7) The average weight of Corsican pine is so near that of Scots pine that these approximate calculations probably apply to both species.

THE MECHANISATION OF FOREST ROAD CONSTRUCTION IN SCOTLAND

BY V. L. MULLOWNEY

Conservancy Engineer, North Scotland

IN THE INDUSTRIAL field to-day, general recognition is given to the fact that large scale mechanisation will effect a considerable economy. This applies, equally well, to road construction work, where, in the past, a very heavy expenditure was necessarily incurred in employing big labour squads. The advent of heavy earth-moving machinery, and the development of efficient road-construction plant generally, have provided a means of reducing this expenditure considerably.

The mechanisation of road work offers numerous advantages over the out-dated "pick and shovel" methods of construction. Bad weather conditions have, under the conventional methods of road construction, often resulted in very heavy losses in labour expenditure, with the consequent drastic increase in the overall costs of roadwork, but, where recourse is not made to the costly expedient of hired plant, and where Forestry Commission machinery can be made available, these losses can be overcome to quite a large extent. A further consideration where forest road construction in Scotland is concerned, is that the use of machinery will help to solve the acute lack of labour experienced in many regions. Speed of construction, however, is one of the salient features of mechanisation and, at the moment, this is an all-important consideration when the extraction of produce is being delayed through lack of adequate extraction routes.

With the employment of mechanical road-making plant, the need for advanced and comprehensive planning is apparent, if full advantage is to be taken of the machines. Before any new property is acquired for Forestry Commission purposes, the question of extraction should be thoroughly investigated and a detailed Extraction Plan drawn up. It is felt that road survey work should be carried out at this stage, for in overgrown plantations the conventional forms of survey cannot be undertaken. Road alignments should be chosen prior to planting, and the construction widths left clear, thus overcoming the unnecessary expenditure incurred in clearing such alignments at a later stage, when the extraction of timber will often prove to be a difficult and costly proposition and, unless the work is undertaken well in advance, will invariably retard machine progress. The present restricted clearance widths provided through plantations do not permit the full and economic employment of road making machinery. The bulldozer is not particularly suited to road construction work where earth-movement over distances of more than about twenty-five yards is involved, and under these conditions the tractor-drawn earth-moving equipment will prove to be quicker and more economical. The tractor-and-scraper, for instance, provided adequate turning space can be made available, is by far the more efficient machine for this work. The scraper possesses the advantage that it can spread in thin layers, making bulldozing unnecessary, and in fills and embankments affords a high degree of preliminary compaction which cannot be obtained with the heaviest of bulldozers. Unfortunately, however, owing to the very limited working spaces available in established plantations, this form of plant cannot be used there, and it is felt that the question of completing all

heavy earthworks and rough grading of extraction roads *prior to planting* should be considered. This policy, too, would ensure quick access to young plantations over the roughly graded roads, when, during the early stages of growth, fire-danger is more prevalent.

With machine-made roads the conventional form of cross-section profile will require to be modified slightly, and in designing such profiles allowance should be made for the capabilities of the various machines. The normal hand-excavated V ditches will be replaced by something more shallow, with the berms sloping towards the ditch centres. This form of profile can be easily and quickly constructed by the motor-grader but, if such a machine is not available, a small bulldozer can be employed, making use of the transverse adjustment of the blade. Drainage ditches thus formed will prove to be adequate for most requirements. In drawing up a machine programme, however, it is not possible to specify a mechanical team which will have a general application to low-grade road construction, for the composition of such a team will depend, to a large extent, upon individual requirements and prevailing ground conditions. Few engineers seem to fully appreciate the potentialities of the various forms of earth-moving equipment in use at the present time and, if full use is to be made of the plant available, it is recommended that some study be given to the question of machine outputs.

The hand-laying of base materials on forest extraction roads will require to be replaced by some other form of construction if costs are to be reduced. Within recent years considerable thought has been given to the question of the stabilisation of soil and its application to roadwork. Recognition is now given to this new aspect of machine road construction by several leading civil engineering contractors and, with an eye to the future large scale road programme to be undertaken in the country, well-equipped laboratories have now been set up for the testing of materials. The demand for cheap, quickly constructed low-grade roads on Forestry Commission areas could probably be met, to a large extent, by the development and application of soil-stabilisation methods of construction. Several forms of stabilisation have been tried, and it is now accepted that, for the climatic conditions experienced in this country, soil-cement stabilisation is the most beneficial: the results of such work completed since 1941, when the first soil-cement road was constructed, have proved most encouraging. This form of road construction is at a very advanced stage in the United States. The latest cost figures furnished by the Road Research Laboratory of the Department of Industrial and Scientific Research show that a six-inch-deep soil-cement stabilised base, with a surface dressing of tar and chips, can be constructed for as little as 3s. 6d. per square yard. This cost includes all overhead charges in the form of works supervision, soil survey expenditure, and the hire of the necessary construction plant. With the employment of Forestry Commission machinery a further reduction in cost could be expected, and the construction of first class surface dressed forest extraction roads, costing very much less than £1,000 per mile, should be possible. Conventional forms of road-making machinery can be employed for this work, and the only specialist plant which might be required would be a rotary hoe, used in conjunction with the Fordson tractor, to ensure adequate pulverisation of the soil and thorough mixing of the added cement. The grading of the soil is an important factor in this class of work, and before any stabilisation work is undertaken it is necessary to carry out a mechanical analysis of the various soils to be treated, and, by other simple field tests, to determine what best use can be made of the materials available. The glacial gravel deposits found in many parts of Scotland are considered to be ideal for soil-cement stabilisation, when as little as 6 per cent. by weight of cement will produce an excellent road base.

A surface dressing on such a base will provide a road which, for Forestry Commission purposes, should give trouble-free service, and in general, it should be found that maintenance costs on such roads are very small. The construction of such roads, however, demands very careful attention to details, and it is suggested that Forestry Commission engineers be given the opportunity of studying the various techniques involved.

It is not suggested that full mechanisation and the employment of stabilisation methods of construction will offer a solution to all road-work problems, nor is it considered that the roadman's pick and shovel will, in time, be looked upon as museum pieces. Hand-labour will never be completely replaced by machines, but the future tendency will be that labour will become more specialised and will be confined to the auxiliary works, which will not readily lend themselves to mechanical methods of construction. Mechanisation and soil-stabilisation methods do, however, provide a basis for economic road construction, and for forest extraction roads, it is felt that the methods suggested could be very usefully employed.

FOREST ROADS AND EXTRACTION COSTS**BY F. C. HUMMEL***District Officer, Alice Holt*

GENERAL HUTSON, in his interesting article on Forest Roads in No. 19 of this Journal, issued in 1948, raises some important points which merit closer study. He estimates the average requirements at five miles of road for every square mile of forest. Assuming all-weather roads to cost an average of £2,600 per mile, and fair-weather roads £650 per mile, then the cost per acre of forest works out at £20 and £5 respectively for these two types of road, and the annual cost of maintenance and interest at, say, £1 and five shillings respectively.

The average production of timber per acre is probably between 80 and 160 cubic feet per annum, or from three to six tons, but of this only about one-third, or one to two tons, will be available for exploitation until the growing stock has been built up to the level at which it is intended permanently to maintain it. Usually this will be some twenty to forty years after the first thinnings; thereafter all annual growth is likely to be exploited. During the first twenty to forty years after construction, the cost of road maintenance per cubic foot of timber extracted will thus be fourpence to eightpence in the case of all-weather roads, and one penny to twopence for fair-weather roads. Afterwards the costs will be about one-third of the above figures. The position is entirely different if an old existing forest is opened up for exploitation, where the initial growing stock is in excess of what is required for efficient production, and the removable surplus pays for the initial capital expenditure on road building.

It is also of interest to consider the volume of traffic on forest roads. According to the above figures, the last mile (i.e., the mile farthest into the forest from the exit point) of every road would carry 120 to 240 tons per annum during the initial period, the next mile twice that amount, and so forth; and when the desired level of growing stock has been reached the volume of traffic on each section will be roughly trebled. In addition there is the limited traffic connected with fire protection and getting labour to and from work in the forest. At three man-days work per acre per annum on silvicultural operations, including felling, and a wage rate of two shillings and sixpence per hour, a reduction of one chain in the walking distance between road and place of work is worth about one penny per acre per annum. Having two-and-a-half miles of road, instead of one-and-a-quarter, for every square mile of forest, will, on this basis, reduce silvicultural costs by one shilling and fourpence per acre per annum, but having five miles instead of two-and-a-half will bring about a further reduction of only eightpence—an interesting example of diminishing returns. It might be very misleading to give a general average figure for the fire protection value of roads in terms of shillings per acre per annum; but a close study of all the relevant factors should enable a forester to arrive at a rough estimate for a given area.

The figures used in the above calculations are, it is hoped, realistic, but in practice the cost of silvicultural operations and of roads, the rate of growth and the fire hazard, will be much greater in some parts of the country than in others; and even within one forest they may vary within wide limits so that the actual road costs per cubic foot of timber extracted, and the volume of traffic, may differ considerably from the figures quoted above. Three facts, however, emerge with fair certainty:—

- (1) Where growth is slow and topography or soil conditions unfavourable, the cost of road per cubic foot of timber extracted may be very high, probably one shilling or more.
- (2) The volume of traffic over some sections of road is likely to be very small, perhaps only 120 tons per annum.
- (3) The volume of timber to be extracted will be only about one-third of current production, for at least twenty years after the first thinnings. Factors (1) and (2) will be particularly important during this initial period.

To what courses of action do these facts point? Some may think there is a good case in the more inaccessible areas not to thin at all, and to wait with road construction until the older plantations reach rotation age, when the annual volume to be extracted will be very much more than earlier on. If normal thinnings produce one ton per acre per annum, and if, by not thinning, half of that is lost through deaths and slightly reduced increment; and if the annual cost per acre of road maintenance and interest is £1; then the cost of the extra half-ton per acre per annum, plus the beneficial effects of thinning on the main crop (for which it would be difficult to state a cash figure), is £1 per year. Are they worth it? That depends mainly on the objects of management (pitwood or timber), the labour position, and on the amount by which we as a nation are willing to subsidise home grown forest produce. It seems essential that we should try to envisage as clearly as possible the consequences of either course of action.

An examination of road costs also points to the desirability of exploring carefully alternative means of extraction, by which the actual cost of transport per ton-mile may be greater, but the capital expenditure on the transport system correspondingly lower. Where soil conditions are very favourable, as in parts of Thetford Chase, the best solution may be to let lorries operate on ordinary forest rides as they have done in the past; but there seems to be a good case for trying to develop special vehicles with a short wheel-base and with particularly broad low-pressure tyres, which could operate on suitably-graded forest rides even under less favourable conditions. Extraction by wire ropeways and very light railways are other alternatives in some types of country, and recent examples of these techniques in Great Britain and on the Continent of Europe deserve close attention. Quite clearly these alternative extraction methods will never replace a proper road system, but will supplement it, and the correct balance between the various methods will depend on local conditions. But the crux of the matter is that in each forest the ideal transport system is not necessarily five miles of adequate road, or even five miles of adequate road at the lowest possible cost, but that transport system which, with due regard to considerations of silviculture and fire protection, costs least per cubic foot of forest produce brought on the market. For anything that engineers can do towards achieving this object, foresters and taxpayers alike will be truly grateful.

PRESERVATION OF EXISTING NATURAL PROTECTION FOR OLD HOUSES

BY H. WALCOT

Estates Officer, North Wales

DURING THE PAST two years in North Wales there have been several interesting cases of the cost that can be occasioned by disturbing the immediate surrounding of a house.

Case 1. A tree which appeared dangerous by its proximity to an F.W.H. house was felled in 1946, and subsequently there were complaints of a smoky chimney on which considerable sums have had to be spent without as yet curing the trouble. While it is often rightly assumed that nearby trees can cause down-draught, it is equally so that such trees can protect a house from down-draught, which in this case appears to be caused by the lie of the ground and the nearest plantation, over 150 yards away.

Case 2. Four cottages on a new acquisition showed severe dampness when a wood approximately thirty yards from the cottages was felled. The walls of the cottages which were then exposed were affected, and once again considerable expense has been occasioned to try and keep the cottage dry.

This case was, however, useful in that on the same acquisition the mansion house, which is being converted to a hostel, is covered with ivy, and our first reaction was to strip the ivy; but bearing in mind the facts that: (1) the mansion after being empty for three years was unexpectedly dry; (2) one wall of the mansion house not covered with ivy had been slate hung; and (3) the experience with the nearby cottages stated above, it was decided to retain the ivy, merely clipping it back, which it needed badly.

On this estate the previous landlord frequently planted ivy against his houses, and at a nearby farm, the tenant, a very old man, stated that one gable wall of his house had never been dry until the ivy was planted and had grown up; and further that the local rectory, recently purchased by a private owner, had been stripped of ivy, and over £300 had then been spent to try and keep it dry. Needless to say the stone in this area is porous.

Conclusions

1. Ivy on a house, while it may cause damage to the walls and must of course be kept away from window and door openings and gutters, etc., should not be removed without full enquiries as to why it was planted in the first case. This may seem obvious, but many people have a strong objection to ivy on walls owing to the dampness it is supposed to bring.

2. Trees near a house, which may appear a danger to it, should be felled only as a last extremity, and then only after lopping off the offending parts of the tree has been tried.

3. Where clear felling of a plantation near a house is decided on, a shelter belt for the house should be left, if this can be arranged without great risk of the shelter belt being blown down.

THE USE OF AERIAL PHOTOGRAPHS ON CENSUS WORK

BY J. CHRYSTALL

District Officer, West Scotland

IN 1948 A CENSUS of plantations was undertaken by the Forestry Commission. This census required that plantations should not only be divided up into sections according to species and age, but that sections should again be divided up according to their stage of development. Thus while a species map would indicate that a compartment was wholly stocked with, say, Norway spruce, it would not reveal the stage of development or growth which the Norway spruce had reached. The census required these facts, so that a plan of work could be compiled indicating the amount of brashing, thinning, etc., required to bring the forest into a good silvicultural state.

In the case of recently formed plantations the work was simple, but when plantations in the unbrashed, thicket stage were encountered, the rate of progress was very much reduced. If really accurate information were to be won, the various species boundaries, and also the boundaries between the same species at different stages of growth—requiring different treatments—would have to be surveyed. To do this on the ground would have taken much longer than the time allowed.

At Inverliever Forest, where planting commenced in 1909, and a steady planting programme was undertaken until 1928, the plantation consists of the majority of the commoner species, i.e. (European and Japanese larches, Norway and Sitka spruces, and Douglas fir; with small patches of Scots, lodgepole, and mountain pines, thuya and silver fir) These occur in all stages of development from unestablished to the thinning stage. A survey of such a plantation to comply with census requirements would have been indeed a task. This work was, however, greatly simplified by the introduction and use of aerial photographs.

The photographs available, which covered the whole of the forest, must have been taken on an above-average West Coast day, for they were very clear—no blurring or dimming, being very little distorted, and they were evenly developed. Furthermore they were almost exactly to scale. When the forest map was superimposed on the photographs, it was found that the mapped compartment boundaries almost coincided with the photographed features. The difference was so small that adjustments could be made in the office when sketching in boundaries, and ground checks revealed that the further alterations required were of so small a degree that nothing was to be gained by further ground surveying, especially as the information required was to the nearest acre.

The photographs revealed at a glance the blank and checked areas. At Inverliever the checked areas are confined almost wholly to high ground. The planting years involved are from P.10—P.14 inclusive. A feature of these checked areas are the patches, extending from a few trees to blocks of up to five acres, which have succeeded in growing, so that checked trees one to two feet high surround a block thirty to forty feet high. These were clearly shown on photographs, and could be easily mapped, thus saving time and surveying. Also plainly visible were the larches. These, occurring throughout the forest in blocks, could be plotted on to the survey sheet by

superimposing the map on the photographs, checking the correct position by known features, on both map and photograph, and then marking. With this done, not only were the larch blocks located, but the species adjoining the larches had also at least part of their boundaries fixed. Other objects clearly visible were hardwoods—conspicuous when adjoining pure conifer blocks—small blank areas, and bare rocky outcrops. These also had their value in checking survey work. It is, of course, essential that the location of these features should be checked themselves, before other work is checked with them.

For greater detail than above, a slightly magnifying stereoscope was used. Studying the photographs with its aid, differences in tone and texture were evident. In this case the light tone represented the deciduous larches, and the varying darker tones the evergreens. Texture might be described as smooth, medium and coarse. Both tone and texture proved to be of value. With a chinagraph pencil, areas similar in tone and texture were marked off on the photograph, and then sketched lightly on to the survey sheet. Two or three compartments would be done at a time in the office, and then checked on the ground. By this means good progress was made. It should be stressed, however, that some ground checking in conjunction with any information derived from the photograph is essential. Experience proved that texture could be upset by silvicultural conditions; thus an area of, say, well-thinned Sitka spruce would be of coarser texture than a denser block of the same species. Tone can also be upset; for example, light tone in the larch areas was greatly influenced by the open condition of the crop, resulting in the light colour of the ground vegetation being prominent. Conversely, at a neighbouring forest (Asknish) Japanese larch, approaching the thinning stage and surrounded by Norway spruce not yet in close canopy, appeared dark in tone, and the Norway spruce light. The important and helpful factor was that in the main these differences in tone and texture, while not running true to form as species indicators, did indicate a change of species or condition. Whether light tone represented larch or Norway spruce was immaterial. What was important was that there was a change of species, and that this species was contained within the boundaries indicated by the tone. The species would in any case be identified when surveyed for collection of census data.

The object in the use of aerial photographs was to eliminate unnecessary ground survey work, and in this we were successful. The amount of time saved was considerable. Boundaries were not always correctly located, but many were accurate. A compartment with several correctly located stands was easy to complete. Another advantage was that the ground surveyor had advance knowledge of the type of forest in which he was to operate, and the location of any unusual features in the area was known to him and could be harnessed to assist if required.

In concluding, I believe that for quick survey work the use of aerial photographs plus ground checking is an effective way of getting a fairly accurate picture of any unknown and unsurveyed area.

SOME OBSERVATIONS ON FOREST MAPS AND RECORDS

BY W. F. STODDART

Forester, Glentress Forest School

I DOUBT IF IT is sufficiently realised how essential it is that Forest Stock Maps should be accurately made. The stock map is the basis of the forest Working Plan and, if accurately set out, can save the forester many a headache in the future.

First and foremost there is the question of rides. Past experience has proved how inadvisable it is to put rides first of all on the map, and then transfer them on to the area. The procedure should always be the reverse, for obvious reasons.

In field work, magnetic compasses should be tested first of all on a fixed line on the ground and one which is also shown on the map. By this means any compass error can be noted and also the magnetic variation. On the six-inch-to-the-mile scale map, a chain distance is small, but such a distance out at the end of a long survey line can upset the acreage calculation considerably.

Now let us consider the question of plotting the various blocks of species. It is seldom that a forester is left in charge of one particular area from the start of a new forest until it reaches the production stage, and, such being so, he may be a bit haphazard in the blocking in of the different species in a compartment. Every forester should give some thought for the man who is to succeed him, and who will have to rely on the accuracy of the forest records which he takes over.

In my opinion, the best time to map in the different species is when planting operations are in progress; as soon as each compartment is completed, whether wholly or partially, it should be surveyed.

If a forester cannot find time to block in the species himself, then he can instruct his foreman how to do the job accurately, providing him with a sketch map of the planting area, complete with compartment boundaries. If the work of mapping in the species is left to the end of the planting season, there is the possibility that some of the smaller blocks may be overlooked, particularly if the planting programme is a large one.

I have often come across a small block of less than half an acre in a compartment, and found that this small block was not shown on the stock map. I suggest that small blocks, if too small to show in outline, should be marked with a dot or a cross, and the initials of the species and size of block, shown in brackets alongside, e.g. : × (S.S. †).

I have also come across stock maps which had the different species in a compartment initialled in without any outline to indicate the particular species boundary, or the size of block. This type of stock map is valueless as far as forest records are concerned.

The value of a correctly surveyed species map lies in the fact that, when brushing or cleaning is being done, an accurate cost can be arrived at per acre without further measurement of area, and, when thinning is done, then the correct volume per acre can be shown. Likewise, when laying out sample plots to estimate thinning yields periodically, it gives a forester confidence to know that his acreage figures are correct.

Now we come to the question of compartment records. When a forest is visited by a senior official, the forester should be in a position to supply any information asked for relating to the forest. Now it is neither convenient nor desirable to carry around the multitude of record forms applicable to the forest. For this purpose I found that the most convenient note book to use is the one with the number: S.O. Book 130, Code 28—71 (which measures $9\frac{1}{2}$ inches by $7\frac{1}{4}$ inches).

On every alternate right-hand page of this note book, sketch in the outline of each compartment in turn, showing the blocked-in species. This can be done by using tracing paper and carbon paper, although the carbon paper can be dispensed with if firm pressure is put on the pencil when going over the tracing, which will show up the outline of the compartment sufficiently well on the page of the note book to enable it to be gone over with ink. (The compartment is shown at the top right of the page).

At the top of the page, enter in the compartment number and total acreage. Then enter in the acreage of each species according to P. year. If desired, one can also enter in details such as aspect, exposure, soil, ground vegetation, soil preparation (i.e., ploughing), method of planting and manuring if any. Enter then the words "treatment received," and from then on, enter in such information as beating up, drains cleaned, thinnings carried out by species, giving acreage and volume of thinnings and so on.

By adopting this method a forester thus has all the information he requires in a convenient form. An index page should be completed at the beginning of the book.

THE INTERNATIONAL UNION OF FOREST RESEARCH ORGANISATIONS

BY W. H. GUILLEBAUD

Deputy Director General

IN SEPTEMBER, 1948, Mr. James Macdonald and I visited the Swiss city of Zurich to attend a Congress of the International Union of Forest Research Organizations. This body was established about 1890 with the intention of pooling information and ideas about forestry research throughout the world, and of carrying out co-operative research in certain fields. When it started there was, apart from India, very little systematic forest research outside the continent of Europe, so, from the first, the organization has had a strongly European bias. It proved a useful agency for getting forest research workers in the different countries acquainted with each other, and doubtless helped to encourage the less highly organized forest services to set up their own research branches.

Nothing very tangible came out of the first few meetings of the Union, apart from an international co-operational experiment on the collection and planting of different origins (provenances) of Scots pine seed about the year 1904, and some preliminary work on the classification of forestry literature.

Then came the 1914-18 war which destroyed all prospects of collaboration, and it was not until 1929 that it was possible to hold a Congress in Stockholm and put the Union on its feet again. The revived Union made quite an auspicious start, and although European influence was still very strong, delegates from the United States were present at Stockholm and took an active part in the proceedings. The Union appointed a standing Executive Committee, of which our Chairman was a member, and this Committee met annually in one of the member countries to transact its business. Full Congresses were held in France in 1932 and in Hungary in 1936.

The next Congress was due to be held in Finland in 1940, but then came the second World War, and the foundations of the Union were once again shattered. This time the recovery was quicker and it was only three years after the end of the war that Switzerland offered its hospitality to a new Congress of the Union. This met under its pre-war President, Professor Lonnroth of Finland, and Secretary-General Professor Sven Petrini of Sweden, and there were representatives of some fourteen countries, including such unlikely bedfellows as Czecho-Slovakia, Poland and Spain. Among the three German forest scientists present was Professor Dr. Ludwig Fabricius, of Munich, a former stalwart of the Union, and an esteemed colleague in the pre-war era. His presence caused some embarrassment because it was challenged by the Polish and Czecho-Slovak delegates, who refused to take any part in the Congress if the German and Spanish delegates were recognized as official members. It was in vain that our Finnish President pleaded eloquently for a spirit of toleration and of internationalism in science; the central Europeans were obdurate, and the eventual solution was to allow the German and Spanish delegates to act as observers and not as full members of the Congress.

The main task of the Congress was to reorganize the International Union, and in particular to establish if possible a *modus vivendi* with the Food and Agriculture Organization of the United Nations (F.A.O.), the higher

officials of which were believed to have designs on the Union ; there were many rumours that we were to be taken over. F.A.O. sent two representatives to Zurich, the chief of whom was Mr. D. Roy Cameron whom many of us met when he was over here in 1947 as chief Canadian delegate to the Fifth British Empire Forestry Conference. The negotiations were long and involved, but finally a tentative agreement was reached which left the International Union with a substantial measure of autonomy, but under the watchful eye of F.A.O. The attitude of the latter virtually amounted to this : " We won't interfere as long as you get on with the job, but there is a lot of work to be done and it is up to you to do it, and meanwhile we shall hold a watching brief." While these negotiations were in progress, and the future of the International Union hung, more or less, in the balance, there was not much scope for constructive work on the part of the Congress as a whole. A few set papers were read and there were two whole-day excursions into forests in the vicinity of Zurich, which were most enjoyable but did not directly contribute to the cause of international co-operation in forest research.

At its final session, the Congress elected Professor Dr. H. Burger of Zurich as President, and Professor Dr. A. Pavari as Vice-President. The composition of the new Standing Executive Committee was not finally decided, one or two vacancies being left to be filled later when relations with F.A.O. are finally cleared up. The members elected to date are :

Professor Burger, *Switzerland*
 Professor Pavari, *Italy*
 Professor Lonroth, *Sweden*
 Mons. A. Oudin, *France*
 Mr. W. H. Guillebaud, *Great Britain*
 Dr. H. van Vloten, *Holland*
 M. S. Schabinski, *Poland*
 Dr. Buresch, *Argentina*

The Committee are to meet for the first time in Helsinki in July, 1949, and it is to that meeting that we must look for a constructive policy for the new Union.

Looking back for a moment to the first achievements of the International Union, there is unquestionably one field in which the Union has done really useful work, and that is in organizing international experiments in seed provenance. Full-scale experiments have been carried out with three species—Scots pine, Norway spruce and European larch. The Union organized first the collection of the seed to cover the full geographical and elevational range of each species, and then distributed the seed to each of a large number of participating countries. In the case of larch, thanks to Sweden's position as a neutral, the distribution was able to proceed during the early years of the war. We in Great Britain have taken part in each of the provenance experiments. Results of much interest are already appearing from these provenance plots, which will provide a mine of information for decades to come.

The Union has dabbled in various other forms of co-operation, but with conspicuously lesser success. Bibliography is one such field which has obvious potentialities, but the interruptions of the two world wars have seriously affected this undertaking. Whether under the guidance of F.A.O. a universally acceptable system of classifying forestry literature can be devised, still remains to be seen.

Permanent sample plot work is another branch of forest research into which the International Union has attempted to bring some measure of uniformity, but there are many difficulties in the way, the chief of which is the vested interest, as it were, created by the older established sample plots in any one country. However desirable changes in procedure or method may be, it goes sorely against the grain to introduce a new method if the effect is to lessen the value of plots which may have been continuously recorded for thirty or forty years, or even longer.

Having regard to the overwhelming importance of local factors in forests, the species, site, climate, etc., it remains a question whether the newly constituted International Union can find many other fields for co-operative endeavour which are likely to be as fruitful as that of the provenance investigations already mentioned. The value, however, of periodic Congresses as a means of personal contact between research workers in different countries, is beyond challenge.

EUROPEAN COMMISSION ON FORESTRY AND FOREST PRODUCTS, GENEVA, JULY, 1948

BY O. J. SANGAR

Director, England

THE FIRST MEETING of the European Commission on Forestry and Forest Products may possibly mark a new era in international co-operation so far as foresters are concerned. The Conference was convened by the Food and Agriculture Organization of the United Nations, as the outcome of a series of talks which started at Hot Springs and continued at Quebec, Copenhagen, London, and ultimately at Marianske Lazne in Czecho-Slovakia in 1947, when Sir William Taylor represented the Forestry Commission.

The idea behind the setting-up of this European Commission is to secure such adjustment in European forestry policies as may be necessary to make Europe, so far as possible, self-supporting in forest products. The achievement of this aim necessarily involves close co-operation between all interested Governments, and it was encouraging to find that nineteen countries were represented at Geneva, even including delegates from five countries which are commonly regarded as behind the "iron curtain."

Immediately before the Forestry Conference, there had been a meeting of the Timber Committee of the Economic Commission of Europe; this had dealt with current questions of timber supply and was therefore directly complementary to the Forestry Meeting, which was concerned only with medium- and long-term forestry problems. This was made quite clear by M. Bernard Dufay, Director Général des Eaux et Forêts, France, who had been appointed by the F.A.O. Conference as Chairman of the Forestry Meeting, and who dropped rather a bombshell on the first day by asking delegates to present statements of requirements, consumption and production, together with potential production and forest acreages; these admittedly were necessary to provide a background for the deliberations as a whole, but were by no means easy for any of the delegates to prepare at short notice from the information available to them. However, certain figures were in fact produced, and presented for the first time an overall picture of the European position sufficiently precise for the immediate purpose.

An analysis of the inventory led the Commission to conclude that the raw materials, from the present rate of cutting of softwood and hardwood, are twenty to thirty per cent short of total requirements but that, nevertheless, the 1947 fellings were almost forty per cent in excess of increment; also that the present increment is low and demands close attention to silviculture. It was interesting to find some parallel between the situation which obtains in this country to-day and that for Europe as a whole.

The reaction of the Conference was very definite, and took the form of the setting-up of a Committee to make recommendations for the improvement of production in, and the conservation of, European forests. Another Committee dealt with the possibility of extending the productive forest area; and yet another with the procedure to be adopted in securing and presenting such basic data as to requirements, production, and potential yields, as alone can provide the basis for intelligent future planning. A separate Committee was also set up to deal with purely Mediterranean problems.

The recommendations in respect of Forest Inventory and Statistics are of little immediate interest, and were designed primarily to secure the avoidance of duplication in returns to F.A.O. and the European Commission, together with uniform presentation of data ; the recommendations as regards the Mediterranean are of purely local interest, and those dealing with extension of the productive area stressed the need for each country to establish, by enquiry, the acreage of unquestionable forest soil which ought to be under timber, having due regard to the agricultural and grazing interests of each area concerned. In this connection it was interesting to hear that Poland and France, for example, are planning to deal with two and a half million acres and ten million acres, respectively.

The recommendations concerning improved production and forest conservation are probably those of most interest, and drew attention to the need for intensive silviculture, developed to the greatest possible extent, whilst maintaining the fertility of the soil and observing phyto-sociological principles. Periodical and effective control of output was regarded as essential, and it was pointed out that the full implementation of the proposals would probably be handicapped by a shortage of trained staff ; meantime, countries might exchange specialists through the medium of F.A.O. As regards species, it was felt that in the majority of cases countries should play for safety, and should adhere to well-proven indigenous trees, although the urgency was such that exotics with a high yield might in some cases be fully justified if used under careful control ; in this connection, attention is again drawn to the possibility of collaboration through the medium of F.A.O., particularly as regards genetics. Special attention was paid to the danger from insects and diseases, and to the need for international collaboration in connection with troubles such as now face us in this country with *Ips typographus* and *I. sexdentatus* ; also the possibility that such insects and certain diseases are made the more dangerous by various silvicultural methods, particularly the establishment of pure, even-aged plantations. There was a strong view that certain countries must extend still further their control over the management of private forests, preferably through the medium of freely-constituted associations.

Reference may be made to certain matters of general interest, particularly the clamant need for greater efficiency in conversion ; this must extend not only to the elimination of waste during manufacture, but also to the adoption of a policy closely related to European needs ; for example, material which could make either pitwood, pulpwood, or box-shooks, should be converted in accordance with general need rather than immediate local profit. It was strongly suggested that there are still considerable areas of unexploited forests which should be managed as soon as possible, but these do not in themselves provide a solution to the problem. A point of immediate importance is the rehabilitation of forests ruined during the war, either by military action or by ruthless felling ; judging by figures supplied, such destruction in three countries (Poland, Italy and France) totals some four million acres.

One must add that whilst the first meeting of a Commission such as this is necessarily inconclusive, it may be hoped that it opens the way to still closer co-operation for mutual good in practical measures designed to ensure that commodity problems are dealt with to the best advantage of all concerned, and to the advancement of international well-being and unity. Apart from the business of the meeting, the Forestry Commission representatives, Mr. Gosling and the writer, found much of interest and value in conversation with other delegates and, if two names may be mentioned, it was a great

pleasure once again to meet Mr. Roy Cameron, whom many will remember from the Empire Conference, and also to have long talks with Professor Sari of Finland and with the Swiss Forest Officers ; the latter were most helpful, and organized a very instructive excursion to the Forêt de Couve, which is of spruce and silver fir run on the selection system, and said to have been seriously overcut during the war, although now carrying a stock stated to be over 8,000 cubic feet per acre !

ORGANISATION AND METHODS AT CONSERVANCY LEVEL

BY T. FARMER

Chief Clerk, West Scotland

THIS ARTICLE IS offered as a continuation of the one published in the Forestry Commission Journal for 1948 under the title "Organisation and Methods in a Conservancy Office." All Conservancies are not identical, but they probably have sufficient in common for the experience of one to be of some interest and value to the others.

1. Organisation

The previous article claimed that during the eighteen months following the re-organisation of the Forestry Commission as at 1st January, 1946, the emphasis in Conservancy Offices had probably been on organisation rather than methods, but that by the middle of 1947 a reasonably satisfactory organisation structure would have evolved, and the emphasis would be changing over to method. It raised the following points of doubt for future clarification and decision :—

- (a) Did the State Forest Officer require separate whole-time office assistance, or could he be adequately served by a common-service office section which laboured for other masters also ?
- (b) Should the clerical work in connection with Forest Produce be dealt with by a common-service office section (e.g., Finance), or should it be transferred to a separate section working to a Utilisation Officer ?
- (c) Was it desirable to appoint specialist officers to Conservancies for Utilisation and Acquisition duties, or could this work be effectively undertaken by the existing staff of Forest and Estate Officers on a territorial basis ?

These were questions of organisation which were under consideration in January, 1948. They remain largely unsettled to date and this may be indicative of their difficulty. In the Conservancy under review it has been decided in principle that the State Forest Officer does need the whole-time assistance of at least one clerk for clerical work in connection with State Forest and Nursery Records, plant supply, silvicultural planning, forest management and protection. The clerical work tends to be seasonal rather than a steady flow. At the peak periods additional clerical assistance is necessary. In practice it has until very recently been impossible to allocate and train a clerical officer for these duties, and the State Forest Officer has had to make do with the services of the Executive Officer and Clerical Officer who comprise the Stores Section.

As regards question (b), the decision has been reached in principle that all clerical work in connection with Forest Produce, up to the point of invoicing sales and transfers, should be performed outwith the Finance Section. In time the staff serving a Utilisation Officer would no doubt undertake this work. In the continued absence of a Utilisation Officer, it is proposed that such duties be undertaken by the office section serving the State Forest Officer. The need for a specialist Utilisation Officer has not yet been established, but it is thought that as sales increase, a Utilisation Officer may be required to relieve the Conservator and State Forest Officer at Conservancy level, and

indeed, the District Forest Officers in the field also, unless the territorial charge of the latter is considerably reduced—and consequently their number increased. This, together with the continued lull in acquisition work, which in this Conservancy is well within the powers of existing staff, answers question (c) also, if only temporarily.

The Office Organisation by the Autumn of 1948 had developed as follows :—

(a) Estate Section	1 Higher Clerical Officer 2 Clerks	serving District Officer (Estate)
(b) Stores/State Forests Section	1 Executive Officer 1 Clerk	serving State Forest Officer and acting as Common-Service Stores Section (reporting to Chief Clerk)
(c) Engineering Section	1 Clerk	serving Conservancy Engineer
(d) Private Woodlands Section	1 Clerk (part-time)	serving Private Woodlands Officer
(e) Establishment Section	1 Executive Officer 2 Clerks 1 Labour Officer	} Common-Services reporting to Chief Clerk
(f) Finance Section (incl. Forest Produce — (Higher Clerical Officer reporting direct to Conservator)	1 Higher Clerical Officer 5 Clerks	
(g) Registry/Despatch	1 Clerk 1 Messenger 1 Telephonist	
(h) Typing Pool		
(i) Drawing Office		

The results of this staff organisation, which had evolved in the course of dividing up the work into functional blocks, were to overburden the Chief Clerk, who had no less than nine Section Heads or representatives reporting to him, in addition to his frequent contacts with Conservator, the four technical heads of Branches (State Forest Officer, District Officer for Estates, Private Woodlands Officer, and Conservancy Engineer), and the Labour Officer, not to mention Regional Advisory Committee duties. Moreover, there was lack of adequate supervision in some of the smaller Sections and over-specialisation leading to blind spots during the leave season. By this time, too, it was clear that several if not all of the four senior Section Heads had their own work well organised and full advantage was not being taken of their ability and experience. Accordingly the following re-grouping was planned and implemented between October, 1948 and January, 1949 :—

- (a) Estate/Private Woodlands Section under a Higher Clerical Officer (3 clerks).
- (b) Stores/Engineer/State Forests Section under an Executive Officer (3 clerks).

- (c) Finance Section (incl. Forest Produce) under a Higher Clerical Officer (6 clerks).
- (d) Establishment Section—(Non-Industrial)
(Industrial)* } under an
Common Services—Typing Pool } Executive
Registry/Despatch } Officer
(2 clerks)
- (e) Drawing Office under Draughtsman.

It is as yet too early to criticise this set-up from experience, but the immediate advantages seem to be :

- (i) A relief for Chief Clerk by reducing the Section Heads reporting to him to five, plus the Labour Officer.
- (ii) Better control and supervision, with the opportunity for wider training of clerical staff and elimination of blind spots in the event of sick leave and during the leave season.
- (iii) Increased scope for Executive Officers and Higher Clerical Officers to improve their techniques of management and their knowledge of the work of the department.

Probable disadvantages are apparent as follows :

- (i) The range and diversity of work in the Estate/Private Woodlands Section may become too much for the Higher Clerical Officer to maintain control of, particularly as the full effect is felt of new legislation (Agriculture (Scotland) Act, 1948, and the Town and Country Planning Act), and if the volume of work arising out of the Dedication Scheme tends to increase suddenly.
 - (ii) Even if the Executive Officer in charge of the Stores/Engineer/State Forest Section allocates one of his three clerks to each function, his range of attention tends already to be too wide. With the growth of Mechanical Engineering work as well as increasing volume generally, it may soon exceed his span of control. In addition there is the constant difficulty of trying to serve four masters (i.e., Chief Clerk, Conservancy Engineer, Assistant Engineer (Mechanical) and State Forest Officer). It appears likely that the Section must eventually be split in two and an additional Executive Officer recruited. Possibly one could take the Engineer Section, and the other purchasing plus the State Forest work (including Utilisation transferred from Finance Section in exchange for Bought Invoice checking and Stores recording).
 - (iii) As a result of general expansion, and possibly added accounting work arising out of the Dedication Scheme, the Accountant may find Utilisation and Forest Produce too much of a cuckoo in the nest. It may be necessary to transfer the latter work to State Forest Section, possibly in exchange for the Bought Invoice and Stores Records work, as indicated above.
- It will be noted that the organisation structure outlined and forecast above makes progressive provision for the operation of the internal check. The latter is not yet fully achieved, at least from the structural viewpoint.

* Labour Officer (Temporary Assistant) in charge.

2. Methods

During 1948, as was forecast in the previous article, it has been found possible and necessary to devote a good deal of attention to the detailed revision of methods and procedures. Reasonably satisfactory progress has been made, and the results of revision have been, and still are being, recorded in a standard form of Procedure Record. Some of the subjects covered are listed below with explanatory notes.

(a) *Staff Duties and Responsibilities*

A standard form of record sheet has been introduced on which the duties and responsibilities of every post in the office are defined. The sheet defines the post, shows the name and grade of the officer filling it, and the period of his appointment. Space is left to provide for changes. The Office Section is indicated. The duties are then listed in general terms with explanatory notes and/or a reference to the relative Procedure Record. The officer to whom the post is responsible is indicated, and reference is made to other posts with which liaison must take place. All the necessary Procedure Records are not yet complete, but now that the duties and responsibilities have been defined from the top (i.e., by Chief Clerk) it is hoped that the task of preparing the Procedures can be initiated from the bottom (i.e., by the man on the desk), subject to co-ordination and approval in turn by Section Heads and Chief Clerk. A copy of all Record Sheets is held by Chief Clerk. Section Heads hold a copy of their own and a copy of the Record for each subordinate. A further copy is held on each desk.

(b) *Procedure Records*

Detailed Procedure Records have been prepared for the under-mentioned subjects, and there is no doubt whatsoever that this preparation has clarified and defined the practice, has eliminated some unnecessary operations and circuitous transmission, and has improved the internal check. As training media they have already proved most helpful, particularly for new recruits. In some cases they have merely crystallised and confirmed existing practice, but even this is surely worthwhile. Much ground remains to be covered, but the task can and will be decentralised increasingly as Section Heads acquire the technique and come to appreciate the value and importance of maintaining Procedure Records, and of keeping them up to date. The intention is that eventually when an officer is appointed to any post he should find at the desk a folder containing in one side the Record of his duties and responsibilities, and in the other side copies of all the relevant procedure records, amended up to date.

Specimen List of Subjects covered by Procedure Records

1. Sales of Plants.
2. Auditing of Sub-Accountants' Monthly Cash Accounts (A.100).
3. Checking of tractor logs.
4. Checking of vermin returns.
5. Checking of telephone accounts.
6. Returnable containers.
7. Surprise checks.
8. Inspection of insurance cards.
9. Forest Produce Monthly Returns (A.71).
10. Receipt of rent remittances.
11. Customers' orders for supply of pitwood.
12. Ordering of stores.
13. Use of Goods Inwards Notes and Certification of Bought Invoices.
14. Receipt, registration, and distribution of incoming post.

15. Receipt of cash and valuables.
16. Receipt of registered letters and packages.
17. Checking of Ministry of Works accounts.
18. Operation of telephone switchboard.

Priority has been given to subjects involving payment or receipt of money and to subjects which overlap one or more office sections. Other subjects, where intricacy or the question of co-ordination warrant it, will be covered as time permits. The heading of the Procedure Record provides for stating (a) the subject (b) the date (c) the office section mainly involved (d) the parties concerned (e) the forms used, and (f) the objects of the procedure.

In conclusion, I would say that most of the action taken in this office in this sphere has been recommended by Treasury and Departmental Organisation and Methods authorities, or by similar authorities in the realm of modern management outside the Civil Service. Many of the recommendations of these authorities may appear at first sight to be merely common sense or a statement of the obvious. They strike a response in the reader's mind. They draw out the acknowledgment of truth from the reader's own experience. They ring a bell. But there lies the danger! So often O. and M. pronouncements are received with the exclamations: "Just common-sense" or "Of course, I appreciated that years ago." Such a reaction is natural but often unfortunate. The truth is that frequently the O. and M. teachings are not merely common-sense and a reflection of the reader's own experience. In fact, they are the sum-total of many people's common-sense, common-sense which has been subject to critical, almost scientific, analysis and refinement; common-sense which has been put to test and revision in the light of the experience of many. They crystallise and define—ready for conscious and deliberate use—what in fact is very often only *unformed* and *subconscious* experience lying in the depths of the reader's mind, where it is of little or no practical value in day to day activities. O. and M.-ers are honestly trying to be of service to their colleagues. What a pity to reward their efforts with a show of prejudice and thoughtless opposition. Let us accept with good grace the fruits of their labours, and test over a period of a year or two whether they be wholesome. Don't let us argue about O. and M. advice, but act on it. The proof of the pudding is in the eating.

PERMANENT INSTRUCTIONS

BY T. FARMER

Chief Clerk, West Scotland

TOWARDS THE END of F.Y. 1947 the need became pressing to revise the method by which instructions of reasonably permanent significance were communicated to the field staff from West Scotland Conservancy Office.

By that time we had experienced some eighteen months of the post-war re-organisation period. The nature and scope of the various changes were becoming clearer. It was appreciated that this re-organisation of the Forestry Commission embraced more or less simultaneously :

- (i) A change-over from war to peace conditions.
- (ii) A general, and somewhat rapid, expansion of work and staff.
- (iii) A considerable measure of mechanisation.
- (iv) Functionalisation (e.g., creation of Estate, Engineering and Private Woodlands Branches at Conservancy level, in addition to the old pre-war State Forests Branch).
- (v) Development of new trends in labour conditions and personnel management.
- (vi) Introduction of new clerical and accounting methods, and of new techniques.

The day of the pre-war "one-man or two-man band" (Divisional Officer and Divisional Accountant) was over. It was no longer possible for one or two officers at Conservancy Office level to know all the answers to all the questions in detail. In fact it was becoming increasingly difficult for them to know even where to find the answers in the rapidly swelling correspondence files. And still fresh instructions and policy correspondence flowed in from higher authority. Foresters were being submerged with correspondence and memoranda, policy, routine and matters of a permanent and of a fleeting nature interspersed. The Conservancy Office telephones tinkled with queries, and it was often no easy task for a Chief Clerk to find the answers himself or to contact the officers who knew or could find the answers for him. The need for a code of permanent instructions was overwhelming.

Accordingly it was decided to make a start on building up a code or reference manual. The method adopted, based upon the Treasury E.O.C. principle, is outlined below.

Four series of permanent instructions were created in October, 1947, namely Establishment, Accounting, Technical and General. All instructions other than those of a purely transient nature were grouped into one or other of the four series, and each was given a serial number within that series. Serial numbers for each series commenced at number 1 and ran for the Forest Year. The first instruction issued in each Forest Year was numbered 1. A separate file cover was kept for each of the four series and held by the appropriate office sections, i.e., Finance Section held the Accounting Instructions file, Establishment Section held the Establishment Instructions file, and so on. Registry kept a central folder containing a complete set of these permanent instructions, all four series. This was for easy reference by Conservator, Chief Clerk and staff in general.

The form of these instructions is illustrated below :

West Conservancy, Scotland
Establishment Instruction No. . . /F.Y.47
date :

Subject :
(File ref. :.....)

1. Introduction, giving explanatory, background information. (Answers the Why ?)
2. Purpose or Object of the Instruction. (Answers the What ?)
(*H.Q. or Director's authority :*)
3. Main Body of the Instruction stating how the object is to be achieved (detailed Procedures, new Forms, etc., attached as appendices). (Answers the How ?)
4. Timings—effective date, due dates for action, returns, etc. (Answers the When ?)
5. Staff re-organisation (if applicable).
(sgd.)

.....for Conservator

6. Distribution :— (5 and 6 answer the Who ? and the Where ?)

Features of this lay-out to which attention is drawn are :

- (a) Office and date of origin are clearly shown in the heading.
- (b) Subject is briefly and clearly defined, and is related to the appropriate correspondence file.
- (c) The instruction follows a uniform and logical sequence, and is in a form which will become common and familiar, so helping the local officer to find what he wants to know with the minimum of time and trouble.
- (d) The authority for issue is clearly stated. If the basic authority is a H.Q. or Directorate one, the reference is quoted.
- (e) The distribution is included in full for record purposes and for information of addressees ; distinction is often made between addressees " for action " and those " for information " ; distribution includes a note of other files on which copies have been placed when the subject overlaps two or more subjects.
- (f) The distribution includes a specified number of spares to be held for issue as replacements or to new staff.

These permanent instructions are issued on an appointment, and not a personal basis ; e.g., a Forester's set of four permanent instructions files must be handed over by him to his successor should he be transferred from his unit.

At least one Forester has found this code of instructions of great value on his return to the department after an absence of some years. It is believed that on the whole the method is accepted as an improvement on the former haphazard means. And it is hoped that as post-war conditions improve and transfers of staff become more frequent again, the uniform method of filing these permanent instructions at Forest level will ensure greater ease and continuity of control. (Uniformity of filing systems in the Forester's office is the next step.)

There is a drawback, of course. Once issued these instructions have to be kept up to date. Amendments are necessary from time to time, and sometimes a permanent instruction becomes obsolete. However, amendments are not too great a burden if promptly made ; and it is better to have something concrete to amend rather than a hazy recollection. A periodic (say half yearly) review of each series in the Conservancy Office is sufficient to spot the obsolete numbers, and then to issue a comprehensive list of cancellations up to date. Much of the clerical work involved in the field offices can and should be done by junior assistants and need not waste the time of technical officers. The individual instructions need not be memorised in detail on receipt, so long as one recalls when necessary that there *is* an instruction on the subject and can find it readily ! A simple index inside each of the four file covers provides the key.

THE ESTATE SECTION

BY A. A. COWAN
Clerical Officer, West Scotland

VERY OFTEN THE worst part of a Civil Servant's work is its monotony—the endless checking and filing of forms, making the same returns to H.Q. every week or month, doing the same thing day in, day out and so on ; but it can be said quite truthfully that monotony does not exist in the Estate Section of a Conservancy office.

Into this section comes everything which cannot be strictly called accounts, stores or staffing, and it will be readily appreciated that this makes for a wide variety. To the town-bred clerk the most interesting part is the farms in hand. To hear a farmer speak of hogs, gimmers, wedders, tups and ewes, and know what is meant, is an achievement, although it is sometimes confusing at the end of the forest year, when the sheep stock return is being prepared, to reconcile the fact that hogs became gimmers in the middle of the year. Hill Sheep Subsidy, Hill Cattle Subsidy, Potato Subsidy, Liming Subsidy, Marginal Land Scheme, Draining Scheme, prices realised for sheep and cattle, sale of wool—all seem to indicate that there are no "poor farmers" nowadays. It is no wonder that much difficulty is experienced when land is resumed for planting. However, the work connected with the farms only extends over a short period of the year, and as more and more farms are being let or transferred to the control of the Department of Agriculture for Scotland, no doubt this work will become less and less.

Shootings and fishings are other attractions, and it is very interesting, if nothing else, to hear a prospective tenant relating how excellent a shot he is, only to learn afterwards that this same person while shooting in another Conservancy was almost responsible for taking the lives of two keepers. The number of stags and hinds killed annually is a revelation to a city dweller who was under the impression that these "wild animals" were almost extinct.

With an annual rent collection in the region of £11,000, naturally the bulk of the work is concerned with tenancies. Many old houses, neglected during the war years, are in need of repair, and as it has not been possible to overtake all the outstanding work yet, many complaining letters are received, especially at "rent time." One tenant requiring a new lavatory complained that it wasn't good for an old lady to take her life in her hands, as she had to cross the Aberfoyle to Glasgow road every day !

The new housing programme is very much to the fore, and although the bulk of this work has not been devolved to Conservancy offices, there is still a considerable amount of time spent on it. The selecting of sites, applying for approval of these sites to the County Councils, the allocating of houses to the forests most in need, the resuming of sites, and the eventual selecting and installing of tenants, are broadly the stages gone through. The programme is proceeding slowly, but this work will increase as time goes on, and labour and housing needs expand.

As the necessity of growing timber in this country becomes more and more evident, the acquisition of new areas for afforestation also increases. The reading and interpretation of Deeds and Missives must always be interesting, and comparison of Deeds dated 1860 and 1949 show how very slightly legal language has altered with the passing of the years. The Forestry Act, 1945, the Hill Farming Act, 1946, and now the Agriculture Act, 1948, affect the wording of Leases appreciably, and a knowledge of these Acts is required when considering these documents. The full effects of the Town and Country Planning Act, 1948, are as yet not appreciated, but will in time undoubtedly alter the present "routine" in many ways.

Landholdings and Statutory Small Tenancies have to be dealt with entirely differently from other subjects, and contact is made with the Scottish Land Court when anything appertaining to this type of subject arises.

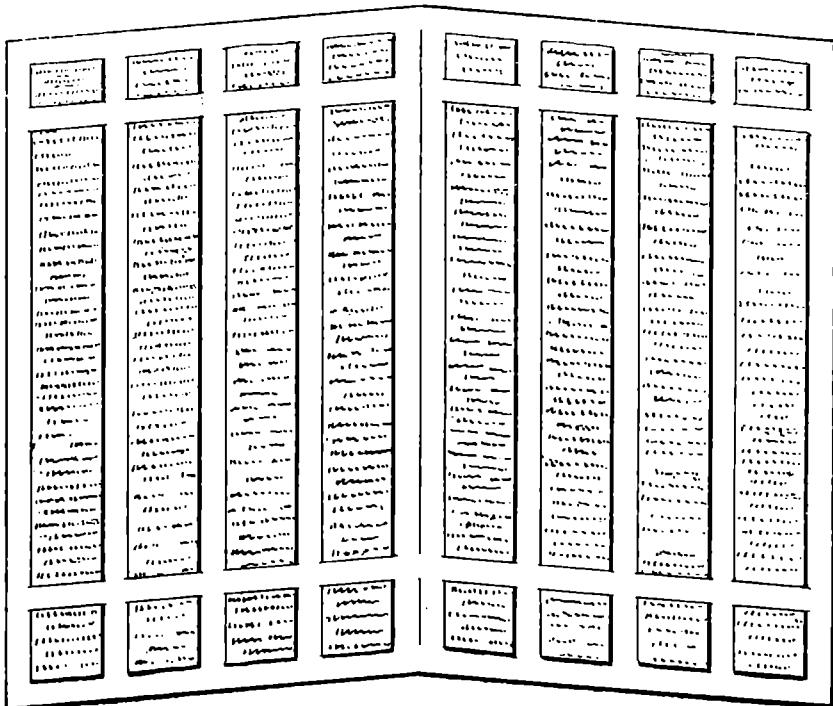
March fences, muirburning, rental demands and rent collection, North of Scotland Hydro-Electric Board, occupation of land by service departments, and fox club subscriptions are a few of the many other things which are dealt with, and it will be seen that although the primary task of the Commission is to grow trees, the "estate side" is not as far removed from the "forest side" as is sometimes thought.

FILING OF PROOF SLIPS

PROOF SLIPS ARE problematical objects whichever way you look at them. It is desirable that they be viewed from as great a distance as possible, but in the Finance Section this is not possible. We simply have to cope with them. Treat them with a decent respect and a wary approach, and they may do you little harm. But pick up the wrong proof slip and bang goes your balance ! Nor are they to be discarded when their day of usefulness is over. But where then can they find a home ?

For a long time we tried binding each month's proof slips with elastic bands and storing them in a large envelope, but at best it was an untidy job. Then one of our temporary clerks solved the problem.

He took an ordinary foolscap file cover and cut a series of parallel slots along four straight lines ruled on the two inside pages of the file cover. The first straight line is ruled an inch-and-a-half below, and parallel with, the top edge of the file cover ; the second half-an-inch below the first. Line number three is ruled two-and-a-half-inches above, and parallel with, the lower edge of the file cover, and the fourth line half-an-inch below the third. A series of incisions is made on the upper ruled line, each incision just under an inch-and-a-half in length and half-an-inch apart, starting half-an-inch



from the outer edge of the file cover. The incisions are repeated on the three lower lines and immediately below those on the top line.

The rest is easy. The top edge of a batch of proof slips is inserted through the upper incisions and the bottom edge through the two lower incisions. Repeat this along the series of incisions and your proof slips are filed neatly and tidily (as shown in the sketch) against the day when they can be consigned to the pit. What's more—the auditors love it.

J. STEELE

Accountant, West Scotland

THE STAFF SUGGESTION SCHEME

(SECRETARY'S CIRCULAR)

1. **Introduction.** After consideration by the Departmental Whitley Council, it has been decided to set up machinery for considering suggestions (by the Staff) for which awards could be made by the Commissioners in appropriate cases. At the outset, the scheme will be limited to suggestions from the non-industrial staff (Office Staff and Technical Staff down to and including Foremen), and may be extended later to include industrial staff.

2. **Scope of Scheme.** It is the essence of a staff suggestion that it should not relate to a matter in which it is the Officer's ordinary duty to review methods and submit proposals for reform. Ideas for the improvement of organisation may be put forward, but the suggestions machinery is generally not appropriate to matters of policy, although such matters are not expressly excluded.

3. **Suggestions Committee.** The Committee will be composed as follows :—

- (a) Director General (or Deputy Director General) as Chairman.
- (b) One Director (to be selected from a panel).
- (c) The Secretary (or Deputy Secretary) of the Department or, Controller of Finance.
- (d) Two Staff Side representatives of the Whitley Council.
- (e) Secretary of the Committee.

The Chairman will call meetings as and when necessary.

4. **Procedure.** The originator of a suggestion will send his suggestion to the Secretary of the Suggestions Committee at Headquarters (25 Savile Row, London, W.1). Each suggestion will be given an identification number and will be acknowledged.

The suggestion will then be typed under its identification number (but without the name of the originator) and sent to each member of the Committee ; a copy also being sent to the officer in Charge of the Branch or Section to which the suggestion relates. The Officer will give his recommendation for adoption of the suggestion or otherwise and will advise the Committee accordingly. All papers relating to a suggestion will be submitted to a meeting of the Committee, which will then consider acceptance (either in full or in part) or rejection ; and formulate the reason for rejection whether in full or in part.

The Committee's decision will be notified in writing to the originator, on whose personal file a copy of the notification will be placed.

Within twenty-one days of the meeting, a notice will be issued to H.Q., each Director's office, Conservancy office, Deputy Surveyor's office, C.R.O. and C.E.O. offices, showing :—

- (a) Suggestions outstanding from last meeting.
- (b) Suggestions submitted since last meeting.
- (c) Accepted (and total to date).
- (d) Partially accepted (and total to date).
- (e) Rejected (and total to date).
- (f) Names, amounts of awards and brief details of suggestion.
- (g) Suggestions still outstanding—Identification Numbers and dates submitted.

The Committee will decide the specific wording to appear on both the notifications of acceptance and of rejection, and further, which of those partially or fully rejected merit a personal interview (by a member of the Committee) with the originator for explanation and encouragement.

5. **Appeals.** The originator of a suggestion deemed unsuitable, to have the right of Appeal to the Chairman of the Committee.

F. W. HAMILTON

Secretary

March, 1949

SOURCES OF INFORMATION

BY H. L. EDLIN
District Officer, Publications

FEW PRACTICAL FORESTRY problems can be solved, and still fewer technical articles compiled, without recourse to sources of information that lie outside a forester's customary day to day contacts. The object of this account is to provide signposts to those sources that are most likely to prove useful to the man in the field.

Libraries. Books are the first source of information that springs to mind, and although every keen technical officer naturally tries to maintain a selection of up-to-date textbooks and periodicals, the number of new issues is so great, and the scope of subjects with a bearing on forestry so wide, that he soon has to draw upon the deeper resources of central or public libraries.

The two main forestry libraries available to our staff are :

The Forestry Commission Library,
Alice Holt Research Station,
Wrecclesham,
near Farnham,
Surrey

and :

The Imperial Forestry Institute Library,
Parks Road,
Oxford.

Both are primarily reference libraries, but, provided the books demanded are available, their librarians will gladly lend volumes required by our staff for official or semi-official enquiries.

Three other forestry lending libraries are available to members of forestry societies, those of the Royal Scottish Forestry Society, the Royal Forestry Society of England and Wales, and the Empire Forestry Association. The Royal Botanic Gardens at Kew and Edinburgh, the Forest Products Research Laboratory at Princes Risborough, Bucks., and the Timber Development Association of 75 Cannon Street, London, E.C.4, maintain reference libraries which are open to outside enquirers ; but they do not normally send out books on loan.

Reference libraries that cover other subjects besides forestry have, in the main, the great drawback that they are so huge that only a full-time student can use them to the best advantage ; those whose time is limited can rarely find out what they need to know from a casual enquiry. But it is useful to remember that there are libraries in Edinburgh, Aberystwyth, Oxford, Cambridge, and at the British Museum in London, which receive every book published in Great Britain. In London, also, are the Science Museum Library, Imperial Institute Road, South Kensington, and the Patent Office Library, Southampton Buildings, Chancery Lane, W.C.2, which maintain extensive collections of scientific and technical works from all over the world. The several universities also possess scientific libraries which are usually open to any serious enquirer.

Most of our foresters and forest officers, however, live remote from these large centres, and for them one of the most useful, as well as economical, library services, is that provided by the public municipal and county libraries. It is not generally realised that behind the row of rather dusty classics on the schoolroom shelf stand the resources of nearly every library in the kingdom. If you know the title, the author, and if possible the publisher of any standard text book, and are prepared to fill up a form, pay a few pence, and wait a few

days, the librarian will produce it for you, with the help of the national inter-library loan service. From time to time the Publications branch needs some odd, out-of-the-way, and out-of-date books to refer to, and they have come to us from some odd places, but so far they have always come.

A similar system of inter-library loans is operated by the Forestry Commission's own librarian at Alice Holt, who is often able to secure copies of the less usual scientific textbooks and periodicals for a member of the staff who would not, as an individual, be permitted to borrow them directly from the reference library concerned. Moreover, he maintains records and catalogues of the books held at many of these libraries, and may be able to suggest a library close to the enquirer's own station, at which the books required may be consulted.

Literature References. Assuming then, that you can buy, borrow, or at least see the books and periodicals that you need for your particular line of enquiry, your next problem will be to ensure that you read everything that has a bearing on it. To some extent you will find that one book or paper leads on to another, particularly if it includes a bibliography or set of literature references. But to get complete results the referencing must be done systematically.

The main agency for carrying out this reference work is the Commonwealth Forestry Bureau, New Bodleian Buildings, Oxford, which publishes that familiar periodical *Forestry Abstracts*. In passing, copies of these *Abstracts* are available for reference at all our Conservancy offices, whilst those who do not care to pay the full subscription of 36s. per annum for the full volume, may obtain that portion which deals with *Forest Products and Utilization*, for 15s. per annum only.

Forestry Abstracts, however, naturally includes *current* literature only. But the Bureau is prepared to supply, free of charge, lists of references to literature on any specific forestry subject. One must stress the word "specific," because if an enquirer asked the Director of the Bureau to supply references to books and papers on a broad subject, such as "silviculture," the answer might run to many pages; whereas all one usually wants to know is where to find accounts of some far smaller field of knowledge, such as the silvicultural treatment of one particular kind of tree.

A similar referencing system is now being built up at Alice Holt, special attention being paid to forestry in Britain. Already ten thousand entries have been made, sufficient to enable the librarian to satisfy most enquirers; and this centre will, very shortly, become our first line of approach for all enquiries on published work.

Maps. After books and periodicals, the next most valuable source of printed information is the map. No man in charge of an area can become too familiar with the 6 inch, 2½ inch, and 1 inch Ordnance Survey sheets of his forest and its surroundings. Every mark and every name has its meaning, for these early surveyors did their work with surprising thoroughness. From the map you can pick up reliable information on height of land, old field boundaries, streams and outcrops of rock; and learn a good deal about old roads and buildings, and past utilisation of the ground. Remember, however, that the *date* of a map is, in many districts, an important point to consider; I can well remember "exploring" several hundred acres of potential acquisitions, shown on a map dated 1906 as scrub and pinewoods, only to find that it had since been thoroughly "developed" with highly desirable suburban residences.

Really early maps are not much help to the forester. Until about 1800 few map-makers plotted the boundaries of woodlands with any accuracy, and those pretty little trees one sees scattered over eighteenth-century sheets are little more than decorative symbols, showing that there was some woodland

somewhere—nobody knew how much or just where !

The one-inch geological map is invaluable to every forester who pursues his craft seriously ; but it does not tell him all he needs to know about his soils, for surface deposits and glacial drift complicate their composition. Those who wish to study the geology of their neighbourhood more deeply will find the *Handbooks on the Regional Geology of Great Britain*, published by the Stationery Office at 2s. 6d. each, of great help ; the eighteen volumes of the series cover the whole mainland, and include maps, diagrams, and photographs.

For information on the prevailing climate, a good atlas should first be consulted, as it will include maps of annual rainfall and average winter and summer temperatures. If possible, this should be supplemented from actual records taken at the nearest meteorological station, which are not only more complete but more up to date.

The forest stock maps are of course familiar to everyone in the field, but it should be remembered that care is needed in their interpretation. As the details on them are entered up at the close of each planting season, they show what was planted, which is not always the same thing as is actually growing on the ground twenty years or so later. For example, there are certain areas in the New Forest carrying good crops of naturally regenerated Scots pine, although the original entries for them on the stock maps were of planted Norway spruce, which the pines outgrew. Fires, failures, and fellings must all be kept in mind when interpreting a stock map.

Aerial photographs of forest units are now available at many Conservancy offices. Their interpretation is a study in itself, beyond the scope of this article, but in common with other maps they carry a date. They represent the appearance of the forest from the air at a particular instant of time, and, as with other maps, allowances must be made for subsequent changes.

Personal Contacts. So much then for cold print ; but a good deal of knowledge about your particular problem or area may never have found its way into printed works, or even into the Departmental files and records. Hence it is often necessary to draw on the personal knowledge of men who have been associated with the job or the district in question. Provided their knowledge has been gained at first hand, it may be just as reliable as the printed record ; but before accepting it one should ask oneself mentally : How did this man first gain this knowledge himself ? The oldest inhabitant, whether of the forest or of the nearby village, is often a mine of information, and although his hearsay stories may take a bit of believing, the things he knows about his own countryside, the tree crops that have grown or failed there, and the methods, successful or otherwise, of former landowners or forest officers, are often well worth heeding.

Besides the men on the job, there will often be found local experts in some particular branch of study, who are only too pleased, as a rule, to share their knowledge. The compilation of the National Forest Park Guides, for example, has brought members of our staff into touch with keen amateurs in natural history, antiquarian studies, and hill walking, who often appear to know as much (or more) about our properties as we do ! The resources of local museums, universities, research stations, and technical colleges should also be kept in mind. Nor should the forester neglect the farmer's favourite pastime of looking over his fences to see what his neighbours are up to !

Finally, there are one's own observations made actually on the ground, which will often outweigh all the facts gleaned from the reference books. It is this personal knowledge that gives life and authenticity to an article, since it brings out the author's individual approach to his subject of study, aided though he may be by the many experts whose records and theories fill the tomes in the technical libraries.

AMATEUR PHOTOGRAPHY IN FORESTRY

BY B. R. FEAVER

District Officer, East Scotland

THE AMATEUR PHOTOGRAPHER is limited by two things, his equipment and his technical knowledge. With some knowledge excellent photographs may be taken with very simple equipment, whilst however good the equipment may be, it is useless unless its workings are understood.

Considering equipment first, cameras may be broadly classified into simple box type affairs with no focussing, only instantaneous and time exposures, and possibly some stops to control the light admitted. Next come simple folding cameras with some focussing arrangements, and limited controls of lens aperture and shutter speed. Thirdly come the cameras possessing full focussing, a range of shutter speeds and lens apertures, and possibly provision for extra close-up work by additional lenses or extensions of bellows.

The range of subjects available to the forest photographer is great, and extends from minute objects like insects and tree flowers to great vistas of country. Unless one is both keen and skilful, the difficult realm of extra close-up work on small objects is best avoided. Here may one say how important it is for owners of non-focussing cameras to know the distance of their nearest sharp object, and not to try photographing anything any nearer, even though it looks all right through the viewfinder. Simple folding cameras with focussing will often focus down to about six feet whilst advanced models usually go down to three or four feet. At this range an object needs to have little "depth" to it, as the range of sharpness will likely be small. Thus a line of transplants will take well if they extend across the field when in focus at three feet, but only one or two of them will be sharp if the row runs towards the camera, owing to the small "depth of focus," as it is called, available at close ranges. However, close-up photographs tend to be of the record or specimen kind, and are best taken by the professional or skilled amateur.

It is in the middle distance and long range types of photographs that owners of all three kinds of equipment share common ground, and it is here the amateur can take the most pictures with the greatest chance of success. Groups of men at different tasks, lay-out of nursery or conversion site, big machines at work, plantations at all stages, views of afforested country—many subjects spring to mind. The main factor to be considered in recording them will be light. If there is any movement, then the shutter speed must be fast enough to arrest it. If the shutter only opens very briefly, then enough light must pass through the aperture of the lens to expose the film adequately. If the light is poor this may mean either a fast film or a fast lens. A correctly exposed negative only results if the right amount of light has reached the film. Too much light reaching the film results in over-exposure and a dense black negative. Too little results in a thin ghost image or none at all.

Any camera is essentially a light-tight box having a window (the lens) at one end and the film at the other. The light entering through the window is affected by the size of the window—technically the aperture, stop, or "f" number—and the duration of the passage of the light—the exposure. This duration is controlled by the shutter. Thus two variable factors are introduced, the size of the window and the duration of the exposure. It is possible to admit the same amount of light with a big window and a very brief click of the shutter, as it is with a tiny window (the lens "stopped down") and a prolonged exposure. This possibly confusing state of affairs, nevertheless,

has its uses, as the range of shutter speeds can deal with objects moving at various speeds, and the size of the lens aperture controls the range within which objects are sharp at a given setting of the focussing lever. The aperture of a lens is usually given as an "f" number, e.g., f.4.5, f.8, f.11, etc., and as this number gets bigger so the size of the aperture gets smaller. It is disastrous if this progression is memorised the wrong way !

As far as possible it is a good principle to decide beforehand on the subject for a photograph, and to go and take it when conditions are best. This may clearly be impossible with some subjects, but it will apply to all types of views, either of country or plantations. As the human eye is so adaptable to varying conditions of light, judgment of exposure presents some difficulties. There are to-day such excellent little pocket exposure calculators for sale that their small cost is quickly repaid by the film saved, and any man who can master current records and forms will find an exposure calculator refreshingly simple. Costlier but more accurate gadgets are available to measure the actual light on the spot by means of a photo electric cell.

If exposure can be mastered, then the only other bars to success are focussing, if necessary, and a steady hand. One of the major causes of poor photographs is camera movement. If brick walls were more easily portable I would always carry one on which to rest my camera securely and so rule out this cause of fuzziness.

Until some experience has been gained, it is a great help to write down everything done at the time of taking a picture, as one's memory will be severely strained when asked some weeks later for details of exposure, light, subject and other points. Therefore write them down at the time. You will never regret it, and it will be of great help in giving you a sound judgment if your exposure calculator has been left at home.

So far no mention has been made of composition—the eye for a picture. Some people have it instinctively, others can learn it to a degree, whilst some will never acquire it. There are some rules which are helpful, and these may be found in current small booklets. But it is suggested that photographers take note of pictures which please them and try and analyse them to find out why—where the centre of interest lies, how the masses of light and shade are disposed—because after all any photograph is only an arrangement of tones from white to black. They should not be afraid to try imitations of striking subjects. The camera can accurately and quickly portray an object or scene that may require a chapter of prose to describe.

It can also, accidentally or deliberately, distort objects almost out of recognition if the perspective is distorted. The modest stem due to come out in the first thinning can approach the stature of a giant redwood if the camera angle is artfully chosen.

Alternatively the pattern of light and shade in the woods, bare stems of beech or birch, the soft receding planes of the hills viewed from a high point of the forest—these and many more may be taken for the pleasure they will give or afterwards recall.

As forestry concerns itself with living crops that normally increase their size year by year, so this growth changes the appearance of the countryside. Photographs taken in the early days of plantations acquire a great interest when the crop has grown, as also do landscapes of areas before afforestation. Systems of silviculture, especially methods of thinning and

natural regeneration, and of ploughing and the tackle used, all can be conveniently recorded. An attractive series of photographs showing work in progress and the state of plantations at a point in a forest's history will always be of subsequent interest, and may provide valuable information for dealing with similar areas elsewhere later.

In taking a series of operations it is useful to remember that many actions, swift though they may be for the most part, often have a brief pause at some point. Thus the axeman laying-in is virtually motionless at the end of his swing, and a fine sense of movement will be captured if he is taken with the axe at the end of his swing back. Similarly the cross-cut saw has two periods of rest when the direction of cut is changed. If the light is poor the camera can often take advantage of these very brief periods of arrested motion in which to make the exposure, often using quite a slow shutter speed. This is of great help in a wood, where the light is usually very weak. It takes some practice to get the right anticipation of the pause, and the usual thing is to be too late with the shutter.

When a certain brand of film has been found to give good results, then it should be used consistently. This will reduce the number of variable factors in the exposure and lead to greater confidence. It is not usually necessary to use the fastest film for the greater part of the year. One of moderate speed should meet all demands of straightforward work, and will usually give a better range of tones, fast films tending to produce rather flat prints when used out of doors.

Perhaps a great opening for photography in forestry, that so far has not been much used, lies in recording the ground flora at the time of planting and then following up the subsequent changes. Whilst a written description would be necessary to list the species present, a good photograph would greatly enhance the written word and convey a better picture of the ground at planting. It would be helpful if the spot from which the picture was taken could be found in later years and care should be taken to record it. Of particular interest would be such a series taken on a sand dune area like Culbin, showing the transition from bare sand to moss or heather after thatching and planting.

On the practical side the photographer would need an efficient camera capable of focussing down to at least five or six feet. The lens would be stopped right down to f.16 or f.22 to get maximum depth of focus, and a suitable exposure given. As it would probably be a time exposure of more than a second, a firm tripod or other rigid support should be used. Two pictures suggest themselves, one of the ground vegetation and another to give a more general view, but including an object also taken in the first close-up, e.g., a prominent stone or stump. When the crop has grown and the canopy closed, the exposure may well run into minutes under a heavy shade-casting species. A good day is one when there is plenty of light reflected from white clouds, but with the sun temporarily screened by a cloud. This will prevent any patches of sunlight in the picture; these are normally too bright for the film to be able to record detail in them as well as in the other parts of the picture where the light is dim.

On the market to-day are several brands of colour films, and, correctly used, they yield excellent colour transparencies. The limitation at present is that these can only be fully appreciated when projected onto a screen like a lantern slide. The coloured paper print is not yet available in this country, but a time must come when it will be possible to expose the film

and the chemist will do the rest, handing back a series of pictures in full natural colours where we now receive prints in black and white.

These colour films are admittedly expensive, they require good cameras and meticulous attention to exposure, they require careful handling and binding up into slides, and they call for efficient projection onto the screen. The capital sum involved is very considerable, but the result can be more satisfying than anything black and white can offer. Their value in forestry is considerable, as the film is able to follow the changing tones of natural colour and to show an object as it really is, and not as it is translated into a language of greys. It is possible to pick out objects by their colours as well as by their shapes, and this gives greater emphasis to slight differences. For example, a near picture of ground vegetation is quite easily interpreted from the colour image, whereas laborious study of a similar picture in black and white is necessary. A coloured photograph of nursery stock distinguishes instantly between Scots and Corsican pines, Norway and Sitka spruces. The use of colour for recording ground vegetation will be of greater use when colour prints are available. Whilst good transparencies can already be made, they are not convenient to examine and file unless a definite study is being made of the subject and a collection of slides built up.

TOURING IN INDIAN FORESTS

BY R. O. DRUMMOND

District Officer, North Scotland

IT MAY BE OF interest to readers to know how the Forest Officers in India tour and inspect their forests. Generally, each Division has a headquarter bungalow in the main town of the Civil District in which the forest lies, and this town is usually the headquarters for all the Government officials who are serving in the district. This headquarter bungalow is the property of the Forest Department, and contains a minimum of essential furniture. It is maintained as the residence of the Divisional Forest Officer, but has one or two rooms set aside for the use of the Conservator or other forest officers who come on tour. In a few cases it may lie close to the forest area, but more often it is at some distance therefrom and is only occupied from July to September. This is the monsoon period, when work in the forest is almost at a standstill, and all roads are closed owing to the heavy rainfall.

For the rest of the year, the bungalow is used as a store for clothes, furniture and stores not wanted while on tour in the forest, and is only visited for short periods to replenish stocks between tours, or to attend the office for such important duties as holding auctions, closing the accounts at the end of the financial year, and so on.

Throughout the Forest Division, which is usually a fairly compact block of forest, there is usually a road system, with Forest Rest Houses, built and owned by the Forest Department, at intervals of fifteen to twenty miles. In the sub-montane tracts, where the ground is usually fairly level, there are fair-weather motor roads which are cheaply made and maintained by roughly levelling two tracks for the wheels ; these are suitable for light motor traffic only, and cannot be used after heavy rain. Water courses are usually dry during the touring season, and their usually sandy river beds are crossed by laying two tracks of duck-boards ; each section of duck boarding is connected to the next, starting from midstream and connecting right up to the two banks. The two sections at midstream are not connected to each other. At the two banks the last section is heavily anchored to the bank. Thus, if a spate occurs, the two lengths from the anchor at the bank to midstream are washed downstream, pivoting from the anchored end, and swing back to the edge of the stream, whence they are easily collected and re-laid after the spate has passed. Where the stream has a permanent flow of water, bridges are prepared annually. They are usually constructed in the form of wooden cribs, filled with heavy stone. Each crib is connected to the next by three heavy beams, across which lighter poles are laid and nailed or tied down. On these, branches, straw or grass is thickly laid, and finally covered with gravel from the river bed.

Just before the break of the monsoon, the duck-board crossings and the poles and beams of the bridges are dismantled and stacked above flood level for use in the following year.

Motor roads of the type described above permit of a speed of thirty miles an hour with fair comfort, provided one is always on the look-out for sections damaged by rooting by pig, construction of ant-heaps by white-ants, and so on. Many Divisions now have light motor-lorries which accompany the Divisional Forest Officer on his tours, and carry all his stores, crockery and other goods, together with his camp office equipment, his camp clerk, and office records. These are usually allowed to travel on the light motor roads.

Elsewhere, however, the light motor road is paralleled by a cart road, prepared and maintained in much the same way as the motor-road but less carefully levelled. The passing of long trains of bullock carts laden with forest produce soon levels out any irregularities, and often deep ruts are made. But as the carts have high wooden wheels giving ample clearance, and as the two bullocks or buffaloes which pull the carts walk in the wheel ruts, this does not matter provided that, before the monsoon starts, the ruts are levelled off and filled in. The rain consolidates the filling, and the road is made good in this way before the following working season.

Where motor-lorries are not available for carrying the camp kit, bullock carts or camels are employed and they use the cart road. Each Forest Officer is allowed to employ six bullock carts or ten camels at Government expense, but if his requirement of transport exceeds this, he pays for the balance.

Each Division has one or two elephants which are used for inspecting the forest, as they are able to move through heavy and thorny undergrowth which could not easily be penetrated on foot. Moreover, they raise the observer above the general level of the undergrowth, and enable him to see the timber trees, which would be hard to see from ground level, through the heavy low-cover. On tour, the elephant is usually allowed to carry the light and important articles of kit and some of the servants in rotation, whose early arrival at the next Forest Rest House is desirable. An elephant on the march travels at a speed of about four miles per hour, while camels travel at about three miles per hour and bullock carts at about two miles per hour only.

In the more mountainous Divisions, situated on the foothills of the Himalayas, motor roads are impossible owing to the mountainous and rocky terrain. Here there are bridle paths, tracks six to eight feet wide, often cut into steeply sloping hill-sides.

The distance between rest houses is usually ten to fifteen miles. A ten mile march, starting at 6,000 feet elevation, dropping to 4,000 feet and rising again to perhaps 8,000 feet, is quite enough for most people. Ponies have to be bought or hired, or else one walks. A carrying chair or dandy is used by children or the less agile or energetic "mem-sahib." It consists of a seat and footrest, built into a frame, at the ends of which a short pole is connected by leather thongs. Two coolies lift the ends of the pole in front and two take the ends of the pole behind, and the four men can then lift the whole. With two relief men, who change places every mile or so, it is possible to cover the whole distance between rest-houses without a halt. Usually, however, the more level and less precipitous parts are walked, and the dandy used only for steep gradients or uneven and frighteningly precipitous parts of the march.

The camp kit is transported by mules, ponies or coolies. In one hill Division in which I served there were five Government-owned mules, five Nepalese coolies hired for the whole touring season, and I was allowed to charge to Government the cost of hiring on a march day either four ponies or mules, or ten local coolies. As I had my wife and four children on tour, I had to pay for a further four ponies or ten coolies from my own pocket. The cavalcade when we marched was quite a sight to see. First, my wife and I headed the column, walking, followed by two children riding ponies and two others in a double dandy. Then came the mules and ponies, followed by the coolies. Add to this the five camp servants, the camp clerk, the Range Officer and their kit on ponies or coolies, and the camp followers, and we

soon spread out to cover about a mile of road as we marched along. Feeding ourselves, the staff and the camp animals was quite a task. It was usually possible to obtain milk, flour and eggs at or near each rest-house. In many villages, a shopkeeper is subsidised by Government to set up a small shop close to the rest-house, to sell these and other commodities to the local forest staff, touring officials and camp followers. Butcher meat is only available near a big village. Elsewhere the choice lies between buying the local undernourished poultry or a whole goat, shooting a deer, or opening a tin. During the war, the enormous increase of labour employed in the forest, resulted in such a reduction in the local poultry and goat population that it became a question of either shooting for the pot or living on tinned meat. As a keen sportsman, I found this no hardship, and it was a fine sop to my conscience to be able to take time off occasionally to shoot a deer, or one of the many kinds of game birds—pheasants, partridges, jungle fowl, duck or snipe.

My last charge in India was the Andaman Islands, which lie in the Indian Ocean, between Madras and Malaya. Most of the several hundred islands carry forests consisting of many different species of dipterocarps, *Terminalias*, mangroves, *Lagerstroemias*, and many other genera. Touring here was by motor launch, using a wooden-hulled, Diesel-driven craft, about sixty feet long, having a spacious cabin with four bunks, ample storage space, a galley, and a large cabin shared by the cook and the crew. This launch was my home while on tour, and the inspections were done by going ashore in a dinghy and walking through the area to be inspected. This frequently meant a journey of several miles through the forests across an island, to be met and taken aboard again by the crew of the launch who had circumnavigated the island by sea or creek. Navigation had to be learnt, as the charts in force were old, and in many cases the growth of coral had completely altered the sea floor. As I have always been a good sailor and interested in little ships and sailing, this was one of the happiest times of my life. Add to the other attractions, really first class big-game fishing, and you will appreciate how sad I was to leave this job, following the constitutional changes in India.

Life in the Andamans was a real South Sea Island existence with all the loveliness of blue skies and seas and wonderful clear lagoons, teeming with innumerable gorgeously coloured fishes and coral gardens. The sub-tropical forests are luxuriant and almost impenetrable except along cleared paths, with creepers and climbers so dense that one can seldom see more than the first thirty feet of the timber trees, and identifications have to be made from the bark and bole. Indeed, it is seldom possible to see more than fifty feet in any direction. Add to this that the forests have a population of poisonous snakes, millions of vicious leeches and a scattered population of hostile aborigines who ambush stragglers and kill them with arrows, and you have a truly adventure-story atmosphere.

NEW FOREST COMMON RIGHTS

BY H. W. GULLIVER

Chief Clerk, South East England

TO ONE ASSOCIATED with the New Forest for many years, the *Report of the New Forest Committee, 1947*, as presented to Parliament, was of particular interest. I am certain that it must have made pleasant reading, not only to the many who are well acquainted with this natural beauty spot in the county of Hampshire, but also to those who have not yet had the good fortune to visit the New Forest, still the home of ancient rights and privileges.

Reading the sections of the Report dealing with "Administration" and "The Commoners and their Rights" turned back for me the pages of time to my early service in the office of the Deputy Surveyor of the New Forest. Housing in those days was, fortunately, not the problem which it is at the present time, and the estate agents dealing with Forest properties were forced to make their particulars of sale notices as attractive as possible. To advertise a property as having "valuable forest rights attaching thereto" often had the desired effect of inducing a potential purchaser to make just that extra fifty-pound bid which would enable him to set up as a country squire.

A day or so after the sale, a visit to the Crown Office would follow to find out all about those valuable forest rights. Now these rights appertain to certain properties only and the *Register of Claims* which defines them, as a result of awards made by a statutory committee, has not been revised or amended since 1854. Naturally there have been many changes in ownership and boundaries since that date, but fortunately all the properties concerned are marked on the parish tithe maps, and copies of these are preserved in the Crown Office. Hence, if the property could be found on the tithe map, the definition of its rights became a simple matter.

Now to those who have not had reason to consult a tithe map my advice is: Don't! As these maps were drawn on parchment-like linen of unwieldy dimensions, it was necessary to lay them out on the office floor, which indeed they almost covered, and invite the lady or gentleman enquiring to accompany you on a crawl of discovery.

The draughtsman entrusted with the task of preparing such important records must have been an embittered man to have created so many difficulties for those needing, in later years, to pore over his handiwork. For one thing he had no use at all for north points, the omission of which certainly did not help matters. It was most important to know whether one was crawling in a north, east, south or westerly direction.

Further, drawing maps to a standard scale was not considered a necessity by our draughtsman friend and, just for good value, he omitted, with very few exceptions, any place names which are so helpful on our present-day Ordnance Survey maps.

By now the enquirer was down to earth in more ways than one, and had thrown up the sponge by freely admitting defeat at the hand of the tithe map. It was now necessary to tackle the problem from another angle. A step towards identification on the tithe map was to locate the property on the

twenty-five-inch scale Ordnance Survey map. This did not present any great difficulty, even with only the 1910 edition available. Having pin-pointed the property on the Ordnance Survey sheet it was, with practice, a reasonably simple matter to site it on the tithe map and now the trouble really started.

Each message and parcel of land shown on the tithe map bears a tithe number, and to identify the claim it was necessary for that particular number to be traced in the *Register of New Forest Claims*, a book of some 498 pages, containing reference to 1,311 claims. Familiarity with the *Register*, however, did enable one to develop a technique of "short-cuts" and it was at least possible to say which, if any, of the different rights (common of pasture, mast, turbarry, fuelwood or marl) might be exercised.

It was the disclosure that Common of Turbarry was attaching to the message that often led to misunderstanding. This information often drew forth the spontaneous remark "But how lovely! The turves will be just right for re-turfing the badly worn lawn of our new home."

Alas! The need to dampen such rash enthusiasm with an explanation that the turves could not be used for such a purpose but were, in fact, peat turves for burning in a specially constructed fireplace. With the advent of modern fireplaces in forest homes this right is little exercised at the present time, and I know of only one existing dwelling at which a turf fire can be seen to-day.

This is at the "Royal Oak" Inn at Fritham, where the chimney can still be "hired" from the landlord for smoking your own side of bacon—that is, if there really is such a thing to-day as a side of bacon! A few years ago a Southampton Civil Servant friend of mine jocularly "booked" the chimney when next there might be a vacancy. Unfortunately for him the landlord took his request seriously and imagine my friend's horror on being solemnly informed some weeks later that he could now bring along his side of bacon for hanging up the chimney. Only after his pocket had been considerably lightened and his health drunk with gusto was he allowed to live down his indiscretion.

How well did I get acquainted with the *Register of Claims* when undertaking the voluntary task of assisting the Verderers to produce evidence on which to state a reasoned case to the Treasury requesting financial assistance because of the difficulty in exercising their right, under the Act of 1877, of levying a penny rate on all properties to which any rights of common attached. This research work was undertaken in the evenings, and I had the assistance of the Rating Officer to the New Forest Rural District Council and a local rate collector, whose father and grandfather before him had held the post of Rate Collector for the parish of Lyndhurst. We took that parish as our test case and the local knowledge my rate collector friend possessed was phenomenal. The procedure was for me to identify each message or parcel of land from the *Register* and the tithe map and in such a way that my Council colleagues were able to trace the present day ownerships in the voluminous Valuation Records, which set out the individual rateable values.

The Lyndhurst of to-day is very different from the Lyndhurst of 1854. What was shown in that year as fields now appears on the up-to-date Survey maps as fully developed residential districts. This applies especially to the outlying parts of the Northerwood Estate, which had been sold off in the early part of the century for private development.

It was a formidable task which we had before us, as it was essential that not a single property was forgotten in considering how this agricultural land had been developed. This was where my rate collector friend played a very important part in our investigation. Once we had decided that it would be necessary to deal with a certain road, his memory served him so well that he could name each property in the road and give the name of the owner and/or present occupier. This, of course, enabled the rateable valuation to be obtained from the Rating Valuation Register, without any great amount of trouble.

In due course all the required data had been collected, and I was then left with the task of compiling the information in a suitable form for presentation to the Verderers. When this had been completed it gave a complete and up-to-date picture of the parish of Lyndhurst as related to the *Register of Claims* and connected tithe map, and illustrated the impracticability of the Verderers being able to exercise their right to levy the penny rate. The cost of collection would, in any case, have exceeded any income which they might derive from it.

For that investigation we each received an honorarium from the Verderers of ten pounds, which worked out, in my case, at something like sixpence an hour, but I enjoyed every minute of it.

It was only a short time before the gathering Munich war clouds that the Verderers were considering what line of approach to the Treasury they should take, and I gather from the *Report* that the compensation which the Verderers eventually received from the War Department for loss of grazing rights, as a result of the aerodromes, etc., which had been built on the forest during war years, made the presentation of the proposed petition unnecessary.

The committee have recommended that the existing Register of Claims should be replaced by an atlas, showing all lands to which rights of common were attached according to the *Register* of 1854, and that a new electoral roll should be prepared showing the names of those entitled to vote at an election of representatives of the Commoners to serve on the Council of Verderers ; what an interesting job awaits someone if it should be decided to adopt these recommendations.

HISTORY OF BLENGDALE, WORMGILL AND CALDER

BY F. CLOSE

Forester, North-West England

THE DETACHED BLENGDALE Section of Ennerdale Forest is situated about three miles from Wastwater in the Lake District. I have often wondered how old were the surrounding farm houses, the sheep folds, and the numerous heaps of stones scattered over the fells, and to satisfy my curiosity I have been able to get the following information from Miss M. C. Fair of Eskdale, a noted authority on the history of this district.

The wild and lonely upland moor from the river Calder to the Bleng, that paradise of those who love the great solitudes of mountain and stream, crag and heather, has a story going back to that dim age before history was written. The people of the New Stone Age, our first agriculturists in Britain, arrived about 2,000 B.C. and the great Long Tumulus nearly one hundred feet in length is their memorial. Dotted about are other impressive monuments of different form indicating their successors of the earlier Bronze Ages, pre-Celtic peoples of about 1,000 B.C. The earlier folk preferred the upland moors for their settlements, where they lingered on through the coming of the Romans till the advent of the Angles and the Norse colonists. Of the later Bronze Age and Iron Age folk, the Celtic peoples, we have in West Cumberland no trace whatever, though across the Duddon in "Lancashire North of the Sands" and farther east in Cumberland they were fully represented.

The Angles did not like the upland moors, but made their settlements along the coastal belt, but the Norsemen colonised the fell dales, carving out homesteads and highland pastures for their flocks. Many of the names of our homesteads to-day keep green the memory of those hardy Norse farmers; Skalderskew for example (the grove of the bard), Guards, Thwaites, Garths, are all of Norse origin.

Scalderskew was one of the Granges of Calder Abbey, with Thornholme and a place called Moghton, till the reign of Henry VIII, when the Abbey and the Granges were granted to Dr. Leghe the Commissioner. The Abbey grazing rights extended to Borrowdale. The ancient trackway from the pack horse bridge across the Calder, via Sergeant Ford of the Bleng to Wasdale and Gosforth, must certainly have been the highway of the prehistoric dwellers through whose housing and burial sites it winds its way.

In the early years of the reign of Henry I came a Norman overlord, to whom had been granted the Barony of Egremont, and the wild moorlands became forest land under forest law, but with the rights of the commoners within the area strictly preserved, rights still surviving. There are ancient sheepfolds dotted about and remains of little shelters for farmer and forester. Peat can be dug and bracken cut for bedding for stock. Sheep and cattle have their allotted grazings on the common, a heritage of the fell-dale commoners from time immemorial. The monks of Calder had farms for their sheep and cattle; Thornholme was one. The ancient bridge, 15th century probably, may have been their work, for it is quite different in type from the usual pack horse bridges of the district and is an ancient monument which should be carefully preserved. The little groups of homesteads at Calderbridge on the north bank of the Calder are themselves of origin so ancient that it fades into the mists of the unknown.

New Stone Age men, early Bronze Age folk, Romans, fierce, big, fair-haired, blue-eyed Norsemen, Norman knights and squires, foresters in Lincoln green, farmers in duffel brown or hodden grey, monks, pack horse trains, travellers on horseback, these are the people who through nearly 4,000 years have travelled and spent their lives on the rugged common twixt Calder and Bleng.

WOODMAN, SQUARE THAT TREE !

BY J. Q. WILLIAMSON

Chief Education Officer

THE JOURNEY TO the office is normally a drab and tedious affair. First the converging lines of people scuttling along to the bus stop, all apparently obeying the proverb of "Go to the ant, thou sluggard, consider her ways and be wise." Then the morning misery of queueing. The ant analogy of a perfect community is, however, upset as each bus arrives, and civilised man shows his dissimilarity to brute creation by exercising his individuality to the utmost in attempting to embark by every mean trick at his disposal. And at last, after ten minutes worth of Christian humility, I manage to obtain standing room by a similar technique. From then on the journey is comparatively peaceful, but at the journey's end, when I reach the haven of my office chair, I feel with Thoreau that "the mass of men live lives of quiet desperation."

And yet every day is different, as the kaleidoscope of London is ever changing, and during this daily journey there is always some new aspect of life offered to the mind to chew over, and digest or expectorate according to its taste.

This morning I was lucky enough to get a seat, and after making myself comfortable I casually inspected the man sitting beside me. He was dressed in the conventional City wear, and yet there was something about his appearance that was vaguely disturbing. At last I spotted it—a very little thing, but sufficient to catch the observant eye—the handle of his umbrella was square instead of circular in design. And as a very little thing, the smell of dust after rain, the feel of bark, or even the clink of a decanter can bring back vividly to mind some experience which seems dead and gone, so did this square umbrella handle bring back to my remembrance an episode which occurred during the days of the British Empire Forestry Conference in 1947.

The delegates had settled down to a full day's debate on land utilisation, and as I was not needed in the conference chamber I decided to concentrate my energies on checking last minute details of the forest tour which was shortly to follow. No sooner had I begun this work when I was interrupted by the messenger, who asked whether I could see a gentleman who had called on extremely important conference business. I did not know his name, but I decided it would be best to find out what he wanted. He did not leave me long in doubt as to what that was. A very pleasantly worded request to halt the conference proceedings immediately, so that he could address the assembled body or, as this might not be possible to arrange, to put the subject matter of his proposed discourse as the agenda for the following day. His proposition was a simple one, but are not all great truths simple? Why not grow *square* trees instead of round ones? Think of the tremendous saving if you make trees grow in the form wanted by the sawyers! And even more revolutionary, why not grow your trees so that you can, at intervals, take slices of utilisable heartwood out of them, naturally cut to millable size, and then help the tree to heal the wound, so that it can replace this lost heartwood by the renewed vigour of the remaining part of the organism. Timber could be periodically extracted from large trees, not only without impairing their productivity, but in such a way as to enhance both quality and quantity, and finally, timber extraction machines could be designed for ready infiltration

between trees. Without contact with the ground, they could travel along regularly patterned rows. Thus work could proceed in all weathers, with manageable sizes of timber left upright so that, on calm days, blimps or dirigibles could quickly and inexpensively remove all accumulations to a not-over-distant surface transport system or direct to destination !

Revolutionary talk, and yet was not Galileo haled before the Inquisition because of his heretical beliefs ? Do not think that the outline I have given represents all that my visitor said. He had an apparently reasoned answer to all my objections, and in the course of the hour's discussion emphasis was laid on such varied matters as the colchicine principle, stimulation by fungus aid to growth, diploid chromosomes, blending of double-hearted seedlings, penicillin, non-corrodable tubes for deep fertilisation, wind shakes and methods of Ultra-production. He very nearly convinced me that his propositions were sound, and I sometimes regret that I did not allow him to address the august body assembled in the hall next door.

I clung to one rock all the way through—my belief that there is not and never will be a square tree. Square roots perhaps—square trees never ! But, even here, I was nearly defeated because my guest quoted an article which he had read in a well-known timber journal of May, 1920, in which a forestry expert had ventured the opinion that trees could be artificially stimulated to grow in any desired direction. Fortunately, the Secretary of the Empire Forestry Association was sharing my office, and he gallantly came to my aid, so that our combined efforts persuaded our visionary friend that he was perhaps arguing in a circle. He left, promising to supply me with fuller details of his proposals in a day or two. They arrived, eighteen closely typewritten pages of them, and I must admit that the arguments given were intriguingly convincing. Alas, the pressure of conference work, and then the normal arrears, made me neglect his theory, so that as the months passed the vision faded. But now—I wonder—after all, there was that square umbrella !

FORESTRY COMMISSION STAFF*(as at 1st November, 1949)*

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<i>Technical Commissioner :</i>	SIR WM. L. TAYLOR, C.B.E.	
<i>Director-General :</i>	A. H. GOSLING	
<i>Deputy Director-General :</i>	W. H. GUILLEBAUD	
<i>Secretary :</i>	F. W. HAMILTON, M.B.E.	
<i>Deputy Secretary :</i>	E. C. SHANKS	
<i>Controller of Finance :</i>	V. BATES	
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<i>Information Officer :</i>	HEALEY, D.	
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	CHARTERS, H.	Finance
	COGGINS, W. E.	Secretariat
	HAMILTON, W. H.	Stores
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	PINK, C. R. C.	Organisation and Methods
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	MINTER, A. F.	Establishment
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	PRESTON, J.	Establishment
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<i>Senior Temporary Assistant :</i>	SUMMERS, J. J. V.	Finance

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<i>Conservators :</i>	CONNELL, C. A.	(State Forests)
	EDWARDS, S. W.	(Estate)
	RYLE, G. B.	(Private Wood- lands and Ac- quisitions)
<i>Directorate Engineer :</i>	Brigadier S. A. H. BATTEN, C.B.E.	
<i>Divisional Officer:</i>	PEARSON, F. G. O.	(Utilisation)
<i>District Officers Grade I :</i>	BAMFORD, J. A.	(Acquisitions)
	KENNEDY, J. B.	(Utilisation)
	PATERSON, A.	(Nurseries)
<i>District Officer Grade II :</i>		
<i>Mechanical Engineer :</i>	RICHARDSON, M. C.	

<i>Assistant Engineers</i>		
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(Mech) :	TICKELL, D. J.	(On loan S.W. (E))
(Mech) :	WILLSON, J. M.	(London)
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<i>Senior Executive Officer :</i>	LEWIS, E. R.	
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DIVISIONAL OFFICERS :	Barrington, C. A. J.	Chester (Private Woodlands)
	Mackenzie, G. I.	Chester (State Forest Officer)
DISTRICT OFFICERS I :	Raven, W. J.	Chester (Estate)
	Dixon, E. E.	Carlisle
DISTRICT OFFICERS II :	Chard, R.	Chester (Utilisation)
	Flynn, A. E. G.	Chester (Acquisitions)
	Adams, C. A.	Chester (Estate)
	Jackson, W. V.	Mansfield
	Roberts, W. G.	Shifnal
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ASSISTANT ENGINEERS		
(Civil) :	Croft, G. W.	Chester
(Civil) :	Priestley, J. B.	Chester
(Civil) :	Jones, F. G.	Chester
(Civil) :	James, J. E.	Carlisle
(Mech.) :	Chapman, R. W.	Chester

HIGHER EXECUTIVE

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2. Thornthwaite : Walton, W. (I) ; Wells, H. (II).
3. Cannock : Tribe, W. (Head) ; Hall, D. (II) ; Morgan, L. G. (II).
4. Mortimer : Adams, I. (I) ; Francis, E. R. (II) ; Shelley, W. R. (II) ; Stokoe, J. (II) ; Lloyd, J. C. (II).
5. Walcot : Rees, T. J. R. (I) ; Wilson, W. J. (II).

6. Clipstone I : Arnott, W. (II) ; Garner, W. (II).
 Clipstone II : Simpson, G. A. (Head) ; Rowlands, I. G. (II) ;
 Gilson, R. B. (I).
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8. Hope : Sarsby, O. R. (II).
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12. Hardknott : Murray, M. (II).
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 D. S. (II).
14. Greystoke : Guthrie, F. H. (II).
15. Cotgrave : Keens, D. W. (II).
16. Dalton : Thomas, D. R. (II).
17. Kinver : Stockley, G. H. (II).
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19. Long Mynd : (New unit).
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 Satterthwaite : Small, J. R. (I).
- Estate :*
 Mansfield : Dean, S. W. (I).

ENGLAND, NORTH EAST CONSERVANCY

Briar House,
 Fulford Road,
 York
 Telephone : York 4684

- CONSERVATOR : Batters, G. J. L.
- DIVISIONAL OFFICERS : Forsyth, W. York (State Forests)
 Portlock, W. J. J. York (Estate)
- DISTRICT OFFICERS I : Haldane, W. D. York
 (Private Woodlands)
 Maund, J. E. York (Utilisation)
 Conder, E. M. Thornton-le-Dale
 Garthwaite, P. F. Kielder
- DISTRICT OFFICERS II : Forrester, S. Hexham
 Marshall, I. R. B. Kielder
 Smith, W. T. Hexham
 (Private Woodlands)
 White, A. H. H. York (Estate)
 Wood, T. G. York
 Selby, B. C. York (Acquisitions)
- CONSERVANCY
 ENGINEER : Sergeant, T. J. York
- ASSISTANT ENGINEERS
 (Civil) : Perkins, J. S. Bellingham
 (Civil) : Preston, G. W. Thornton-le-Dale
 (Civil) : Cooper, D. Kielder
 (Mech.) : Wortley, A. York
- HIGHER EXECUTIVE
 OFFICER : Chaplin, L. A. York

FORESTERS :

- | | |
|----------------------------|---|
| 1. Chopwell : | Cumming, W. B. (II). |
| 2. Allerston : | Anderson, T. E. (Head) ; Kirby, C. (II) (Estate). |
| Dalby : | Snowdon, L. (I). |
| Wykeham : | Gough, W. R. (I). |
| Bickley : | Woodward, G. (II). |
| Harwood Dale : | Yeomans, F. W. J. (Foreman). |
| Staindale : | Woodward, F. G. (Foreman). |
| 3. Rothbury : | |
| Thrunton : | Stanley, W. E. (II). |
| Swarland : | Gledson, J. G. (II). |
| 4. Selby : | Wood, W. (II). |
| 5. Kielder : | Weir, A. B. (Head) ; Wensley, A. (I) (Estate). |
| Kielder : | Daglish, T. E. (II) ; Tait, J. (II) ; Straughan,
J. G. (II) ; Stokoe, G. (II). |
| Whickhope : | McCavish, W. L. (II) ; Martindale, J. M. (II). |
| Mounces : | Hislop, J. J. (II). |
| Tarset : | Scott, J. J. O. (Foreman). |
| Chirdon : | Fox, T. F. (II). |
| Plashetts : | Parker, G. W. (II). |
| Smales : | Anderson, J. T. (I) |
| 6. Hamsterley : | Bewick, T. (II). |
| 7. Ampleforth : | Cumming, J. (II). |
| 8. Rosedale : | |
| Cropton : | Frank, H. (I) ; Nicholson, J. A. (II). |
| Newton Dale : | Young, R. E. (Foreman). |
| 9. Harwood : | Masson, R. H. (II). |
| 10. Slaley : | Fawcett, E. (II). |
| 11. Arkengarthdale : | Hird, J. T. (Foreman). |
| 12. Redesdale : | Scott, J. F. (I) ; Bolam, T. W. B. (II). |
| 13. Langdale : | Anderson, T. E. (Head). |
| Langdale : | Marsh, E. W. (II). |
| Broxa : | Mennell, J. (II). |
| Broxa Nurseries : | Chisholm, J. D. (II). |
| 14. Widehaugh : | Davy, J. H. (I). |
| 15. Wark : | |
| Wark : | Brown, W. C. (I). |
| Pundershaw : | Marshall, J. A. (II). |
| 16. Scardale : | Bewick, W. J. (I). |
| <i>Private Woodlands :</i> | |
| York : | MacDonald, I. A. D. (Head). |

ENGLAND, EAST CONSERVANCY

Brooklands Avenue,
Cambridge
Telephone : Cambridge 54495

CONSERVATOR :	Backhouse, G. W.	
DIVISIONAL OFFICERS :	Morrish, C. G.	Cambridge (Estate)
	Ballance, G. F.	Cambridge (State Forests)
DISTRICT OFFICER I :	Dent, T. V.	Cambridge (Private Woodlands)
DISTRICT OFFICERS II :	Anderson, J. W.	Santon Downham (Utilisation)

	Davidson, J. L.	Santon Downham (Utilisation)
	Weston, F.	Santon Downham
	Mackay, D.	Santon Downham
	Rogers, S. W.	Santon Downham
	Halton, K.	Cambridge (Acquisitions)
	Chapman, E. S. B.	Cambridge (Private Woodlands)
	Carnell, R.	Rushden
	Payne, S. R.	Tealby
CONSERVANCY		
ENGINEER :	Dufton, F. G.	Cambridge
ASSISTANT ENGINEER		
(Mech.) :	Cook, G. O.	Santon Downham
HIGHER EXECUTIVE		
OFFICER :	Clark, G. H.	

FORESTERS :

1. Hazelborough : Beasley, G. F. (I).
2. Salcey : Clark, J. F. (II).
3. Ampthill : Ingram, L. D. (II).
4. Rendlesham : Brook, J. W. (Head) (also at Dunwich and Tunstall) ; Wellington, C. R. (Head) ; Bewick, R. (I) ; Gracie, A. (II).
5. Rockingham :
 - Apethorpe : Cottenham, W. (I).
 - Fermyn : Halsey, H. R. (I) ; Walton, R. (II).
 - Fineshade : Rowell, J. (I).
6. Swaffham : Parry, A. A. (Head) ; Lawson, G. E. (I).
7. Thetford :
 - Cranwich : Morris, A. M. (II).
 - Croxton : Woodrow, R. B. (II).
 - Didlington and Buckenham : Camp, R. G. (II).
 - Downham : Salisbury, J. (I).
 - Elveden : Cameron, A. H. (I).
 - Harling : Steel, W. H. (I).
 - High Lodge : Redford, C. W. (I).
 - Hockham : Birkitt, A. (I).
 - Lynford : Johnson, H. (II).
 - Methwold : Mitchell, A. L. (I).
 - Mildenhall : Roberts, G. (II).
 - Roudham : Pywell, A. (II).
 - Santon : Davis, S. (II).
8. Bourne : Wyatt, L. (I).
9. Laughton : Adams, H. (I).
10. Swanton : Jones, F. B. (II).
11. Dunwich : Brook, J. W. (Head) ; Paulley, H. W. (II).
12. Yardley Chase : Dyer, H. C. (I).
13. Bardney : Jones, G. (I).
14. The King's Forest : Smith, J. J. (I).
15. Wigsley : Hall, V. B. (I).
16. Willingham : Marshall, D. F. (II).
17. Wendover : Bloor, C. A. (II).

18. Hevingham : King, S. G. (Foreman).
 19. Shouldham : Woollard, R. P. C. (II).
 20. Watlington : Hendrie, J. A. (II).
 21. Bramfield : White, S. L. (Foreman).
 22. Burwell : Hardy, R. B. (II).
 23. Gaywood : Smith, W. P. (II).
 24. Tunstall : Brook, J. W. (Head) ; Mortlock, R. F. (II).

The following Foresters engaged in specialist duties are stationed at Santon Downham, Thetford Forest :

Button, G. H. (Head) (Utilisation).
 Pritchard, R. (I) (Private Woodlands)
 Shinn, F. (II) (Seed Store and Fire Control)

ENGLAND, SOUTH EAST CONSERVANCY

“ Danesfield,”
 Grange Road,
 Woking,
 Surrey

Telephone : Woking 2270-1

- CONSERVATOR : Smith, R. H.
 DIVISIONAL OFFICER : de Uphaugh, F.E.B. Woking
 (Private Woodlands)
 DISTRICT OFFICER I : Ross, J. M. Woking
 (State Forests)
 DISTRICT OFFICERS II : Snook, K. R. Woking (Estate)
 Burton, E. S. V. Woodchurch
 Sutton, A. R. Farnham
 Wallington, A. W. Woking (Utilisation)
 White, J. East Grinstead
 Wilson, J. F. Woking (Acquisitions)
 ASSISTANT ENGINEER
 (Mech.) : Crawford, P. C. R. Woking
 HIGHER EXECUTIVE
 OFFICER : Gulliver, H. W.

F O R E S T E R S :

1. Alice Holt : Aston, T. H. (I) ; (and at Woolmer).
 2. Bere : Hyett, S. (I) (and at Bishopstoke) ; Lawes, R. (II).
 3. Woolmer : Aston, T. H. (I) ; (and at Alice Holt).
 4. Bedgebury : Nelmes, F. (Head) ; Awbery, P. P. (II).
 Hemsted : Hart, G. C. (II).
 5. Bramshill : Lingwood, N. J. (I).
 Crowthorne : Videry, F. J. (II).
 Eversley : Watts, F. C. (II).
 6. Chiddingfold : Francis, R. E. (I).
 7. Lyminge : Watkins, S. (I).
 8. Friston : Holter, G. E. (II).
 9. Micheldever : King, B. H. (I).
 10. Buriton : Laney, H. (I).
 11. Westbury : Ingram, H. C. B. (Foreman).
 12. Challock : Cross, L. G. F. (II).
 13. Goodwood :
 Charlton : Cooper, J. H. (II).
 Slindon : Davies, G. S. (I).
 14. Vinehall : Hallett, T. W. (Foreman).

15. Gravetye :	Craft, J. H. (I).
16. Marden :	Shepherd, W. R. (II).
17. Arundel :	Middleton, W. F. C. (I).
18. Orlestone :	Beaumont, D. R. (II).
19. Alton :	Richmond, P. C. (II) (and at Basing).
20. Andover :	Cook, E. (Foreman).
21. Southwater :	Moseley, J. (II).
22. Basing :	Richmond, P. C. (II) (and at Alton).
23. Bishopstoke :	Hyett, S. (I) (and at Bere).
<i>Private Woodlands :</i>	Hollis, G. W. (Head). Stationed at Woking.

ENGLAND, SOUTH WEST CONSERVANCY

9 Downfield Road,
Bristol, 8
Telephone : 34029-20

CONSERVATOR :	Popert, A. H.	
DIVISIONAL OFFICER :	Stileman, D. F.	(Private Woodlands)
DISTRICT OFFICERS I :	Grant, D.	Bristol (Utilisation)
	Stocks, J. B.	Bristol (State Forests)
	Good, F. G.	Bristol (Estate)
DISTRICT OFFICERS II :	Semple, R. M. G.	(Launceston)
	Purser, F. B. K.	(Devizes)
	Vetch, C. F.	Bristol
		(Private Woodlands)
	Hughson, T. A.	Bristol (Estate)
	Guile, A. W. L.	(Bristol)
	Williams, D. N.	(North Petherton)
	Dickenson, M. E. S.	(Worcester)

CONSERVANCY

ENGINEER :	Gladwell, L. B.	(Bristol)
ASSISTANT ENGINEERS		
(Mech.) :	Inglis, E. J.	Bristol (Mechanical)
(Civil) :	Shillito, P. E.	(Bristol)
(Civil) :	Hughes, R. E.	(Bristol)
HIGHER EXECUTIVE		
OFFICER :	Taylor, G. F.	

FORESTERS :

1. Dymock :	Beard, A. C. (II).
2. Brendon :	Bowdler, T. C. (II) ; Burton, H. J. (II).
3. Eggesford :	Kibble, E. C. (II).
4. Haldon :	Scott, G. H. J. (II).
5. Halwill :	Wilkinson, W. E. (I) ; Ball, W. F. (II).
6. Quantocks :	Jenkinson, G. A. (II) ; Humphries, W. J. (II).
7. Bodmin :	Bowman, P. (Foreman).
8. Haugh :	Milne, D. G. (Foreman).
9. Wyre :	Fairman, E. (I).
10. Wilsey :	Brain, R. G. (Foreman).
11. Bruton :	Stannard, A. J. (II).
12. Dartmoor :	Williams, J. (Head) ; Poll, E. A. (II).
13. Herodsfoot :	Strong, T. G. (II).
14. West Woods :	Reid, D. (II).
15. Lydford :	Jane, T. A. (II).
16. Collingbourne :	Hammond, B. R. G. (II).

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| 17. Hartland : | Fife, R. G. (Foreman). |
| 18. Mendip : | Fowler, J. (II). |
| 19. Savernake : | Wildash, J. T. (I). |
| 20. Stanway : | Bultitude, R. (Foreman). |
| 21. Braydon : | Wills, K. G. (Foreman). |
| 22. Okehampton : | Smale, E. R. (II). |
| 23. Neroche : | Law, H. G. (II). |
| 24. Culmhead : | Rayner, J. R. (II). |
| 25. Plym : | Whale, R. S. (II). |
| 26. Wareham : | Colwill, S. W. (Head) ; Green, W. J. (II). |
| Puddletown : | Fulford, A. G. (II). |
| 27. Gardiner : | Parsons, F. F. G. (I). |
| 28. Charmouth : | Everitt, E. C. W. (II) ; Green, W. J. (II). |
| 29. Purbeck : | Freeman, J. E. D. (Foreman). |
| 30. Blandford : | Coles, L. H. (II). |
| 31. Fernworthy : | Wray, N. (I). |
| 32. Glynn : | Everitt, F. W. (I). |

ENGLAND, NEW FOREST

The King's House,
Lyndhurst,
Hants.

Telephone : Lyndhurst 300

- | | |
|------------------------|------------------------------|
| DEPUTY SURVEYOR : | Wynne-Jones, E., Conservator |
| DIVISIONAL OFFICER : | Rouse, G. D. Lyndhurst |
| DISTRICT OFFICERS II : | Simmonds, S. A. Lyndhurst |
| | Winchester, P. L. Lyndhurst |
| ASSISTANT ENGINEER | |
| (Mech.) : | Sandwell, A. C. Lyndhurst |
| CHIEF CLERK : | Coote, R. |

FORESTERS :

- | | |
|-------------------|--|
| 1. New Forest : | Young, H. C. (Head). |
| Rhinefield : | Williams, L. H. (I). |
| Stockley : | Adams, J. H. (I). |
| Lyndhurst : | Liddell, J. (I). |
| Lodgehill : | Broomfield, G. (II) ; Palmer, C. H. (II). |
| Holmsley : | Cuff, E. W. (II) ; Deal, W. (II). |
| Holidays Hill : | Green, F. J. (II) ; |
| Burley : | James, H. B. S. (II). |
| Shave Green : | Holloway, A. T. (II). |
| Roe : | James, A. L. (II). |
| Godshill : | Longman, F. C. J. (II). |
| Working Plans : | Lewis, C. J. (II). |
| 2. Parkhurst : | Parry, A. A. (Head Forester for Isle of Wight
Units). |
| 3. Ringwood : | McNab, C. (Head) ; Harvey, D. R. (II). |
| 4. Ferndown : | MacDonald, R. (II). |
| 5. Brighthstone : | Parry, A. A. (Head) ; Butchers, H. J. (II). |
| 6. Combley : | Parry, A. A. (Head). |
| 7. Osborne : | Parry, A. A. (Head). |
| 8. Shalfleet : | Parry, A. A. (Head). |

KEEPERS :

New Forest (North) : Blake, W. G.
 New Forest (South) : Cutler, T. H.

ENGLAND, DEAN FOREST

Whitemead Park,
 Parkend, Nr. Lydney,
 Gos.

Telephone : Whitecroft 305

DEPUTY SURVEYOR : Wylie, N. A., Divisional Officer.
 DEPUTY GAVELLER,

MINES : Tomlinson, A. R.
 DISTRICT OFFICER II : Osmaston, J. F. Parkend
 CHIEF CLERK : Morris, T. W.

FORESTERS :

1. Dean Forest : Walker, A. E. (Head).
 - North : Lees, G. (I).
 - North, Lea Bailey : Roberts, G. E. J. (Foreman).
 - South : Lewis, A. E. (II).
 - East : Marston, W. H. (II).
 - West : Daniels, P. R. (II).
 - Centre : Lee, J. J. (II).
 - School : Davies, C. H. (II).
 - Cockshoot : Lloyd, F. O. (II).
 - Blakeney Hill : Allinson, G. (II).
 - Highmeadow : Watson, F. (I) ; Davies, D. J. (I).
 - Serridge : Phelps, S. E. (I).
 - Nagshead Nursery : Parry, H. M. (II).
2. Tidenham Chase : Jones, H. (Foreman).

DIRECTORATE FOR SCOTLAND

OFFICE OF DIRECTOR 25 DRUMSHEUGH GARDENS, EDINBURGH
 Telephone : Edinburgh 33561
Director : SIR HENRY BERESFORD-PEIRSE, Bt.
Conservators : MACKIE WHYTE, J.P. (Estate)
 NEWTON, L. A. (Private Wood-
 land and
 Acquisitions)
 WATT, A. (State Forests)
District Officer Grade I : FORREST, G. (Acquisitions)
District Officers Grade II : CASSELS, K. A. H. (Acquisitions)
 FEAVER, B. R. (Acquisitions)
 ROBERTSON, I. O. (Nurseries)
Conservancy Engineer : CRANE, W. A.
Mechanical Engineer : BLANE, J. W.
Assistant Engineers
 (Mech.) : JOHNSTONE, G. M. Blair Atholl
 (Civil) : PHILLIPS, W. M. Edinburgh
Chief Executive Officer : HANDFORD, F. C., M.B.E.
Senior Executive Officer : CHILDS, G.
Higher Executive Officers : BROOKS, MISS A.
 EADIE, T. L.
 JONES, N. R.
 KINNAIRD, B.
Senior Temporary Assistant : FERENS, J. R.

SCOTLAND, NORTH CONSERVANCY

60 Church Street,
 Inverness
 Telephone : Inverness 223

CONSERVATOR : Fraser, J., O.B.E.
 DISTRICT OFFICERS I : Crawford, A. R. Inverness
 (Private Woodlands)
 Fraser, A. M. Inverness
 Dickson, J. A. Munloch
 (State Forests)
 Drummond, R. O. Fort Augustus
 Gascoigne, C. A. H. Inverness (Estate)
 Richards, E. G. Inverness
 DISTRICT OFFICERS II : Innes, R. A. Dingwall
 MacLean, Jas. D. Fort William
 MacNab, J. D. Dornoch
 CONSERVANCY
 ENGINEER : Mullowney, V. L. Inverness
 ASSISTANT ENGINEER
 (Civil) : McMahon, C. D. Inverness
 HIGHER EXECUTIVE
 OFFICER : Nicholson, M.

FORESTERS :

1. Borgie : Phipps, N. (II).
2. Inchnacardoch : Macdonald, D. (Head) ; Smith, D. R. (II).
3. Portclair : Lambie, H. (II).
4. South Laggan : Murray, R. (I).
5. Achnashellach : Mackenzie, A. (II).

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|---------------------------------------|--|
| 6. Ratagan : | Mackay, A. (I) (also at Glen Shiel). |
| 7. Slattadale : | Mackenzie, A. (II). |
| 8. Glen Righ : | Murray, A. R. (I). |
| 9. Glen Hurich : | MacClymont, W. (I). |
| 10. Glen Urquhart : | Munro, G. (I). |
| 11. Culloden : | Mackay, W. (I). |
| 12. Nevis : | Mackie, A. (I). |
| 13. The Queen's Forest : | Fraser, J. (II) ; Robertson, D. D. C. (II). |
| 14. Creag nan Eun : | Fell, J. B. (II). |
| 15. Craig Phadrig : | Murray, D. (II). |
| 16. Glen Shiel : | Mackay, A. (I) (also at Ratagan). |
| 17. North Strome : | MacLeman, A. (II) ; Mackay, J. (II) (also at South Strome). |
| 18. Salen : | Mackay, J. A. (II). |
| 19. South Strome : | MacLeman, A. (II) ; Mackay, J. (II) (also at North Strome). |
| 20. Findon : | Gordon, J. (I). |
| 21. Glengarry : | Grant, J. D. (II). |
| 22. Kessock : | Ross, D. M. (Foreman) |
| 23. Eilanreach : | MacPherson, E. (II). |
| 24. Dornoch : | Gunn, J. (I). |
| 25. Inverinate : | Mackintosh, C. O. (II). |
| 26. Balblair (including Carbisdale) : | Sutherland, R. A. R. (II). |
| 27. Clunes : | Officer, A. W. (I). |
| 28. Lael : | Macrae, D. J. (I). |
| 29. Fiunary : | Drysdale, A. (I) ; Nicolson, W. J. (II). |
| 30. Glen Loy : | Grant, A. (I). |
| 31. Glen Brittle (including Raasay) : | Macdonald, C. (I). |
| 32. Longart : | Brown, R. S. (Foreman). |
| 33. Leanachan : | Campbell, R. W. (I). |
| 34. Guisachan : | Macintosh, W. (I). |
| 35. Ardross : | Mackay, K. (I). |
| 36. Inshriach : | Thom, A. B. (II). |
| 37. Millbuie : | Murray, W. (Head) ; Stewart, A. C. (II) ; Mackenzie, A. S. (II). |
| 38. Assich : | Macleod, D. M. (II). |
| 39. Morangie : | Small, G. (II). |
| 40. Kilcoy : | Frater, J. R. A. (II). |
| 41. Strath Nairn : | Fraser, W. A. (II). |
| 42. Ferness : | Stobie, F. D. (II). |
| 43. Strath Conon : | Mackenzie, J. (I). |
| 44. Strath Dearn : | Sutherland, D. R. (Foreman). |
| 45. Farigaig : | Macrae, M. (II). |
| 46. Urray : | Morrison, W. W. (Foreman). |
| 47. Bataan : | Dyce, W. J. B. (Foreman). |
| 48. Rumster : | Morris, H. D. (Foreman). |
| 49. Laiken : | Black, D. F. D. (Foreman). |
| 50. Clach Liath : | McAllan, F. M. (Foreman). |
| 51. Shin : | Maclean, A. R. (Foreman). |
| <i>Private Woodlands :</i> | Macleod, D. (Head). Stationed at Munlochty. |

SCOTLAND, EAST CONSERVANCY

6 Queen's Gate,
Aberdeen
Telephone : Aberdeen 33361

CONSERVATOR :	Oliver, F. W. A.	
DIVISIONAL OFFICERS :	Bird, D. H.	Aberdeen (Private Woodlands)
	Bennett, A. P.	Aberdeen (Estate).
	Woolridge, T. H.	Aberdeen (State Forests).
DISTRICT OFFICERS I :	Stewart, I. J.	Aberdeen (Private Woodlands)
	Gillespie, I.	Aberdeen (Acquisitions)
	Maxwell, H. A.	Laurencekirk
DISTRICT OFFICERS II :	French, W. F.	Bridgeton
	Grant, G.	Aberdeen (Estate)
	Horne, R. J. G.	Kinellar
	Kennedy, J. A. M.	Forres
	Murray, G. K.	Aberlour (Estate)
	Rennie, J.	Crieff (Estate)
	Shaw, R.	Dunkeld
	Watt, I. S.	Kinfauns
	Fergusson, J. L. F.	Perth

CONSERVANCY

ENGINEER :	Blenkinsop, R. I. C.	Aberdeen
HIGHER EXECUTIVE OFFICER :	Lenman, J. P.	

FORESTERS :

1. Monaughty :	Watt, D. M. (I).
2. Kirkhill :	Gilbert, Geo. (I) ; Crawford, D. B. (II).
3. Montreathmont :	McConnell, J. (I).
4. Culbin :	Milne, W. G. (Head) ; Linder, R. (II).
5. Edensmuir :	Scott, J. (I).
6. Tentsmuir :	McDonald, W. (I).
7. Drummond Hill :	Ross, W. L. (Head) ; Maxtone, J. R. (II).
8. Teindland :	Reid, J. G. M. (II).
9. The Bin :	Urquhart, D. J. (I).
10. Speymouth :	Robbie, J. D. (Head) ; Clark, J. F. (II).
11. Blairadam :	Ritchie, M. A. (I) (also at Glen Devon).
12. Drumtochty :	Hendry, J. B. (I).
13. Kemnay :	Allan, J. (I).
14. Midmar :	Innes, G. C. (II).
15. Deer :	Thow, J. B. (II).
16. Scootmore :	Murray G. J. A. M. (I) ; Seaton, J. A. (II).
17. Clashindarroch :	Kennedy, J. M. (Head).
18. Roseisle :	Mason, W. (I).
19. Blackcraig :	Reid, J. (I).
20. Carden :	Mitchell, F. M. (II).
21. Inglismaldie :	Mackay, W. (I).
22. Durris :	Paterson, S. H. A. (Head).
23. Newton :	Lamb, J. A. (Head) ; Coull, G. (II).
24. Newtyle :	Douglas, W. S. (II).
25. Alltcailleach :	Munro, A. A. (I) ; Reid, J. K. (II).

26. Kinfauns :	Russell, J. C. (I).
27. Whitehaugh :	Duguid, C. (II).
28. Craig Vinean :	Reid, R. (Foreman).
29. Glen Devon :	Ritchie, M. A. (I) (also at Blairadam).
30. Lossie :	Scaife, C. (II).
31. Keillour :	Marnoch, D. M. (II).
32. Tilliefoure :	Anderson, F. (I).
33. Blackhall :	Pacey, R. H. (II).
34. Rosarie :	Pennet, H. (I).
35. Pitfichie :	McDowall, C. (I).
36. Fetteresso :	Anderson, D. (II).
37. Strathord :	Anderson, J. A. (II).
38. Allean :	Corbett, J. (Head).
39. Auchernach :	McMaster, A. J. (II).
40. Gartly Moor :	Watt, W. J. (II).
41. Dallas :	Stewart, E. A. (II).
42. Countesswells :	Cassie, A. (II).
43. Pitmedden :	Allison, R. A. (II).
44. Rannoch :	Whayman, A. (II) ; Whyte, C. M. (II).
45. Tomintoul :	McRae, J. (II).
46. Hallyburton :	Hepburn, N. R. (II).
47. Glenisla :	Grigor, E. (II).
48. Corrennie :	Biggar, A. W. (Foreman).

HEAD KEEPER :

Clashindarroch : MacDonald, S.

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- | | |
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| 7. Greskine : | Hunter, J. (I) (also at Auchenroddan). |
| 8. Auchenroddan : | Hunter, J. (I) (also at Greskine). |
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| 22. Shielswood : | (New Unit). |
| 23. Mabie : | Graham, A. (Head). |
| 24. Wauchope : | McNicol, F. (II). |
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| 30. Craigieburn : | Jamieson, R. A. (II). |
| 31. Leithope : | (New Unit). |
| 32. Dalmacallan : | (New Unit). |
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| 34. Kilgrammie : | (New Unit). |
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| Laurieston : | Cameron, D. M. (I). |

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21. Minard :	Kennedy, J. (Head).	
22. Saddell :	Hamilton, J. (II).	
23. Kilmichael :		
South :	MacRae, D. J. (II).	
North :	Ross, I. (II).	
24. Corlarach :	Morrison, N. (II).	
25. Glendaruel :	Stout, H. C. (II).	
26. Strathlachlan :	MacKenzie, I. H. M. (I).	
27. Torrie :	Cameron, A. (Head) (also at Strathyre).	
Loch Katrine Woods :	Angus, R. S. (II).	
Private Woodlands :	Ross, A. (I).	

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Hughes, L. E. (II) ; Morris, O. I. (II) ;
Thomas, T. W. (II) ; Powell, T. W. (II).
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- Kerry : Hughes, A. (I).
- Beddgelert : Evans, J. E. (I).
- Cynwyd : Roberts, R. H. (II).

7. Dovey :
 Valley : Fraser, R. (Head) ; Bell, H. C. (II) ; Evans, A. C. W. (II).
 Corris : Griffiths, I. L. (II) ; Lloyd, I. (II) ; Williams, R. J. (II).
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8. Radnor : Yapp, P. W. C. (I).
9. Cwmeinion : Williams, W. G. (II) (also at Dovey Bryn cynffil).
10. Mathrafal : Reese, W. H. (I).
11. Tarenig : Hughes, J. W. (II) (also at Bryn Mawr).
12. Bryn Mawr : Hughes, J. W. (II) (also at Tarenig).
13. Myherin : Jones, E. T. (Head) ; Price, G. (II) ; Griffiths, E. (II).
14. Clocaenog : Davies, A. I. (I) ; Pryce, E. E. (II) ; Roberts, T. (II).
15. Dyfnant : Waters, R. W. (I).
16. Hafren : Jones, J. T. (I) ; Jones, Morris (II) ; Pierce, G. J. (II).
17. Coed Sarnau : Jones, W. E. (I).
18. Newborough : Griffiths, R. W. (II).
19. Aberhirnant : Jones, O. (II).
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22. Coed y Goror : James, J. E. (II).
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- Dovey Woodlands, Ltd. : Jenkins, W. T. (I).

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 - I : Little, T. E. (I).
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17. Coed-y-Rhaiadr : Rudge, G. I. (II).
18. Cwmogwr : Brown, E. (II) ; Norman, A. S. (II).
19. Giedd : Morgan, W. E. (Foreman).
20. Michaelston : Lloyd, J. E. W. (II).
21. Tair Onen : McNulty, M. E. (I) ; Slatter, F. (II).
22. Usk : Butter, L. (II).
23. Monmouth : Bowen, J. F. (II).
24. Wentwood : Browne, T. N. (I).
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Form T.Y.3.

THINNING SHEET

Conservancy : *New*

Forest : *New, Wilverley Inclosure*

Compt. No. : 21

Species : *Corsican pine*

P.Yr. 1921

Size of plot : 1/20 ac.

Plot No. : 1

PRODUCE FROM FELLED TREES

Q.G. b.ht. ins.	Length to tip feet	TIMBER over 9 in. diameter			PITWOOD 3 in. to 9 in. diameter			PULPWOOD 1 1/2 in. to 3 in. diameter			FIREWOOD			Remarks
		L. ft.	Mid. Q.G. o.b.	Vol. cu. ft. and ins.*	L. ft.	Mid. Q.G. o.b.	Vol. cu. ft. and ins.*	L. ft.	Mid. Q.G. o.b.	Vol. cu. ft. and ins.*	L. ft.	Mid. Q.G. o.b.	Vol. cu. ft. and ins.*	
2 1/2	29		3	5	8	2 1/2							No volume	
4 1/2	35		20	2.3			6	1 1/2	.1				No volume	
1 1/2	18						17	2	.6				No volume	
1 1/2	17						10	1 1/2	.2				No volume	
1 1/2	22						19	1 1/2	.6				Scots pine	
2 1/2	27						17	2 1/2	.4					
1 1/2	21						8	2 1/2	.3					
1 1/2	23						19	2 1/2	.6					
2 1/2	28						15	2 1/2	.3					
5	37		24	3.0			23	2 1/2	.6					
2 1/2	30						15	2 1/2	.10					
5	37						23	2 1/2	.10					
2 1/2	33						12	2 1/2	.5					
3 1/2	31						8	2 1/2	.3					
3 1/2	32						2	2 1/2	.5					
4	39						2	2 1/2	.7					
2 1/2	30						9	2 1/2	.4					
3	35						17	2 1/2	.7					
3 1/2	30													
3 1/2	36													
Totals	619			15.4										
Trees	21													

NOTES :—(i) Produce to be classed as Timber, only if there is a minimum length of 10 ft. of 9 in. top diameter over bark or more.
 (ii) Pitwood includes all reasonably straight lengths below timber size, measured down to 3 in. diameter over bark.
 (iii) Pulpwood runs from 3 in. to 1 1/2 in. top diameter over bark (Minimum length with mid Q.G. of 1 1/2 in. to be 6 ft.)
 (iv) Firewood is any wood that owing to bad shape is unsuitable for other use. (Minimum diameter 1 1/2 in.)
 * Hoppus measure.

Average length of thinnings to tip : 30 ft.

Total volume of thinnings : 22 cu. ft., one inch Hoppus measure (over bark)

Initials : *G.D.R.*

Rank : *Divisional Officer*

Date : *30th December, 1947*

Form T.Y.4.

SUMMARY RECORD OF THINNING YIELDS—PER ACRE

Conservancy : *New* Forest : *New, Wilverley Inclosure* Compt. No : 21
 Species : *Corsican pine* Planting Year : 1921
 Aged 27 years at Date of Measurement, 30th *December*, 1947
 Serial Number of thinning (1st, 2nd, 3rd, etc.) : *3rd or 4th*
 (Volumes to be given to the nearest 0 or 5 cubic feet)

STANDING CROP

Plot No.	BEFORE THINNING			AFTER THINNING	
	No. of Trees per Acre	Av. Q.G. at b.h. ins.	Upper Ht. ft.	No. of Trees per Acre	Av. Q.G. at b.h. ins.
1	1,080	4	38	660	5½
2					
3					
4					
5					
6					
Total	1,080	4	38	660	5½
Av.	1,080	4	38	660	5½

THINNINGS

Plot No.	No. of Trees per Acre	Av. tot. ht. ft.	Volume in cu. ft. Q.G. over bark per acre				
			Timber	Pitwood	Pulpwood	Firewood	Total
1	420	30	—	305	135	—	440
2							
3							
4							
5							
6							
Total	420	30	—	305	135	—	440
Av.	420	30	—	305	135	—	440

Initials : *G.D.R.*Rank : *Divisional Officer*Date : *30th December, 1947*