JOURNAL

OF THE

FORESTRY COMMISSION.

No. 13: MARCH, 1934.

CONTENTS.

JOURNAL

OF THE

FORESTRY COMMISSION.

No. 13: MARCH, 1934.

EDITORIAL.

Commission Staff Changes.

IN September last Dr. H. M. Steven was transferred from Division 5 to the North Eastern Division, Scotland, and Mr. E. Wynne Jones was given charge of the former Division with local headquarters at Cambridge. Mr. R. G. Forbes was posted to the New Forest as Higher Grade District Officer and Mr. A. H. H. Ross left Yorkshire to become District Officer (Acquisitions) attached to the Assistant Commissioner's office at Whitehall, Mr. R. E. Fossey was transferred from the Research Branch to occupy the vacancy thus made. Of newcomers we have to record the appointment of Mr. F. Cownie, District Officer (Division 5), and Mr. J. R. Thom, probationary District Officer (New Forest).

Larch Poles for Transmission Lines.

For some time past it has been maintained by the Forestry Commissioners that home-grown larch is suitable for use in transmission lines but it was only at the end of last year that a specification was secured allowing of the employment of this species for the purpose. There are certain unfavourable characteristics in larch which have caused difficulty but the drawbacks have now been overcome and the specification has been officially issued. One of the difficulties encountered is the twisting due to spiral grain, which is a common feature in larch and is particularly troublesome in the case of transmission poles when it occurs near the top where the cross bars are fixed. Another adverse character is the tendency for seasoning checks to become localized, thereby making the pole unsafe for climbing with spurred climbing irons. It is now considered possible to control the checking by suitable treatment and the spiral twisting is rendered of little account if the points of attachment of the conductor are close to the pole.

Copies of the specification issued by the British Standards Institution may be referred to at all Divisional Offices. Tables of dimensions of the poles and instructions regarding approved methods of creosoting are included in the specification.

The enquiry conducted by this Committee, although intended primarily for the benefit of private woodland owners, is also of interest to the Forestry Commission staff.

Home-Grown Timber Committee's Report, 1933.

Great Britain must continue to depend upon foreign countries for the great bulk of its timber but doubtless more might be made of our existing small supplies with good effect upon prices for the raw material and with gratifying results as regards employment. It is difficult to make up for the neglect and mismanagement which have been the lot of most of our woodlands in the past, but the opinion is expressed in the interim report of the Committee that improvement in marketing the produce could be brought about by the introduction of method and by disseminating information through a central body which would endeavour to bring buyers and sellers together more effectively than at present.

In consequence of the Committee's recommendations, fresh efforts are to be made to find better outlets for small and inferior timber, this being the most urgent need on most estates. As a beginning in this direction selected trades are to be investigated—exhaustive enquiries have already been made as regards the manufacture of wooden boxes and at the same time the precise requirements of the coalfields are being studied further.

Among other matters calling for action, attention is drawn to the shady practice of using for box-making, wood imported as mining timber, thus evading, to the disadvantage of British manufacturers, payment of the 10 per cent. duty imposed on this material.

The Committee seek to assist woodland owners by the formation of local committees and suggest that, if coöperation between vendors can be effected, the marketing of home-grown timber will become easier and more profitable. An impressive list is given showing the number of public and private organisations and trade associations consulted by the Committee. The report, which is issued as a Forestry Commission publication, is available to all, and should be read.

Presentation to Mr. John Sutherland.

The presentation of his portrait was made to Mr. John Sutherland, C.B.E., LL.D., on 23rd November in the New Gallery, Edinburgh. There was a large gathering at the ceremony and Mr. John Cameron, who presided, said that the staff of the Forestry Commission in Scotland desired to give expression in some tangible form to the feelings of admiration, respect and affection with which they all regarded Mr. Sutherland and to convey to him a sense of their gratitude for his guidance and unfailing courtesy. Sir John Stirling-Maxwell made the presentation and Sir Roy Robinson, Colonel Steuart-Fothringham and Major Strang Steel took part in the proceedings. The portrait is by Mr. David Alison, R.S.A., and a second portrait by the same artist was formally accepted by Mr. T. W. Cleland on behalf of the staff and now hangs in the board room at Drumsheugh Gardens.

Divisions 2 and 5 and Scotland N.E. will be the special contributors to the next issue of the Journal. The Editing Committee will however gladly receive notes and articles from members of the staff in other Divisions. Contributors are reminded that there is no close time for the submission of material; notes of all sorts should be sent in just when ready, the collecting of them should be a continuous process and no information likely to prove interesting or helpful should be withheld.

Contributors to the Journal.

It would be invidious to single out for special mention any individual papers appearing in the present number. Attention may, however, be drawn to the group of articles on forest fires.

MEETING OF DISTRICT OFFICERS (ENGLAND AND WALES).

London, October 11th, 1933.

Opening Remarks by the Chairman of the Commission.

This is the first occasion on which all the English and Welsh District Officers have met together and I trust that you will all take the opportunity of getting to know each other and of discussing or providing for the discussion of common problems.

I want to put before you, as clearly and briefly as I can, a few fundamental issues in the work of the Commission and in particular of the place of District Officers in the scheme of things. Let me first offer the general and obvious remark that we are all engaged jointly on an enterprise which depends for its success on whole-hearted team work. It is not the function of Headquarters—Commission, A.C., or D.O.—to sit back and criticise the work done in the forests, to devise tiresome forms, multiply checks and so on. Timber grows in the forest and the District Officer is in closest touch with the difficulties of getting it to grow successfully. The attitude with which I approach the position and endeavour to impress on all officers is one of sympathy and a desire to help. Criticism comes later and is the due reward of the District Officer who does not faithfully do his part.

Now what are the bases for successful work ? We are dependent on two things. First the plantations and silvicultural work of former generations and secondly our own experience since the formation of the Commission. The former is the only basis for estimating the production and behaviour of species in closed canopy. Do we always take the trouble to assimilate and apply the lessons to be learned from other people's plantations ? The latter basis—our own experience over the 14 years' experience of the Commission—covers a very wide range of conditions. We have had our successes and our failures. The proportion of failures has steadily decreased so that the percentage of successful plantations has steadily increased in recent years. It would, indeed, be lamentable if, with increasing experience, such were not the case. Nevertheless, there is still considerable room for improvement. I want, therefore, to devote one moment to the broad reasons why failures are incurred. New problems are constantly arising and a method of approach which helps us to avoid old errors may likewise help us to overcome the new.

Initially important mistakes were made because operations were carried out on a large scale under conditions of which those in charge had no working experience. Thus types of land were planted which we should now class as unplantable or plantable only after adequate preparation. The faulty selection of species and the use of unsuitable planting stock come partly under this head and partly under the next head, which is inadequate preparation of plans of operation. Work has been rushed in an effort to maintain the planting programme ; almost invariably this has led to waste and disappointment.

The excuses that may have existed in the past in these directions no longer hold good. It has been definitely laid down that unplantable or doubtful land is not to be planted, that plants are not to be planted merely for the sake of using them up, and finally that correct silviculture is not to be sacrificed to the achievement of an over-riding planting programme.

There has often been a lack of appreciation of the fact that in planting we are dealing with living material. Good work and thriving plantations have been sacrificed to the costing system. There has been and may still be a good deal of misapprehension about costing. What should be an instrument in securing efficient work is sometimes exalted into the position of the ultimate object of the work. Let me, therefore, emphasize the point; costing is in fact merely the instrument towards efficient supervision; intelligently wielded it is a most useful tool; in the hands of the ignorant it may become a positive danger. The correct procedure is first to determine the methods which will give successful results and then, by means of the costing system, to reduce the costs of those methods to the lowest possible figures. Cheapness in itself or the cheapening of inadequate methods is folly and has to be paid for as such.

The next errors arise in the processes of "establishing" the newly planted areas, *i.e.*, in connection with weeding and beating up. Let us look at this question for a moment, not too technically but with the eye of ordinary common sense. A good plant well treated and well planted (not necessarily expensively) if looked after for two years is obviously well on the way towards taking care of itself. Negligently handled it starts off as a weakling or dies. Beating-up and prolonged weeding follow and the total cost of establishment becomes inordinate. You can all recall examples from your own experience. Are we not too prone to accept beating-up as belonging to the natural order of things instead of the exception which is what it should be?

There have undoubtedly been important losses due to inefficient work, failure to deal in good time with bracken, to cut back coppice, and so on. Beating-up deserves more time than I can spare. There has been unintelligent work, due I think to failure to envisage the development of the original trees, and consequently the fate of the beat-up plants. In this connection I would ask you to re-read carefully the Memo of the 9th November, 1931, circulated to all officers.

I don't want you to run away with the impression that the remarks which I have just made are directed exclusively to District Officers. We all have to bear our share of praise and blame.

I proceed now to state what, in my opinion, should be the District Officer's attitude towards the forests and work committed to his charge. In the first place he ought to feel that the forests are his forests. Good work and good growth should bring pleasure and satisfaction; the reverse should not be lightly tolerated. In the second place he must know his plantations. It is not enough to walk along the rides, but he must systematically inspect the interiors of compartments and satisfy himself that there is no neglect. You may be inclined to say that it is impossible to know 10,000 acres intimately, but I can assure you from personal experience that it really can be done, provided the inspections are systematically made and brief notes are taken at once. The man who is keen on his plantations and knows them is the man who will not tolerate trespass or damage by rabbits.

Then as regards current work it is not enough to issue orders to the forester that such and such operations are to be done. It is necessary to be sure that the forester clearly understands what is required, and, further (and this is most important), to inspect samples of the work while it is actually in progress. If the forester or foreman does not really know how to carry on a specific operation he must be instructed. If on his part the District Officer does not really know he should take the initiative in seeking instruction from those who do know. Only in these ways can errors be corrected before it is too late. Our young and inexperienced District Officers should remember that many of our foresters are experienced men and that only good can result by straightforward discussions of problems and collaboration with them.

And finally, here is a list of things which, if I were a District Officer, I would not accept without representation of the facts to my superior officer :—

(1) The planting of ground which I considered unplantable or with which I really did not know how to deal.
(2) The use of unsuitable plants whether from my own nurseries or from outside my district.
(3) Damage from game.
(4) Delayed, inadequate weeding or over-weeding.
(5) Delayed or promiscuous beating-up.
And to these we shall soon have to add
(6) Delayed thinning.

I want it to be clearly understood, however, that what I have just said provides no licence for reckless or ill-considered expenditure, nor an excuse for failure to carry out a programme of work once it has been approved. My final observation is this: that if, owing to lack of experience of the particular problem, you are uncertain how to proceed, do not hesitate to ask. It will not be counted against a District Officer that he pleads ignorance before the event.

FOREST FIRES IN 1933.

The following articles are a selection from a large number submitted in response to a request for notes on experiences in fire-fighting during 1933. They have been chosen to represent the widest possible range of conditions and to cover the more important fires. Experience has once more confirmed (*a*) the importance of getting even a few men *quickly* on the spot and (*b*) the futility of expecting any ordinary fire-line to serve as an automatic stop.

The past exceptional year has provided the first experience of extensive crown-fires in the Commission's plantations. Effective frontal attack on such fires seems quite impracticable with existing equipment except by counter-firing; flank attack is difficult and may even prove dangerous except upon the rides or in brashed plantations. Extensive brashing throughout young stands has consequently been advocated; the cost of this would be very heavy and might quite possibly bear no favourable relation to the actual saving secured.

In view of the suggestion to use controlled burning operations for the training of staff, it should perhaps be pointed out that this is already prescribed. The difficulties mentioned by certain contributors in organizing the refilling of water packs have apparently been met in other areas by the issue of canvas buckets; water is thus brought to the pack instead of taking the pack to the water.

O. J. S.

(i) Division 5.

The prolonged periods of anxiety and the actual experiences of fire-fighting during the summer of 1933 are not likely to be forgotten readily, but it is of importance to record the lessons which have been learned, and on them to base plans for the future, before perhaps another sequence of wet summers induces a temporary feeling of false security.

There are two general matters which should be emphasized before the question of fire protection is considered in detail. First, that the number of heath and forest fires, in a dry summer, due to the carelessness of the general public and to steam road transport is definitely greater than when the Commission commenced operations, and there is no evidence that the peak has yet been reached. This change is of course due to the enormous increase since the War in the amount of road transport, both private and commercial, and also, but to a lesser degree, to the numbers of irresponsible hikers who are penetrating previously quiet localities. Second, that every year now adds greatly to the number of our plantations which are reaching that most vulnerable period both as regards actual damage to the crop by fire and as regards difficulty of extinguishing, namely the thicket stage. In this direction the danger peak has certainly not yet been reached.

Any protective system based primarily on ploughed, screefed, or burned fire traces must meet certain definite theoretical requirements which may be summarized as follows :—

(*a*) It should enable us to stop fires from spreading to our plantations from the interior of adjoining properties and *vice versa.*
(*b*) It should render possible the prevention of the spread of roadside and railway fires into the main body of the plantations.
(*c*) It should provide internal sub-divisions in large blocks.
(*d*) It must offer suitable attacking points either for beating out a fire or for counter-firing.

While these are the main theoretic requirements it must be stressed that no system of fire protection can ever of itself be automatic and that it must always be considered in relation to the available labour supply.

The following is the general scheme which has already been introduced on a small scale and is to be extended in Thetford Chase. It is intended primarily for large vulnerable blocks (one of which is over 5,500 acres and four of which are between 4,000 and 2,000 acres, in each case without any intervening road or effective natural protective break) in which a conflagration would be a calamity, but it can easily be modified or reduced in application to small blocks where a high expenditure on protection cannot be justified. The object is to have two artificial lines of defence meantime, and eventually a hardwood belt in addition. A belt of mixed hardwoods with conifer nurses is planted two chains wide immediately inside the roadside fence or other danger point. Behind this a strip 60 ft. wide is left unplanted, in the centre of which about 20 ft. is ploughed wherever possible, or burned. Beyond this come the ordinary plantations, and the first compartment is laid out with its long side parallel to the danger point, and not more than about three hundred yards in depth. Then comes another 60 ft. ride with about 20 ft. ploughed in the middle. It is of course hoped that most fires can be stopped at the first ploughed line, as in the maximum distance of two chains which the fire has to travel before reaching an artificial obstruction it should not have had time to assume very large dimensions. Where the danger point is an adjoining property, the first ploughed line can be immediately inside the fence if the fire which may approach is going to be a ground fire, but where the danger is from steam waggons or railway engines the minimum distance to make sure of catching sparks should be at least two chains. As regards the distance which the second line should be from the first, this depends a good deal on local conditions and topography. On the one hand it should not be so far away that any very great amount of damage will be caused before a fire which has crossed the first line reaches it, but on the other hand it is even more important that it should be sufficiently far back to give time for men to be concentrated on it well before the fire arrives.

There will probably be some divergence of opinion as to the width of the ploughed or burned lines which have been suggested. There are two very material factors to consider; (*a*) the potential labour supply available within a short time of an outbreak to be used in conjunction with the lines, and (*b*) the age of the plantations. It is obvious that the smaller the number of men that can be counted on the wider must be the clearing. No economic fire ride can be relied upon as an automatic stop by itself, but the wider the ploughing or fire trace the more automatic would it become, and the smaller the number of men by whom it could be defended successfully. One ride at Thetford is actually ploughed to a width of one chain, and this has been done at a point where there is very material danger of fire, but which is so situated that it would take a very long time to get more than one or two men on the spot in the event of an actual outbreak.

As regards the age of the plantation in relation to the width of the line; in a young conifer plantation up to the time that the side branches begin to overlap it should normally be possible to attack a fire at any point irrespective of the rides and under such conditions it can be definitely held up by men lining even a very narrow ploughed line. It may thus be possible to save some money on protection in early years so as to have more available when the danger of serious damage becomes more acute. In places where rides become quickly covered with masses of inflammable vegetation, it might even pay to start with quite narrow rides and cut out so many rows of trees on either side of the ride to widen it to the required width only in the year before it would become impossible to beat out a fire actually among the trees; that is to say before there was any possibility of anything in the nature of a crown fire. Conditions change materially when the side branches begin really to close up, and these conditions persist all through the thicket stage and probably until after the second thinning. During that rather lengthy period it is physically impossible in most cases to attempt to make a frontal attack on a fire actually inside the compartment, and even a containing flank attack is not only difficult but often dangerous inside the compartment. It is under these circumstances that the condition and width of the rides become the most important factors.

The oldest of the Commission's own plantations in which the writer has had actual experience of a fire was P. 24 S.P. during the summer of 1933, *i.e.*, ten years' growth, and in spite of a strong breeze a fire was completely stopped on a frontage of over 900 yards by counter-firing from a 50 ft. ride with a 24 ft. ploughed strip in the centre. Whether there was a big margin of safety or not it is really impossible to say (it certainly did not seem at the time as if there was any) but as no ignition took place over the ploughed strip, the fire must have in fact been stopped by a break of not over 37 ft. It would be interesting if one could tell exactly how far the counter-firing contributed to this result. The writer is of opinion that it made all the difference in the world, though it is of importance to mention that, burning against the wind, the counter-fire held mainly to the ground, and when it met the main fire the latter was not stopped but continued right to the edge of the ride in the crowns of the trees from underneath which the ground vegetation had already been burned. This is mentioned to show that in some circumstances a counter-fire cannot be looked on in itself as a certain stop, and emphasizes the necessity of the presence of an adequate labour force.

As the plantations grow up, however, it is probable that rides of the width which have been mentioned will be inadequate, and that at least the main fire rides will have to be widened by successive removals of a row of trees on each side. Much of the danger during the thicket stage in a coniferous wood is due to the drawing up of undergrowth such as bracken, brambles, broom and gorse, and to the accumulation of dry needles which are hung up on these and on the lower branches of the trees. Experiments have been undertaken in plantations of P. 20, P. 21 and P. 22 to see whether anything can be done to lessen this danger without prohibitive cost, by some form of brashing and pruning. If a fire is coming out of a thicket such as has just been described, one of the greatest difficulties of dealing with it is getting near enough to beat with any effect, and if it does jump the ride it is almost impossible to get at the new fire also in a thicket. Although the experiments with a view to lessening this danger are not yet far enough advanced to have given any definite results it may be well to mention their nature, which is as follows :—

Pruning all dead branches from,

(*a*) the outside row of trees ;
(*b*) the inside of the outside row and the whole of the second row ;
(*c*) the first three rows complete ;
(*d*) the inside of the first row and the whole of the next five rows ;
(*e*) the first six rows complete.

As far as can be seen at present (*a*), (*b*) and (*c*) will not do sufficient good to be worth while, but (*d*) appears to be the most satisfactory. It gives over 20 ft. from the edge of the ride into which men could enter safely to beat, and if this were to be done on each side of the ride, live sparks coming down within 20 ft. inside the edge of the compartment which it was hoped to save, could be got at without danger. The idea of leaving the ride side green branches of the outside row untouched is to shut out side light from the pruned strip and so prevent an excessive growth of vegetation.

It has been noticed that when a ground-cum-crown fire in a pine thicket reaches a spot where the stocking of trees is poor it very quickly becomes a ground fire pure and simple and only gets into the crowns again when it passes on to better stocking. This change appears to be solely due to the break in the canopy, and advantage is going to be taken of this in a further experiment in the pruned strips referred to, in the form of a premature and light thinning, sufficient to make a distinct difference in the canopy and yet not heavy enough to induce a heavy growth of vegetation. It is probable that expense would preclude the general application of work such as has just been described, but if the experiments appear successful it is intended at least to apply them to some of the main rides in large blocks.

The question of internal subdivisions in a big solid block of woodland is of considerable importance, but it is one which is bound to vary very much according to local topographical conditions, the real risk of fire, and the value of the property to be protected. (In the Thetford Fire Plan it is laid down that no area of over about 500 acres should be without subdivision by an artificial fire line.) Generally speaking it may be said that the clearer the ordinary compartment rides are from heavy inflammable vegetation the less is the need for internal fire lines, certainly for the first five or six years after planting. In a number of areas it has been customary to leave standing any existing rows of trees which had been planted by a previous proprietor to give field shelter, and often such rows or hedges come on our rides. Undoubtedly their shelter value is of use to us for some years, but it has been found in practice that once the adjoining plantations reach the thicket stage, any taller trees on the ride are a distinct menace because when a fire gets up into them sparks are thrown forward considerably further than would be the case if they were absent.

The question of what should be done in large blocks which have already been planted several years, and which experience has shown are really not adequately protected now, and will become less so every year, is one which must be regarded as of primary importance, and worthy of the closest study.

As has already been indicated, no system of fire lines should be thought of without relation to the available man power; consideration must therefore be given to the question of patrols. The main objects of patrolling are threefold :—

(*a*) by giving warnings to the general public and by personal vigilance, to reduce the number of outbreaks to a minimum ;
(*b*) to extinguish minor outbreaks where possible ;
(*c*) to give an immediate alarm according to a pre-arranged plan whenever an outbreak occurs in or near the forest.

The decision as to the number of patrolmen required and when they are to be on duty can only be taken after careful consideration of the actual local circumstances. As the plantations grow up regular revision of the patrol sectors is essential, and such revision can only be satisfactory when done on the ground and not from the map. In flat country, at any rate, the number of patrols required is bound to increase when wide views across the tops of the trees can no longer be had, unless, of course, the range of vision of the patrols can be artificially increased. In some areas (P. 20 to P. 23) it has already been found necessary to erect outlook points either in the tops of old trees or built from the ground. These towers can be quite inexpensive and are of undoubted value, but not being manned permanently nor connected by telephone, they are only a half measure in an attempt to retain a fair amount of direct observation without increasing the patrols.

For large vulnerable blocks it would appear that the time is fast approaching when the only satisfactory means of observation will be from really large towers properly equipped with maps, range finders, etc., and connected through the Post Office telephones to points where labour and staff for fire fighting are available. Such towers would protect one against one of the greatest defects of the patrol system. There are times when the danger of fire appears to be so remote that the very considerable expense of posting patrols would not be justified. It was during one such period that a very serious fire actually did occur at Thetford. Had there been one man with a telephone in a large regularly manned tower that day, it is an undoubted fact that not only the capital cost of the tower but the observer's wages for several years would have been saved by a prompt general alarm.

A most important point in any fire scheme is the procedure to be adopted when a fire actually breaks out. It may seem a truism to say that one man on the spot when a fire breaks out, or several men arriving within a few minutes of the outbreak, can save more than a hundred men later; but our organization should aim at so impressing this truism on all our workers and tenants that it becomes second nature to them, when they see smoke, to proceed immediately to investigate. It is only by this means that the actual damage done by fire can be kept to a minimum. Unfortunately, however, one must admit that fires have occurred, and will occur again, where the outbreak is out of control before even the nearest man can arrive on the scene. It is this fact that makes the advance organization of a large labour force so essential for efficient fire fighting. It is far better to have an organization which turns out say 100 men to a fire which is actually under control before all of them arrive, than to struggle to do one's immediate best with a few men while arranging for more, with the knowledge of what is bound to be devastated before they arrive. In a large city, when a fire occurs in a scheduled danger area a district call is sent out as soon as a fire is reported, on the grounds that at all costs a big blaze must be prevented. It appears reasonable to apply the same reasoning to valuable forest property.

While it should be the natural impulse of all our tenants and workers to proceed immediately to help when they see or hear of a fire it should be the natural impulse of the trained staff to make sure that their efforts on reaching a fire will not be hindered through failure to have arranged for the concentration of the largest possible force in the shortest possible time. Another essential to obtaining the best results in fire fighting is the possession of an intimate knowledge of the topography of one's charge in relation to the layout of whatever protective system has been devised. In a large conflagration the smoke screen becomes so dense and so widespread that only those who have a thorough knowledge of the lie of the land which is temporarily obscured can hope to make the best use of the forces at their disposal.

Methods of actual fire fighting are bound to vary greatly, but there are certain broad principles which must be borne in mind by anyone who has to control the work of extinguishing a fire. The greatest temptation is to rush in and start beating without any very definite plan. Whilst it cannot be too clearly stressed that not a minute must be thrown away, it should be recognized that a definite plan of operations is vitally essential in a large fire if the best possible results are to be obtained. It should only be a matter of seconds for anyone who is really familiar with his area to form a fairly clear picture of what he intends to do, and the main factors to consider are, direction and force of wind, position of nearest cleared lines, relative danger from extension of the fire in different directions, and last, but not least, if there is a shortage of labour, what are the most vital points to attack pending the arrival of reinforcements.

Except in the case of a small fire the whole perimeter of which can be seen from one point, it is normally impossible for the person in charge of the operation to be a beater himself. There are, however, cases in which it is necessary for the controller to get actually into the line himself, either to restore morale among tired men who are becoming discouraged, or to encourage them to press home an advantage which they do not realise exists, or to assist in hanging on at some vital point to the last possible moment.

Working on the side of a fire parallel to the wind for any length of time is exhausting enough but a frontal attack against the main force of flames and smoke cannot be kept up effectively for long, and should not be attempted, except in case of necessity, with men who are already exhausted. If fresh reinforcements come up they are the ones to use for a frontal attack, but if such are not available the only thing is to move the freshest men forward from the back of the line. It is essential, however, that by doing so those portions of the perimeter of the fire which already appear to be extinguished are not left entirely unguarded. This is specially important if the area has any material amount of peat or humus. Only a few men, however, can be spared for this work while the fire is still raging and it is important to ensure that the value of reinforcements, who naturally tend to arrive near where the fire started, is not dissipated by their setting to work beating patches which may still be burning inside the extinguished part of the perimeter.

The provision of readily accessible supplies of fire-fighting tools and equipment is a matter of considerable importance. Beyond, perhaps, the distribution of suitable beaters along the sides of public roads, it is impossible to maintain adequate supplies of tools at all danger points, and the siting of dumps therefore requires careful consideration in which accessibility to labour and facilities for transport must be given due weight. As regards the actual tools, there are numerous types of efficient beaters in use. To be really effective a beater should be large enough to cover a fair amount of flame at one stroke and have a long enough handle to allow the user's body being well back from the flames, but it must not be unduly heavy or cumbrous to wield or carry about. If beaters are made from birch or other tree shoots care must be taken that they are securely wired to the handle so that they do not fall to pieces after a few strokes, and they must always be renewed before they become brittle.

Spades and shovels should be available in adequate numbers, the latter mainly for beating and scattering sand, and the former mainly for trenching after the fire has been encircled. As the plantations grow up, the provision of heavy bill-hooks and axes is also of importance. The use of chemical and other fire extinguishers is limited in many places by the scarcity of water, but even where they cannot be used in the main operation they may afford assistance to men who are left on guard, should smouldering patches burst into flame. The use of tractor ploughs in fire fighting should not be overlooked. They are, of course, not always available, but if one is known to be within a few miles of what threatens to be a big fire it should be sent for. Particularly in heath and grass fires it is remarkable what assistance even one or two furrows freshly turned can be to a line of beaters.

While it will never be possible to eliminate forest fires altogether, much can be done to reduce their numbers not only by means of suitable protective organization but also by the education of public opinion and working for the development of a national forest sense. Much must already have been effected by the facts and figures published in the Press during special danger periods, and also by the B.B.C.'s explanations and warnings at Bank Holidays. But there is still much room for educational work not only for townsmen (who get most of the blame), but even among our neighbours in the country, and all of us should endeavour to take an active share in this direction for the protection of our State forests.

W. A. MUIR.

(ii) DIVISION 4.

The outbreak which occurred at Bramshill on 5th September started two miles away from our area and on an almost level stretch of heath and gorse intersected by two main roads and numerous drives and tracks after a prolonged dry spell. The day started with half a gale from the N.E. and towards our area from where the fire started. Owing to being understaffed, I was particularly anxious to get to any fire as soon as possible and to call up the military if danger threatened. This fire had not been started long before I went up to it. A fire in the same direction was noticed by me at 1 a.m., but at 2 o'clock, as the smoke from this direction was getting alarmingly great, it was time to take action. It was some time afterwards discovered that the fire seen at one o'clock was a different fire, and much further away. In fact there were fires all round, but at some distance away. I arrived at the scene at about 2.15, and came to the conclusion at once to call up the military. This was at 2.30. In the meantime three fire brigades were there to protect a large mansion and some houses. There occurred a serious delay before the troops arrived after phoning a second and third time to the barracks at Aldershot about seven miles distant. Before the troops arrived and after the fire had rushed along towards our forest at an alarming rate, it practically swept through two feet high heather and gorse bushes ten feet high, and left it as level as a road. It was impossible to face the fire owing to heat and smoke. The sky was absolutely obliterated. A ganger and I counter-fired on a drive. This would have proved successful but for sparks being blown over behind us. Owing to only five men being on this beat (and these on patrol on a beat of ten miles), the beat being in four blocks and our dependence on the troops arriving in time, it was not until the fire had almost reached the forest boundary that I was able to get them together. As it was an outside fire and a large one, the men had been informed that the troops were coming to fight it. When the troops did arrive about one hour and a half after being called, the fire had travelled 2½ miles, and was still rushing along. I guided the troops to the S. flank of the fire. The troops were arriving in bus loads by this time, armed with picks, shovels, axes and sacks tied on poles to beat out the fire. I had hoped to keep the fire along our second line of fire traces, but a sudden turn of the wind caused fire and sparks to cross over. At times the flames and heat drove the beaters away, and we had to wait a few moments for a turn in the wind. Then orders were given to rush up and beat. The sacks and poles supplied to the soldiers were quite soon discarded for a better fire beater—the top of a Scots pine tree. We were now in the middle of plantations 8 years old and over ten feet high. Our own men were in advance cutting a way through the trees for the soldiers to beat out the fire. The N.C.Os., the ganger and myself had to urge on the beaters all the time to keep close together, and not to waste their beats in individual efforts. As the flames were put out a man dropped behind to look after a length, and many were the shouts that places had broken out afresh. A few men were rushed back now and then to beat out these outbreaks. The military had steel helmets and gas masks. The respirator part of these was just the thing for the smoke, but with the goggles on at night time, it was difficult for the men to see one another. In fact the gas masks were only used by newcomers who were not long in taking them off. Without the goggles the respirator helps a beater wonderfully, but he must have his eyes uncovered, or he sees nothing but shadows and flames and is liable to hurt the next man by hitting him with his beater. This occurred a few times during the night. This is where I dislike the use of fire shovels even without goggles. A man might easily have his head split open with a blow from a fire shovel. The beaters must be close up to one another to do any good. Some of the N.C.Os. were hopeless, as they would not urge the men on constantly. Luckily there were two or three capable N.C.Os. who urged their men on constantly. Fire fighting even has its humorous moments, especially coming from soldiers, such as "if this is soldiering, then I am deserting." One sergeant, and the best worker in the whole of the 2nd Division, who was at the fire was amusing with his remark—"Get on to it lads, you won't burn, you are too green to burn."

Commotion and misunderstanding were caused by the relieving of troops at a vital spot and moment. Just when a rush to beat might have saved a large area, shouts were heard that a relief was at hand.

The to-be-relieved men stopped at once, although urged on by me and the gangers, and it was difficult to get the relieving men to commence beating, and so a valuable opportunity was lost. Unless I was constantly on the move from one point to another (even where the staff of the 2nd Division were) urging the military on to get the fire under, it would seem that the fire would not be got under. At about 1 o'clock, however, the fire was got under control, and the area was then patrolled from end to end. There were scores and scores of sightseers, and by about midnight there must have been thousands. Bramshill country is often the scene of a heath or forest fire, and except for local workmen who might turn up to help, no motorists, hikers or ladies have helped, and on this fatal afternoon there were plenty about to put the fire out before it got too big. They do not like to face flames. I have seen a few, however, mess about with a smouldering fire after the flames have passed and this is where the reporters see them. Excepting for one break-out next day that might have been serious, scores of bursts were put out until we got rain seven days later. The area was thoroughly trenched on the morning of the 6th and, except for the break-out mentioned, when luckily relieved and relieving troops together with the A.C., D.O. and District Officer, who had arrived, made a grand attack and stopped what might have been another disaster. The gale renewed itself each day for a whole week. The burnt area appeared to be afire a second time. The gale got up huge clouds of black dust. The fire had travelled five miles, the width varying from a bottle neck where we counter-fired to a mile. During the fire the roads were impassable and for some time were closed by the County Council authorities.

Some lessons have been learnt and others unlearnt. Text-book rules and regulations are right enough for a basis, but in a big fire theory is lost. It is impossible to face the front of a big fire such as this one was; one could see nothing but the flanks of the fires. If counter-firing is to be done successfully, you must have sufficient men to do it early enough and safe enough to prevent sparks flying over. At night it is almost impossible to counter-fire successfully with the fire spreading as fast as one can run. A forest should not only have sufficient men for patrols, but a gang of no less than six working together, equipped with bicycles and bill-hooks, and available to be rushed to the scene. We depended on the military arriving in time; this disaster was due to their delay; it took them 1½ hours to come a distance of seven miles in lorries and buses; if they had arrived only 15 minutes sooner, there would be a different tale to tell. If I had known at two o'clock that afternoon what I know now, there is at least one thing I would have done which could have been done; there were five fire engines at that fire protecting property; if only one had been at my disposal, the damage would have been avoided. I did ask one brigade to bring a length of hose on to the heath, but as they had been called to protect house property, they refused to come. One fire engine did save a large area owing to a second wave of fire coming behind the first which the firemen put out right on our boundary. Where there are water mains running alongside the plantations, hydrants should be put in, the mains extended to cover dangerous points and fire brigades called at once. Nothing but water will face an advancing fire such as this. We have not learnt yet how to prevent a fire.

G. H. RICHARDS.

Note by the Divisional Officer:—

I did not arrive on the area until the next day, but from my observation a normal fire line 40 ft. broad is not sufficient to stop a fire even when partly ploughed.

Before the fire could reach the plantation an outside fire line of 40 ft. (burnt heather) was met with. Sparks crossed this and similarly the first internal line, although this line held the fire to a certain extent. In wet molinia ground the ploughed trace had definitely stopped the fire. I consider the main points brought out by the fire are:—

(1) In dangerous periods to keep a gang of at least six men on each dangerous area whether they can be economically employed or not.

(2) The imperative necessity of getting a large number of fire fighters to the scene of the fire as quickly as possible.

(3) To make more use of the plough in ploughing up the sides of rides.

(4) Increase the number of cleared rides in order to afford ample opportunities for counter-firing.

(*A. L. Felton.*)

(iii) DIVISION SCOTLAND N.

The Wajax water pack, supplied for trial by Headquarters, proved this year that it has a definite value in fire fighting. During the very dry season experienced in the north of Scotland we were never without danger from fire until October. The fire hazard was particularly great in July, which is not as a rule a very dangerous period. An outbreak of fire occurred one night early in July, on Craigphadrig, a small forest near Inverness. The fire had started among rock outcrops where the ground is extremely rough. The soil was peaty and dry on top of the rock and the fire had taken firm hold in the peat and in old Scots pine stumps and whin roots. A fairly strong wind was blowing and, if the fire broke away from the rocks, there was every chance of a large acreage of healthy young pine being wiped out. Firebrooms were of little use in this case as they distributed the sparks and mattocks and spades were badly handicapped by the fissures and knobs of rock.

With the aid of the water pack the fire was localized to the rocks and its edges were got under control. One fill of the pack can do more good than six times as much water in buckets in this type of ground, as the spray ensures that the water is directed to the place where it will do most good and none is wasted. In this case the nearest water was

400 yards distant. Carrying the full pack through trees and undergrowth to the top of the rocks at midnight was hard work, but was well worth while.

It might also be remarked that a beer bottle (full) is of great assistance at a forest fire. There is no more exhausting work than fire fighting and a little timely refreshment works wonders.

F. OLIVER.

Note by the Divisional Officer :—

It has been suggested, in connection with the use of the Wajax water pack, that experiments might be made with the various soluble materials that are used in making up fire-resisting preparations used on wood, and also with a preparation used in ordinary fire extinguishers. Such substances as alum, ammonium phosphate and borax might be given a trial. In the fire described above it was necessary to keep watchers on the fire site for forty-eight hours after the outbreak of fire and the price of transporting water to this area might have been cut down by use of those chemicals.

(*J. Fraser.*)

Keep broad rides bare by cutting or grubbing. In case of fire the best that can be done is to beat it from the sides. Counter-firing from a stream or broad ride is the only other means of checking it. Knapsack sprayers are principally of use when burning a strip of ground to wet the side which is likely to get away from one.

Purchase a few strong flash-lamps to help men to pick their way to the fire if ground is rough. Our fires have all been late in the evening and usually when very dark.

Keep the public out of the plantations. Rights of way through plantations are a difficulty at Nevis Forest. People go wandering all over the ground as it is close to the town of Fort William and a favourite walk during the spring and summer.

Link up a few forests with the telephone as this would get men quicker on the spot if required, more particularly when a forest will not carry a big squad of men.

W. MASON.

South Laggan Forest has four miles of railway running on the lower slope of approximately 1,000 acres of young plantations, and danger from fires can always be expected during dry periods. The sites of the earlier plantations, although at the time of planting mostly bare green slopes, are now more or less covered with heather and rank bracken down to the railway side. A fire trace varying from 6 to 10 ft. wide has been made along the plantation edge at 2 chains from the rail side, and has proved indispensable in preventing railway fires from spreading into the plantations. The greatest danger is experienced from heavy excursion trains on Sundays and occasional heavy goods traffic during weekdays.

In the earlier days difficulty was experienced in bringing local non-Commission employees to interest themselves in preventing loss in plantations from fires accidentally started by railway engines, or from other causes. This was to a certain extent changed by the practice of paying small sums to every person who assisted in extinguishing any fires that took place from time to time. Discreet remarks passed from time to time by employees about losses sustained by fires on other forests have gradually changed the position so that although forest workmen may not be present at the actual minute when a fire starts it is almost certain to be extinguished by any local person discovering it before the patrol can call out the workmen. Fire stations with extinguishing apparatus are placed at convenient points along the rail side and an extra store of brooms is kept at the home station. Water packs are also supplied ; these are tested periodically and held in readiness.

The worst fire experienced on this forest started from the rail-side below a stretch of young larch plantation. The weather was very dry and the four workmen first on the scene could do little to prevent it spreading. The nursery workmen were despatched immediately with a supply of brushes from the home station. All local workmen and a timber merchant's squad immediately stopped work and proceeded to assist in extinguishing the blaze. In twenty minutes approximately 30 men were on the scene. A 'phone message was despatched to the neighbouring forest, Inchnacardoch, 10 miles away, for assistance and two lorry loads of men equipped with brushes were at the fire within forty minutes. This raised the squad available to 60 men. The fire, however, had been got under control before the arrival of the Inchnacardoch squad. Workmen flanked the fire up the slope of the hill and brought it to a point on a stream, where the blaze was quickly extinguished. Nature has assisted this forest by providing many such streams and deep gorges at varying distances which are invaluable in preventing fires from spreading over large areas.

R. Cameron.

(iv) Division Scotland N.E.

A fire on Bennachie, a well-known hill in Aberdeenshire, occurred in July, 1933, and was caused, it is thought, by picnickers leaving a fire smouldering. This was not on Forestry Commission property, but the Department was asked to assist in extinguishing it. The hill is covered with thick heather in which there are many large granite boulders, especially towards the summit. When the fire first started, there was no responsible person in control of the fire-fighting operations, with the result that there were local gangs of men each fighting the fire at different places without method.

During the time that the fire was raging there was a high wind blowing and on the third day the fire was completely out of hand and swept down the hillside, carrying all before it, and some young plantations at the foot were only saved by the wind changing its direction in the nick of time.

When the help of the Forestry Commission was called in, the fire was still burning steadily in various parts of the mountain and the first job undertaken was to organize the fire fighters into two bodies, each under a foreman, with a responsible person in complete control. Isolated patches of fire were put out with birch fire brooms and the fire was located in two places. There was an area of unburnt land in between the burning areas which were tending to advance across the hill from west to east. Consequently the work consisted in preventing the fire encroaching to the east and to the north (the bottom of the hill where the plantations were). Broad lines, 10 ft. wide and 10 ft. apart, were screefed on the east and north sides and it was intended to burn the intervening strip and counter-fire if the fire again became serious. All this time the fire was burning steadily and great trouble was caused by the boulders, which assisted in forming air pockets and fresh outbreaks were thus often occasioned. By keeping some of the men perpetually beating out the fire, it was prevented from getting into the peat, except in one small area, which was dug deeply round and isolated. The fire was finally put out without the use of counter-firing.

A few points of interest were brought out by the fire. It was found that birch fire brooms were far more satisfactory than wire beaters, sacks or spades. A large gang of unemployed helped in the fire-fighting, and these men turned out to be very excellent workers under constant supervision, but when constant supervision could not be spared they were the worst idlers. The Gordon Highlanders also helped, and these men were quite good workers on a steady job, but when they were required to go into the smoke and fight the flames close at hand, they were quite useless.

One factor that assisted greatly towards the end of the fire in extinguishing it was that the provisioning of the men on the hill was carried out regularly. The men then knew that they were getting food at certain definite times, and the extra amount of work that was done in consequence was quite noticeable.

D. Murray.

None of the fires which broke out in Roseisle Forest presented any big problem and they were speedily got under control and extinguished before extensive damage had been done. On all occasions wire netting beaters only were used. On three occasions, at fires caused by sparks from railway engines, the wind on each occasion blowing direct on to plantations, the fires were attacked on both sides, to prevent spreading, and they burned themselves out at a fire trace which runs parallel to the railway line.

One fire occurred on the roadside, the wind at the time being more or less parallel to the road but slightly inward towards the plantation. The fire was attacked from one side only, *i.e.*, the side away from the road. Starting at the point of outbreak we followed the fire up (one man being left to attend to any bits that might break out afresh) and eventually got right round in front of the fire. A shallow drain, about 1 ft. wide, which ran across the line of the fire helped greatly and since then all drain sides have been kept clear of withered herbage. This can be done very cheaply on this area.

On three occasions the fire horn was made use of to warn employees of outbreaks. In this way valuable time which would otherwise have been lost in getting messages sent was saved. The fact that the squads carry fire beaters with them to whatever part of the area they are working on, for the time being, was a big factor in getting the fires extinguished so quickly. I might add that I have made arrangements whereby the railway engine drivers who operate the line are to keep a sharp look-out for fires and give warning by two long blasts of the whistle should they see the least sign of smoke on the area while passing through.

W. Mackay.

(v) Division 7.

The following notes are based upon observations made at a large fire which occurred in September in established plantations at Beacons, Tintern. The fire broke out in the afternoon and was fanned by a very strong wind. There were no natural obstacles to its advance.

1. *Reaction of different Species to Fire.*

(*a*) *Conifers.*—The species affected included Scots pine, European larch, Douglas fir and Norway spruce all of up to 25 or 28 years old; there were also small quantities of Corsican pine, Sitka spruce, Japanese larch, and thuya (up to 18 years). Little difference was noted in the inflammability of these species, and none appears to have offered much resistance to the advance of the fire through the crowns. Small patches of Norway spruce, Douglas fir, European larch, Scots pine and thuya escaped the fire in the crowns for no apparent reason; in most cases there are similar plantations adjoining which were completely burnt.

In dealing with the fire from the side and preventing what had been reduced to a ground fire from leaping up again to the crowns, cleanness of floor was an important factor; in this spruce and Douglas fir have the advantage over the lighter crowned species, but European larch was found easiest to deal with on the flanks of the fire by some of those present. The various species of tree showed relatively unimportant differences compared with that between brashed and unbrashed plantations; this question will be dealt with later.

(*b*) *Hardwoods.*—In about 7 acres of 30 year old oak coppice with a sprinkling of birch the fire spread over the ground without reaching the crowns of the trees. Bilberry was the predominant species in the ground flora. It is difficult to say how much damage has been done, but the oak appears to have a fair chance of recovering. Some of the birch and beech have had their surface roots burnt through.

(*c*) *Conclusions.*—(i) Conifers. According to the evidence, no species of conifer is certain of checking the advance of a crown fire in a high wind in a pole crop at the end of a dry spell in the autumn. This does not, however, rule out the possibility that certain differences in the inflammability of the various species might be noticed on a calmer day, or at a different time of the year, or in an older and wider spaced plantation.

(ii) Hardwoods. It can safely be assumed that hardwoods will not support a crown fire, at any rate, when the leaves are green. This points to the advisability of dividing large blocks of conifer by hardwood belts, a question which will be dealt with in a later paragraph.

2. *Brashed and unbrashed Plantations.*

There is no evidence that brashing (up to a height of 6 ft.) had any effect in checking the advance of the fire which had got into the crowns, but a ground fire much more easily climbed into the crowns in a plantation that was not brashed than in one where brashing had been done. Moreover brashing, where it had been done, enabled men to get in and deal with the fire very much more easily than was possible in an unbrashed plantation; it also encouraged them to go to meet the fire in places where it would not have been safe to go if there had not been a brashed plantation to retreat through.

Conclusion.—Even if it is not admitted that the brashing of young plantations is worth while for reasons other than fire protection, it is nevertheless clear that where there is any possibility of fire, it will pay to brash a plantation as soon as the branches are dry up to 6 ft., and possibly earlier in certain places along ride sides. On the edges of plantations brashings should be carried into the rides and burnt. The leaving of belts unbrashed would make ground fires easier to deal with by excluding the wind from the plantation, but this advantage would in most cases be outweighed by the risk of the fire climbing into the crowns *via* the unbrashed trees.

3. *Pruning.*

The fire passed through one half of an area of recently thinned and pruned Scots pine, aged 25, 40 ft. high. The pruning was confined to selected trees. At one corner of this the fire had evidently stopped as a crown fire (on the edge of this area) doubtless owing to the wide spacing of the trees after thinning and the absence of dead lower branches on some of the trees; it is also probable that by the time the fire reached this point the wind had lost most of its earlier violence. Other parts of the pruned area were completely burnt by the crown fire.

Conclusions.—Pruning is not worth considering solely as a measure of fire protection, but where pruning is to be done (for sylvicultural reasons) over a part only of a plantation, it might be worth while to do it in a long strip instead of a square block, so that any effect it may one day have in checking a fire may be extended over as large an area as possible. In a recently pruned plantation, the great quantity of branches lying on the floor must add to the difficulty of dealing with ground fires and along ride sides they provide a likely place for a fire to start. Branches should therefore be dragged away from the ride side into the plantations, or alternatively dragged on to the rides and burnt.

4. *Coppice and Gorse in young Plantations.*

It was quite impossible to put out a fire in a bunch of coppice shoots, and it was difficult to put it out in between the stools, if the stools were close. The heat of the fire in these places was sufficient for the oak leaves to ignite, although they were green, this contributing greatly to the volume of smoke. Gorse and heather were also found to increase the difficulties of extinguishing very considerably.

Conclusion.—It is not considered that the keeping down of gorse and coppice in plantations beyond the time required by sylviculture would be a justifiable expense as protection against fire ; but the thorough cleaning of a chain belt along the side of some or all of the rides is to be recommended.

5. *Distance jumped by Fire.*

Rides and Hardwood Belts.—The maximum distance which a spark was seen to fly was 70 to 80 yards ; this was observed by 3 or 4 men, waiting to stop the fire which was advancing towards them through a Norway spruce plantation. Whilst the main fire was still 20 or 30 yards away, the men saw a small fire break out 50 yards behind them in a young European larch plantation. In the next minute several more outbreaks occurred in the same vicinity, evidently started by sparks which had flown 70 to 80 yards. These sparks started from a Norway spruce plantation 20 to 25 ft. high and travelled right over a 20 yards wide belt of oak coppice 25 to 30 ft. high. Other rides were crossed in the same way by flying brands.

Conclusion.—(i) *Rides.*—For limiting the area of fires in young plantations up to the thicket stage, fire breaks should consist of rides kept clear of vegetation and if possible burned annually or at least biennially. These rides should be a maximum width of 30 ft.

(ii) *Hardwood Belts.*—For checking fires in plantations in the thicket and pole stages, rides are not sufficient owing to the distance which sparks are capable of flying. They should be supplemented by hardwood belts. It can safely be assumed that on reaching a belt of hardwoods a crown fire will be extinguished as a crown fire, but it may get through to the other side in one or two ways :—(*a*) it may send sparks right over the belt, which will set alight the undergrowth on the leeward side and from there the fire may leap up again to the crowns ; or (*b*) it may crawl under the hardwood belt by means of the leaves and undergrowth.

(*a*) Hardwood belts over which sparks could not fly would apparently need to be at least 80 yards wide ; as isolated conifers in such belts would not constitute any danger. Narrower hardwood belts (say 2 chains wide) plus early and thorough brashing of the conifer crop for 2 or 3 chains on either side would be less efficient but would be preferable where the growing of hardwoods is unremunerative or where the danger from fire is small. The brashing would enable any small fires started by sparks to be quickly reached and dealt with.

(*b*) Belts through which a fire is unlikely to travel must be of a species which will not support much undergrowth. In any event, the wider the belt the longer the fire will take to creep under it and the more time there will be to put it out before it gets through to the conifers on the other side. The width which should be employed in any given case, and also the number of belts on an area, will depend on the relative value of hardwood and conifer crops and the area (or value) of the plantation at stake.

The choice of species for a hardwood belt must depend upon the locality. Rapid growth and dense foliage are the most important requirements. On the Beacons site it is considered that beech is the most suitable tree, although it has two disadvantages. It is easily killed by fire owing to its thin bark, and in its young stage it is itself inflammable in winter and spring, as it retains its brown leaves till the following summer. But its defects are outweighed by its merits ; it grows fast in this locality ; it is capable of coppicing after being burnt, even when quite young ; it produces a clean floor after it has formed canopy ; it fetches a fair price when grown to a big size. It will probably be decided to retain some of the beech belts throughout the second rotation.

6. *Fire-fighting.*

(*a*) *Personnel.*—It is considered that the bulk of assistance obtained on this occasion would be sufficient for any fire in this Division. More important than bulk is speed in bringing assistance to the spot. How to arrange for a speedier collection of men is a very difficult question, particularly as fires most frequently occur when the men are not at work, on Sundays, Bank Holidays, etc. The most important thing is to have men concentrated in known and accessible places during any period of fire danger. Outside working hours there is no way of concentrating available assistance except by establishing colonies of holdings. The obvious advantages of having holdings scattered over the forest are admitted, but from the point of view of fire protection a colony of holdings in a central and accessible situation is extremely valuable.

(*b*) *Tools.*—Residents came out with hackers and cut themselves branches to fight the fire. These proved the most serviceable weapons in young plantations. Supplies of slashers, shovels and hackers were sent up with parties from Tintern and Parkend. Axes were also brought by the students from Parkend and by some of the local cutters. Shovels were the most useful weapons for putting out small fires on the floor of brashed spruce plantations, after the main fire was out. Slashers and hackers were used for clearing rides and brashing. Axes were used for widening rides by removing trees along the edge. This proved useless in stopping the fire from the front, owing to burning branches flying across the rides, but it might have been useful in checking the fire on its flanks, where it spread but slowly. Spades and mattocks were used for digging round the burnt area and preventing the fire from spreading through the humus, after the main fire was out.

Staff hooks are useful for clearing rides, for brashing (if necessary), and for cutting green branches for beaters; they are considered to be the most serviceable all-round cutting tool for use in fire fighting. It is also suggested that water packs and pumps be given a trial during fire line burning operations this winter. Two or three galvanised sheets with handles, as used for fire tracing, should also be available in case required for counter-firing. A convenient pattern of smoke mask should also be designed, and if found satisfactory, supplied in quantity. Axes are of little use in unskilled hands; the felling of trees in the middle of a plantation results in a mass of tangled crowns through which it is almost impossible to pass, and in which it is quite impossible to put out a fire, so that it is better not done, unless it can be done in a capable and orderly manner.

N. A. WYLIE.

(iv) DIVISION 3.

A fire at Margam on 13th March was typical of the outbreaks which occur only too frequently all over the exposed molinia clad hills in the industrial areas of South Wales. In this unfortunate case the fire occurred while endeavouring to fire-trace around an unplanted area with the objective subsequently of burning the whole of the waste ground to render it safe from the careless pedestrian. While the result was disastrous, the fire was not without its useful lessons.

Lesson I. Never burn fire traces in molinia ground if there is any other possible alternative. Molinia is the most treacherous type of vegetation which occurs on our forest lands.

Six men were present armed with six long-handled flat shovels and three filled Wajax water packs. For about 30 yards the burning of a 12-ft. trace proceeded easily and was readily controlled by the shovels and with occasional squirts from the Wajax. Just as the first packman had retired to refill at a spring some distance away the fire jumped a low bank and entered the plantation. Of course, the other two packs were emptied before the first had returned.

Lesson II. When using water packs for fire tracing always have one filled in reserve for every two in use and never call on the reserves unless required in an urgency. When not in a hurry, always go to refill before the pack is empty and tip the " dregs " into your neighbour's pack. Thus he will not have to refill before you return.

Five men went ahead to the leeward side of the fire, beating and " wajaxing " in front of the flames, while one remained on the windward side to control the back of the fire. As this latter was burning slowly against the wind and into an unplanted area, its control was comparatively easy, but all the same it was a tough job for one man and he is to be complimented for his work.

Six additional men beating up in a nearby plantation were misled by a thick white mist and ran away from the fire instead of coming towards our whistle and bugle calls.

Lesson III. Always keep the safety gangs actually within sight of the fire-tracing works, even if they have to be doing less useful work. Thus there will be no possible chance of losing touch with them.

One shovel lost its handle in the heat, but fortunately it was quickly replaced.

Lesson IV. Put fresh handles in old shovels and keep one or two spares handy to the work.

Meanwhile, the fire was gaining ground, but fortunately a local unemployed man was quickly despatched to the nearest Police Station, and a contingent of unemployed men armed with shovels (picked up from a County Council road dump) and led by the Police Inspector arrived on the scene and had the blaze under control in a twinkling. This police-cum-unemployed assistance had been pre-arranged and has proved its value on several occasions.

Of all herbage fires, probably those in molinia are the easiest to control *provided that you have the man power to do it.* Molinia burns fiercely, but with a very constant and steady front. There is generally comparatively little smouldering after the fire has passed. This because it is in its most inflammable condition in the very early spring while the soil is damp. It does not spark badly. Its real danger lies in its extreme inflammability and the speed of its burning. A blade of the burning grass whisped up into the air will nearly always burn itself out before it drops down on to the ground again, but if it should drop while still burning it will start another fire with almost explosive suddenness.

Molinia is not readily killed out by over-shading and will flourish comparatively strongly under a light tree canopy. Our Sitka spruce pure plantations on molinia will remain in an intensely dangerous condition for a long period of years.

G. B. Ryle.

The last fire to occur on Haldon, which is situated some 7 or 8 miles from Exeter, had the doubtful distinction of figuring as "news." Even the *Daily Mail* condescended to print a brief paragraph, the contents of which, although like Mark Twain's death "grossly exaggerated," yet served to draw the attention of the *Daily Mail's* many readers to the danger of throwing matches and cigarette stubs into plantations or dry vegetation.

The fire broke out between 1.30 and 2 p.m. in a P. 30 plantation situated on the steep slope of a narrow valley and adjoining a wide and much travelled main road. Nothing can be proved, but there is no reasonable doubt that it was started from a cigarette stub or match thrown from a passing car. Conditions being dangerous, patrols were on duty. The area had been visited by the patrol at about 12 noon. He was on his way back again at about 2 p.m., when he caught sight of the smoke and immediately dashed off for the nearest men, who proceeded to the scene of the fire, while the patrol cycled to the nursery, about $1\frac{1}{2}$ miles away, where the main body of men were working.

A few minutes before the smoke was seen by the patrol, a passing motorist, wishing to be helpful, telephoned the information to the Exeter City Police. They immediately notified the City Fire Brigade and probably the Press. The Brigade, followed by sightseers and others, reached the fire in very good time. Finding inadequate water supplies for the engine, the firemen cut branches and beaters and joined such of our workmen as had already arrived in attacking the fire. Further assistance soon arrived in the shape of the remainder of our employees, who brought the fire-fighting gear, consisting of beaters, shovels, mattocks, bill hooks, buckets and Wajax water packs. The conflagration was very soon extinguished, after destroying 4 acres of good P. 30 D.F. The extent of the damage was variously estimated by the Press at from 20 to 30 acres! It was fortunate that the fire was got under control so rapidly. The wind was blowing the flames in the direction of a further area of good P. 30 D.F. lower down the valley.

Immediately the run of the fire had been stopped, our men were divided into squads and put to extinguishing sporadic outbreaks, smouldering humus, stumps, etc. Incidentally, the dry, smouldering vegetation presented a serious menace for several days and nights, during the whole of which time men were in attendance, complete with water-packs. These water-packs proved invaluable for this kind of work, and furthermore, have on several occasions proved their usefulness in combating active fires.

A brief description of the methods of using water-packs may not be out of place here. Naturally, they are entirely dependent for their usefulness on an adequate supply of water, and wherever they have been extensively used in this district water has been relatively convenient and plentiful. The best method of using them has been found to be in relays, two men with filled packs taking turn about at the fire, and a third filling up. Care in organisation is required to see that both men at the fire do not empty their packs at the same time. The pack-carriers keep just ahead of the leading beater and project a stream of water on the flames, which the beater has then no difficulty in beating out. Other beaters come along behind to make good his work and to extinguish any recurrence of the flames. For each relay of three packs a fourth man should remain at the water supply to fill packs as they arrive. Where the water hole or stream is shallow, it is advisable to have two men filling while the carrier holds open the mouth of the pack. It is, of course, advisable to change over occasionally; working the hand pump in the heat of the flames is nearly as tiring as leading the beating.

W. D. RUSSELL.

PROGRESS REPORT ON RESEARCH: JANUARY, 1934.

By W. H. GUILLEBAUD.

1. NURSERY EXPERIMENTAL WORK.

The climatic feature of the year has been the prolonged drought and high temperatures experienced during the summer. Germination was, however, good generally in Scotland. At Kennington Nursery, March sowings germinated well, but seedbeds sown in April and May have mostly made a poor showing.

Three of the experimental projects have given results of considerable interest.

Weed Control.—Experiments were carried out in four nurseries in Scotland and in six nurseries in England and Wales using different strengths of sulphuric acid. The effect of the acid on germination varied with the species of seed sown and the nature of the soil; in general there have been no ill effects in the better soil nurseries, but germination was seriously affected in some of the sandy nurseries, notably Clipstone (Corsican pine), Haldon (European larch), Altonside and Auchterawe (European larch, Scots pine and Sitka spruce). In almost all cases weeding costs have been drastically reduced. The most striking results have been obtained at Benmore, where the controls took 240 minutes per 100 sq. ft. to weed, while the acid treatment reduced the time to only 38 minutes, *i.e.*, a saving of nearly 3½ hours work per 100 sq. ft. of seedbed. The best results having regard to germination as well as weed control were obtained with a strength of 1 in 110 sulphuric acid applied at the rate of 2 gallons per square yard 7 days after sowing. It should be observed that the abnormally dry summer provided the severest possible test for the acid treatment. The conclusion is that the method is generally applicable except on very sandy nursery soil.

A preliminary weed control experiment, using dilute sodium chlorate solution applied to a seedbed of Sitka spruce, gave very promising results at Kennington. One half per cent. and one per cent. solutions were sprayed over the surface of the bed 12 days after sowing, at the rate of 1 pint per square yard. The soil was very dry at the time of application. The first two weedings in the control took 85 minutes of work per 100 sq. ft., as against only 17 minutes for the ½ per cent. and 2½ minutes for the 1 per cent. sodium chlorate treatments. The chlorate evidently disappeared quickly from the soil for the third weeding took about the same length of time (50 minutes per 100 sq. ft.) in the treated as in the untreated plots. The germination was appreciably higher in those plots to which sodium chlorate had been applied. These results are considered to be of some importance, because there are possible objections to the use of sulphuric acid in nursery soils, also relatively large quantities of water are required which runs up the cost. The chlorate treatment, if this year's results can be confirmed, will be cheaper to apply, and there should be less risk of harm being done to the soil.

Stratification of Seed.—Last year's experiment on stratification was repeated with certain modifications. Douglas fir gave virtually the same result as before, *i.e.*, a poor germination from normal sowing in the spring, but excellent germination from autumn sowing or from stratification in sand at the end of January. Other methods of stratification were either harmful or only slightly beneficial, as shown below.

Treatment.	Germination, per cent.
Normal spring sowing	15
Autumn sowing	68
Stratification in sand in January ..	67
,, ,, ,, autumn	8
,, peat in autumn	32
,, ,, ,, January	0*

* Failure probably due to fungi attacking the seed.

Birch, stratified in sand or peat in February, showed a twenty-fold increase in germination, as compared with dry sown seed. On the other hand, stratification was definitely harmful to seed of Sitka spruce and Corsican pine, and without apparent effect on Japanese larch.

Methods of covering Seed.—Three grades of sand were used in four nurseries in Scotland and tested in each case against nursery soil. The source of the sand and grit used for covering was the same at Altonside and Newton, but different at Auchterawe and Inverleith.

Species.	Nursery.	Yield of Seedlings per lb. (1,000's).			
		Nursery Soil.	Fine Sand.	Medium Sand.	Coarse Grit.
European larch ...	Altonside	4	8	8	8
	Auchterawe ...	45	51	47	43
	Newton	4	8	4	6
	Inverleith ...	12	13	12	10
Sitka spruce ...	Altonside	6	78	18	36
	Auchterawe ...	92	101	83	101
	Newton	20	39	28	32
	Inverleith ...	37	70	63	40

Fine sand has given the best results, and at Altonside has made an astonishing difference to the yield of Sitka spruce seedlings (from 6,000 to 78,000 seedlings per lb. of seed sown). By covering with fine sand, the yield has been doubled or more in five out of the eight experiments. It should be observed that in all cases the beds were rolled after covering.

2. Plantation Experiments.

Peat Project.

Alnus oregona continues to make good growth at Inchnacardoch. The slagged Japanese larch in Achnashellach 9 P. 28 are now in canopy, and presumably the crop can be regarded as successfully established; the unslagged controls continue to make slow progress.

There is increasing evidence to show that a single dose of basic slag applied to Sitka spruce at the time of planting is not going to keep the plants growing vigorously on scirpus-calluna peat, after four or five years growth falls off again badly. The effect of Semsol appears to be more lasting than that of basic slag. Sitka spruce is doing very well in slagged groups on partly flushed ground at Glenrigh. The Beddgelert peat areas are generally promising, Sitka spruce is checking only on relatively small areas of bad scirpus, and here basic slag is giving good results.

An experiment on the lifting of checked spruces at Inchnacardoch (lifted in P. 32) again gave indifferent results, losses ranged from 20 to 30 per cent., and the survivors show little sign of improvement.

Upland Calluna Soils.

The P. 31 and P. 32 experiments on deeply ploughed ground at Allerston are looking extremely well. Two-year seedling Sitka spruce planted in 2-furrow ploughing in 12 P. 31 have put on shoots up to 30 in. in length. The broom hedges are now 5 ft. high and provide excellent shelter, Sitka spruce was introduced between the broom rows in P. 33. In general, P. 33 planting has been successful.

The results at Harwooddale are encouraging; *Pinus contorta*, alder and Scots pine are the most promising species at present.

At Teindland both Sitka spruce and *Pinus contorta* planted in P. 27 and P. 28 on ploughed and slagged ground have grown well. The spruce are from 2 to 5 ft. in height, but on the whole the shoots are shorter than last year, and the colour not so good. Heather has strongly invaded the soil and the grasses which appeared at first as a result of the slagging are dying out. There is a distinct possibility that the plants may go back again into check, but equally the fall-off in growth may be only temporary. So far *P. contorta* is the most promising species.

Dorset Heaths.

P. 33 planting and sowing on ploughed ground at Wareham has done well in spite of the drought. It was found that by running the caterpillar tractor up and down the furrows after full ploughing, level strips were formed which could be satisfactorily sown with a Planet Junior seed drill. The cost of preparing the seedbed and sowing worked out under 10*s*. per acre; a fair germination of Corsican pine was obtained. One-year seedlings of Japanese larch slagged when planted, have done well for the second year in succession. *Pinus radiata* is outstanding among the direct sown pines as regards growth in the second year.

Thetford Chase.

Beech planted in P. 33 under Scots pine of 6 to 8 ft. in height suffered only 4 per cent. of casualties, while those planted among Scots pine of 3 to 4 ft. in height lost 50 per cent. from frost and sun scorch. Much the same result was obtained in previous years, and it seems clear that the pine does not function successfully as a nurse for tender species until it is about 6 ft. high, with the crowns just beginning to meet.

Chalk Soils.

The beech plants introduced in P. 33 among plots of grey alder at Buriton have taken fairly well, and are putting on shoots of 2 to 4 in. The ash planted in one of the alder plots have started well, there have been no failures, and the plants have put on shoots of 1½ to 8 in. The alders are continuing to grow strongly. At Friston, the beech are making excellent progress without nurses, while the alders and other species planted as nurses are still very backward and poor.

Loams and Clay Soils (Hardwoods).

In the Forest of Dean area, the most interesting result is the response of ash to hoeing. There are two experiments, in one of these improved growth showed itself in the hoed plots in the third year after planting, and in the other in the second year. In the latter experiment the plants put on shoots of up to 6 ft. in length in 1933. It should be added that the unhoed plots have mostly done quite well, though growth has not been so spectacular. All the oak plots in the Dean and at Dymock are making satisfactory growth. Experiments at Drayton, in Northamptonshire, on choice of species for planting on heavy clay soils, are beginning to show interesting results, Thuya and Tsuga have done badly, especially the latter. *Pinus contorta* has made the best growth and shows the fewest losses. Other good species are Scots pine, Norway Spruce, *Alnus oregona* and *A. incana.*

Rooted cuttings of poplar planted in P. 32 on mounds at Yardley are beginning to show signs of growth.

3. Field Work in Hand during P. 34 Planting Season.

England and Wales.

Allerston.—Repetition of trial of broom seed. Trial of various species, horse chestnut, etc. Repeat comparison of seedlings and transplants of J. L. and S. S.

Harwooddale.—Repeat experiment on methods of planting.

Clocaenog.—Repeat work on intensity of drainage. Comparison of basic slag and semsol. Extend the nursery experiment on the spacing of spruce seedlings in bedding-out work.

Wareham.—Repeat experiment on direct sowing. Trial of alder in mixture with spruces. Repeat comparison of seedlings and transplants of J.L., S.S. and S.P.

Buriton.—Interplant alder plots with beech. Trial of *Pyrus intermedia.*

Thetford.—Continue underplanting of Scots pine with beech. Repair species plots at Lynford and Olly.

Drayton.—Repeat species experiment. Repeat stump planting of oak and alder.

Forest of Dean.—Repair walnut experiment.

General.—Continue beating-up investigation. Races experiments.

Scotland.

Teindland.—Trial of Henderson plough and draining machines. Sowing of broom on ploughed ground with slag and semsol.

Inchnacardoch.—Small-scale experiments with basic slag and other phosphatic manures.

General.—Continue beating-up investigation. Study of root development of pine and birch on leached mineral soils, especially with regard to the supposed soil-improving properties of birch.

Preparation of publication on the Crown Plantations of Hafod Fawr and the Isle of Man.

4. Sample Plot Work.

From January to October, 1933, 39 sample plots were remeasured; of these 33 were in England and Wales, and 6 in Scotland. In addition eight new plots were established, namely, four Japanese larch and one Sitka spruce at Hafod Fawr, one Japanese larch at Llandinam, and two Corsican at Sherwood. One Norway spruce at Douglas, Lanarkshire, had to be abandoned owing to windblow.

The Japanese larch plots at Hafod Fawr form an interesting series as regards elevation above sea level. The respective elevations are 750 ft., 1,100 ft., 1,250 ft. and 1,480 ft. In the highest of these plots the trees are 28 years old, average 27 ft. in height, and carry a volume of 1,200 cub. ft. per acre. The plot at 1,100 ft. elevation is 44 ft. in height at 26 years, with a volume per acre of 1,750 cub. ft. All the plots have suffered from lack of thinning.

5. Research Work at Aberdeen.

Dr. E. V. Laing is starting a new investigation on the root and shoot development of European larch, with special reference to planting and the avoidance of losses consequent upon spring drought. In this work, periodicity of root growth will be studied, also the question of storage of food materials, as well as the effect of various methods of treatment such as wrenching, autumn lifting, etc., upon root growth.

Dr. G. K. Fraser, working in collaboration with one of the staff of the Macaulay Soil Research Institute at Aberdeen, has carried out during the summer a fairly detailed soil and vegetation survey of Durris Forest in Lower Deeside. The intention is to use this intensive survey as a basis for more general forest soil investigation and to help to determine the deficiencies of poor-quality planting ground. In studying the soil samples collected, Dr. Fraser will concentrate on the properties of the humus layer.

6. Mycorrhiza Research.

The pot culture work with Wareham soil, carried out by Dr. M. C. Rayner, at Bedford College, is giving interesting results. The trouble at Wareham, probably also in other poor calluna soils, seems to be due not so much to a lack of the necessary mycorrhiza-forming fungi, as to the presence of certain conditions which prevent these fungi from functioning normally. In pot cultures these inhibiting conditions can be almost entirely removed by mixing the soil with about one-quarter of its bulk of a compost prepared from dried straw or from sawdust. The nature of the changes brought about by the compost is under investigation.

7. Research on Vole Disease.

Dr. G. M. Findlay, of the Wellcombe Research Institution, has succeeded in transmitting a disease obtained from field voles to laboratory voles. This disease has been found to be due to a protozoan parasite infecting the brains of the voles, and the organism has been named *Toxoplasma microti*. It is believed that the disease is spread in the case of field voles by contaminated food. Much work remains to be done before this discovery can have any practical applications.

8. Advisory Committee on Forest Research.

Professor J. H. Priestley, Professor of Botany at Leeds University, has been appointed to the Committee. The research programme was discussed at a meeting held in London on 5th May, 1933. A field meeting was also held in the Forest of Dean in the latter part of September, when experimental work in progress was inspected.

9. Mycology.

Meria laricis.—This year the control obtained by the use of sulphur spray was again satisfactory. Work on the disease is now virtually completed.

Elm Disease.—A survey was carried out in September. The result shows that the disease is making little progress either westwards or northwards. In general, the attack this year has been more severe than in 1932, but the position remains better than it was in 1931.

Damping-off.—Interesting results have been obtained from the pre-treatment of seed with sterilising agents such as formaldehyde and cresylic acid.

Frost Investigation.—A good deal of work has been done, but the data have still to be worked up.

Heart Rot in Conifer.—A beginning has been made with this work. So far *Fomes annosus* has been the organism isolated in most cases from the material sent in.

Ink Disease of Chestnut.—Mr. Day takes rather a serious view of this disease. A tour of the areas where the disease was known to exist was made this summer, and in each case it was found to be apparently spreading. It has now been found in Devon, Somerset, Herefordshire, Hampshire and Buckinghamshire and is no doubt present elsewhere. This is believed to be one of the most important of the diseases affecting the roots of broadleaved trees.

10. Entomology.

Pine Beetle.—Mr. H. S. Hanson, of the Farnham House Laboratory, has spent a large part of the summer in the New Forest investigating this insect, together with its predators and parasites. Experiments with billet-traps have shown that rough barked billets attracted six times as many beetles per square foot as smooth barked billets. It is proposed to make a sample census of the insect population this winter.

Mr. Hanson also visited pine woodlands on the Seafield Estate round Grantown-on-Spey. He found evidence of a fairly strong resident population of pine beetle (*Myelophilus*), but no appreciable damage in any of the woods. While the system of leaving the woods unthinned provides an ample supply of material in which *Myelophilus* can breed freely, the conditions also favour the maintenance of a large population of predators and parasites and the result would appear to be a state of more or less stable equilibrium between *Myelophilus* and its predators, etc. On the other hand, the bark beetle, *Hylastes ater*, was found to be doing a considerable amount of harm, the insects boring into the base of the stem and the roots, weakening or killing large trees. This is considered to be related to the lack of thinning, the almost complete lack of breeding material on the surface forcing the *Hylastes* to breed in the roots of the standing trees, where they are relatively inaccessible to the predators.

It is hoped that the investigation in the New Forest will indicate the best method of treating pine woods, so as to prevent serious insect damage.

Pine Shoot Moth.—Further work has been done on the disbudding of pines in autumn. There is now conclusive evidence that this method of control is ineffective and should be abandoned. The alternative method of disbudding in spring is still under investigation.

The collection of information as to the status of the pest in East Anglia has yielded interesting results. Over 220 Compartments in Thetford, Swaffham and Rendlesham Forests were visited and 160,000 trees classified. The results may be briefly summarised as follows:—

(i) None of the plantations P. 22 to P. 29 is free from attack.

(ii) The existing Scots pine belts and hedges are considered to be the chief source of infection of young plantations.

(iii) The attack is below average intensity in areas where the pines are growing strongly and also in mixed plantations of Scots pine and Corsican pine. It is worst when the growth is poor.

(iv) The older plantations show in most cases a surprising recovery from the effects of attack.

(v) Corsican pine is relatively immune from injury. The percentage of infection is about the same as that of Scots pine, but a large proportion (80 per cent. in a batch of trees kept under observation) of the caterpillars die without appreciably injuring the buds.

Oak Leaf Caterpillar.—The attack of oak tortrix was considerably worse this year in the Forest of Dean than it was in 1932, but was still chiefly restricted to certain inclosures. The Highmeadow Woods were virtually untouched. Winter moth, which was so prevalent a few years ago, has almost disappeared, but, on the other hand, the mottled umber moth has increased in abundance and is doing a considerable amount of defoliation; there is some evidence, however, to show that parasites are beginning to gain the upper hand of this pest. With regard to 1935, another serious outbreak of oak tortrix is threatened, but whether it will develop seems to depend largely on the time relation between the flushing of the buds and the hatching out of the caterpillars.

Chafer Larvae.—During the summer observations have been made at Lynford Nursery on the flight periods of the different chafer beetles, where they lay their eggs, the population of larvae in the soil, and the relative amounts of damage done.

From the point of view of actual damage *Rhizotrogus* was found to be the most important species at Lynford this year, but as a whole the losses were not serious. It is believed that a close study of the egg-laying habits of the beetles may suggest cultural measures for minimising the attack. Other nurseries will be visited in the spring of 1934.

SEEDLINGS FOR TURF PLANTING: 1933 REPORTS.

By W. H. GUILLEBAUD.

The experimental use of seedlings in accordance with the instructions contained in Silvicultural Circular No. 11 was continued in P. 33 on about the same scale as in the previous year.

The weather conditions at the time of planting were generally favourable in that the late winter and spring were mild in most districts and there was no drought. On the other hand, the summer was abnormally hot and dry in England and Wales, and to a lesser extent also in Scotland. The effect of the summer drought was generally felt, and in many cases seedlings which started normally into growth in the spring withered and died before the dry spell had ended.

The table on page 39 summarises the results for the P. 33 planting of seedlings, with the corresponding figures for the transplant areas established as controls.

Sitka Spruce.—England and Wales used 3-yr. seedlings only, but in Scotland 2-yr. seedlings also were planted. The average loss in the 2-yr. seedlings in Scotland was 12 per cent. and in the 3-yr. seedlings 15 per cent., the corresponding figure for P. 32, when mostly 2-yr. seedlings were used, being 8 per cent. of losses. In about half of the 25 forests in which seedlings were used losses were below 7½ per cent. The transplant losses in Scotland were definitely lower, averaging only 5 per cent. In practically all forests, the soil was peaty, but usually of a good type.

The results in England and Wales appear rather less favourable, losses averaged 30 per cent. for seedlings and 12 per cent. for transplants, but examination of the data showed that most of the heavy losses occurred on mineral soils in Divisions 5 (Bawtry) and 7 (Forest of Dean and Tintern). Good results were obtained for the second year in succession in Division 1 (Kielder and Ennerdale). The transplant data also refer almost entirely to the mineral soil areas and so are not generally applicable.

Norway Spruce.—The results are very similar to those obtained with Sitka spruce and the losses are of the same order as in last year's experiments. The bulk of the heavy losses in England and Wales occurred on mineral soils in Divisions 6 and 7. Elsewhere failures were below 20 per cent.

European Larch.—There was no planting of European larch seedlings in England, but both 1-yr. and 2-yr. seedlings were planted in Scotland. The 1-yr. seedlings were put in in February or early March, but suffered fairly heavily from the summer drought, losses ranging from 28 to 68 per cent. Transplants lost only 12 per cent. in two out of the four forests; in the other two forests there were no transplant comparisons. The 2-yr. seedlings with an average loss of 22 per cent. did better than the 1-yr., *Comparison of Seedlings and Transplants planted P. 33.*

Species and Age.	Country.	Seedlings.					Transplants.			
		Thous. Planted.	Average Loss.	Number of Forests.			Average Loss.	Number of Forests.		
				Total.	Under 7½ per cent. loss.	Over 7½ per cent. loss.		Total.	Under 7½ per cent. loss.	Over 7½ per cent loss.
			Per cent.				Per cent.			
S.S. (2-yr.) ...	England and Wales ...	—	—	—	—	—	—	—	—	—
	Scotland	98	12	22	11	11	5	10	7	3
S.S. (3-yr.) ...	England and Wales ...	240	30	12	3	9	12	4	2	2
	Scotland	26	15	11	6	5	4	9	6	3
N.S. (2-yr.) ...	England and Wales ...	—	—	—	—	—	—	—	—	—
	Scotland	79	15	22	12	10	5	9	7	2
N.S. (3-yr.) ...	England and Wales ...	63	28	5	—	5	28	2	1	1
	Scotland	54	11	15	10	5	4	10	9	1
E.L. (1-yr.) ...	England and Wales ...	—	—	—	—	—	—	—	—	—
	Scotland	7	45	4	—	4	12	4	—	4
E.L. (2-yr.) ...	England and Wales ...	—	—	—	—	—	—	—	—	—
	Scotland	18	22	7	2	5	8	6	2	4
J.L. (1-yr.) ...	England and Wales ...	1	(46)	1	—	1	25	1	—	1
	Scotland	8	30	6	—	6	9	2	—	2
J.L. (2-yr.) ...	England and Wales ...	3	29	3	—	3	18	3	—	3
	Scotland	34	19	13	1	12	8	8	4	4
C.P. (2-yr.) ...	England and Wales ...	10	(47)	1	—	1	44	1	—	1
	Scotland	—	—	—	—	—	—	—	—	—

but still compare unfavourably with the transplants in which there were only 8 per cent. of failures.

Japanese Larch.—One-year seedlings planted in 6 forests in Scotland lost 30 per cent. as compared with 9 per cent. in the case of the transplants. In P. 32 1-yr. seedlings of Japanese larch lost more heavily than those of European larch, but this year the position was reversed. It may be mentioned that both in P. 32 and P. 33 1-yr. Japanese larch seedlings were used very successfully in experimental planting on ploughed ground at Wareham in Dorset and at Allerston in Yorkshire.

Two-year seedlings were planted in 13 forests in Scotland and in 3 forests in England and Wales. The former country gave the not unsatisfactory figure of 19 per cent. for losses (transplants 8 per cent.). Seedling losses were ascribed primarily to the drought. In England and Wales the failures averaged 29 per cent. (transplants 19 per cent.).

Corsican Pine.—A batch of 10,000 1-yr. seedlings was planted on a sandy heath at Laughton Forest in Division 5. Losses were high, averaging 45 per cent.; transplants put in alongside also failed badly.

Summary of P. 33 Planting.

The results of the spruce seedling planting are slightly poorer than last year, but both seasons were relatively unfavourable for seedling planting, 1932, owing to the spring drought and 1933 owing to the hot and dry summer; at the same time it must be remembered that in both years the winters were exceptionally open so that the seedlings had no long periods of frost to contend with. The heavy losses sustained with both species of spruce when mound planted on mineral soils suggests that the use of seedlings should be reserved for soils which have a peaty surface layer. It will be remembered that the P. 32 experiments gave much the same result. It is apparent that the turf cut from mineral soils has not sufficient power of water retention to withstand the effects of a moderately long drought, and turf planting on such soils either with seedlings or transplants is a risky proceeding.

Not the least interesting result of the P. 33 experiments has been the success of the transplants which have done remarkably well in view of the long summer drought. On the peat soils losses have not averaged more than 5 per cent. This is striking evidence of the efficiency of turf planting.

As regards the use of 2-yr. as compared with 3-yr. seedlings, there are too few adjacent experiments to give results of much value, but so far as the data go, there does not seem to be much to choose between the seedlings of the two ages.

Losses in the 1-yr. larch seedlings have again been heavy and for this the drought may fairly be blamed. Two-year seedlings did appreciably better, but even so losses were heavy in comparison with those of the transplants.

The following table provides a list of those forests in which seedlings were planted with almost complete success, i.e., where losses were less than 5 per cent.

Species.	Forest.	Age of Plant.	No. Planted.	Loss.	Soil.
				Per cent.	
Sitka spruce ...	Ennerdale ...	3-yr.	11,600	4	Peat.
	Glen Loy ...	2-yr.	3,300	2	,,
	,, ...	3-yr.	3,300	1	,,
	Lianachan ...	2-yr.	2,200	4	,,
	,, ...	3-yr.	2,200	1	,,
	South Laggan ...	,,	1,100	2	Peat and mineral soil.
	South Strome ...		1,100	4	Peat.
	Glengarry ...		2,200	3	Peat and mineral soil.
	Knapdale ...	2-yr.	4,200	3	Peat.
	Benmore ...	,,	7,000	2	Peat and mineral soil.
	Loch Ard ...	,,	3,000	1	Mineral soil.
	Achray	,,	3,000	2	Peat.
	Fiunary ...	3-yr.	3,000	2	Mineral soil.
	Inverinan ...	,,	3,000	2	Peaty loam.
	Total		50,200		
Norway spruce...	Glengarry ...	2-yr.	2,200	1	Peat.
	,, ...	3-yr.	2,200	2	,,
	Glen Loy ...	2-yr.	4,400	2	,,
	,, ...	3-yr.	4,400	2	,,
	Lianachan ...	2-yr.	2,200	2	,,
	,, ...	3-yr.	2,200	4	,,
	South Laggan ...	2-yr.	1,100	2	Peat and mineral soil.
	Knapdale ...	,,	2,200	1	Peat.
	,, ...	3-yr.	2,000	3	,,
	Benmore ...	2-yr.	7,000	2	Mineral soil.
	Loch Ard ...	,,	3,000	3	,,
	Inverinan ...	,,	4,000	2	,,
	Total		36,900		
European larch	Blackcraig	2-yr.	1,300	4	Peat.
	Longart	,,	—	4	Mineral soil.
Japanese larch	South Strome ...	,,	600	4	,,

The P. 32 Seedling Experiments.

Inspection of the data showed that in many cases a considerable increase in the number of failures took place during 1933. The fact that these second-year losses were higher in most species in England and Wales than in Scotland suggests that the summer drought may have been responsible, as this was more acute in the southern half of the Kingdom. The transplants suffered very few further losses in the second year, and the net effect is to increase considerably the gap between the seedlings and transplants in the matter of survival. The data are set out in the table below.

P. 32 Seedling Planting. Losses in P. 33.

Species.	Country.	P. 32 Plants which died in F.Y. 1933 (expressed as percentage of original number planted).	
		Seedlings.	Transplants.
		Per cent.	Per cent.
Sitka spruce ...	England and Wales ...	10	1
	Scotland	3	0·5
Norway spruce	England and Wales ...	9	4
	Scotland	6	2
European larch (1-yr.) ...	Scotland	12	1
European larch (2-yr.) ...	England and Wales ...	9	2
	Scotland	4	2
Japanese larch (1-yr.) ...	England and Wales ...	14	(14) one record.
	Scotland	18	(0) one record.

As regards the individual species, the most serious increase in the number of failures is in the 1-yr. seedlings of European and Japanese larch, which show additional losses of the order of 12 to 18 per cent. The spruces and the 2-yr. European larch seedlings lost a further 10 per cent. in 1933 in England and Wales. In Scotland, seedling losses in these species were considerably lower, ranging from 3 to 6 per cent. A result of this sort would seem inevitable when the second growing season happens to coincide with a year of exceptionally adverse growing conditions; weakly plants, which might normally survive in a good season, are likely to go under in a prolonged spell of summer drought such as experienced in 1933.

Rate of Growth of P. 32 Plants.

The following table sets out the average shoot growth of the seedlings and transplants planted in P. 32.

Growth of Seedlings and Transplants planted in P. 32.

Species.	Country.	Average Length of leading Shoots (inches).			
		Seedlings.		Transplants.	
		P. 32.	P. 33.	P. 32.	P. 33.
Sitka spruce ...	England and Wales	1·7	2·0	1·8	2·2
	Scotland	1·6	2·8	2·3	4·9
Norway spruce ...	England and Wales	1·1	1·5	2·1	2·3
	Scotland	1·0	2·7	1·5	3·5
European larch (1-yr.)	Scotland	1·9	4·8	5·0*	10·0*
European larch (2-yr.)	England and Wales	2·5	4·7	3·2	6·0
	Scotland	2·3	7·8	2·8	11·4
Japanese larch (1-yr.)	England and Wales	1·5	3·7	5·5*	2·0*
	Scotland	1·8	6·2	2·5*	12·0*

(*Transplant data inadequate to provide a fair basis of comparison.)

As might be expected, the transplants have made the more rapid growth both in the first and second years, the relative difference being greater in Scotland than in England and Wales. The shoots put on by the seedlings in the second year are fairly satisfactory in most species, but a fairer comparison would be possible after the plants have become fully established.

P. 31 Seedling Experiments.

Only a few of these have been reported on in detail this year, but these appear to be satisfactory. The data available indicate that scarcely any losses have occurred in the third season and that the plants are mostly improving in appearance and growth.

Summary.

The exceptionally dry summer of 1933 provided a severe test for seedling planting, but on the whole, results of the year's work have been encouraging. Once again the spruces have done better on turfs composed of peat than on mineral soils where most of the turf is composed of soil particles. In Scotland, although the drought was certainly more prolonged in most areas than that of the previous year, the spruces have done almost as well in point of survival, losses not exceeding 15 per cent. in either species. In England and Wales the failures in the seedlings were higher than in Scotland, but turf planting on mineral soils in the south of England was responsible for most of the heavy losses in the spruce planting. There was no striking difference between the results from 2-yr. seedlings, as compared with 3-yr. seedlings, of the two spruces. The poor results obtained for the second year running with 1-yr. seedlings of European and Japanese larch suggest that the use of such seedlings for turf planting is too risky a proceeding to be practicable. Experimental work, however, shows that 1-yr. seedlings of Japanese larch at any rate can be safely used on ploughed ground.

In spite of the drought, the transplants of all species put in for comparison did well generally, and failures were below 6 per cent. where the turf was composed of peat.

The second assessment of the P. 32 planting showed somewhat disquieting losses in the seedlings, probably as the result of the weather conditions during the second summer. In large-scale work with seedlings it would evidently be unwise to beat up failures at the end of the first year. The P. 31 seedling areas appear to be progressing satisfactorily.

OFFICE PROCEDURE.

With so many Divisional offices in the Forestry Commission it is thought that, even if absolute standardisation cannot be obtained, there must be many processes which are common and for which the best method can be found. With this in view, each of the Scottish Divisional Accountants was asked to write a paper on the procedure and the allocation of duties in his office. The Accountants were brought together to read their papers and these, along with the discussion which followed, proved to be so interesting it was suggested that, if possible, space should be found in the Journal for several articles on the subject.

Mr. Palmer (Scotland N.) and Mr. Wilson (Scotland N.E.) contribute to the series in the present issue, and it is hoped that one or more Divisional Accountants in England and Wales will give us the benefit of their experience in next year's number of the Journal.

T. W. C.

(i) Division Scotland N.

The clerical staff consists of a Divisional Accountant, two shorthand typists and a typist.

One of the shorthand typists is engaged mostly on normal correspondence, copying, etc.; the other is engaged firstly on accounting matters, preparation of draft account, preparation of cheques, typing accounting queries, preparation of classified abstracts, etc., and secondly, on general correspondence.

The typist is engaged on filing, checking time sheets, pay lists and progress reports, and summarising the standard heading of labour charges each fortnight in order that the paylists can be standard headed at the close of the month. She also attends to the despatch of post, parcels, etc., and the copying of orders for stores, tools, etc.

The Accountant attends to the account, preparation and submission of returns to Headquarters at the proper times, preparation of Forest Workers Holding agreements, and other letting agreements. There is no line of demarcation between the correspondence as dealt with by the Divisional Officer and Accountant. The mail is opened by the Accountant, who reserves purely accounting papers for his own attention. The rest of the post is discussed with the Divisional Officer, line of action decided upon and the papers usually taken by the Accountant for necessary action. Some of the matters are of course dealt with directly by the Divisional Officer particularly those dealing with technical questions. In the absence of the Divisional Officer, the Accountant deals with all the correspondence that he can.

The Cash Account.—The chief aim is to spread the preparation of the account over the month rather than try to complete it in a short time as soon as the financial month has closed. With this in view, payments of accounts are made twice a month during those weeks when imprests to foresters are not being made. As soon as possible after cheques have been sent out each fortnight, the payments are entered in the draft account. After the last payments by cheque have been made and entered on the draft account, the entries are totalled by forests and as a grand total. The payments in the cash book are totalled Allowing for imprests and contra entries, the total payments on draft account and in cash book should of course agree, and any error which is disclosed is corrected before any more entries are made.

When the foresters' accounts have been received and checked the payments are entered in the draft account. These entries are totalled by forests as distinct from the entries of payments from the office, and the totals of these entries must agree with the foresters' totals on his account.

In this way the preparation of the account itself is progressive. The checks on entries of payments from the office and payments from the forests, at each stage of entering them, localise any mistakes in entries. In the event of a mistake the number of entries to be checked is small. I have found by this method that the time occupied in balancing is reduced to a minimum.

The accounts paid from the office are checked for arithmetical accuracy by the shorthand typist. They are also checked by her against written orders, where such have been given, for accuracy as to prices charged, responsibility for carriage, etc.

The vouchers are then standard headed by the Accountant who also examines them, checking authorities for purchase from Headquarters, etc., where necessary. The shorthand typist then prepares the cheques for payment. The standard heading before payment helps to keep the work flowing evenly instead of having a spate at the end of the month. The very fact of standard heading the account necessitates a closer examination than just an arithmetical check and the obvious time for this is before the account is paid. The standard heading of course is based on notes from the receiving foresters where the nature of the purchase does not clearly indicate the head. The standard heading of labour charges is taken from the progress reports. On these there are generally some items, the correct standard heading of which had led to doubt in the foresters' mind, and which have been left for attention in the office. These are dealt with by the Accountant, sometimes, if necessary, after consultation with the Divisional Officer.

The standard heading done, the accounts are sorted into forests so that the entries for each forest are next each other in the cash book. This in turn facilitates entering the payments in the draft account.

Estimates.—These are prepared in the first place by forester and District Officer and submitted to Divisional Officer on separate sheets for each forest, detailing work to be done, rates, etc. These sheets are scrutinised by Divisional Officer and Accountant, the latter providing information to check unit costs upon which estimates are based, providing estimated expenditure under heads such as local supervision, and also preparing the office estimate. When the separate sheets have been approved they are copied in the estimate from A.76 for submission to Headquarters.

Nursery.—All office work in connection with nursery records is done by the Accountant, *i.e.*, checking and summarizing nursery forms, N.R.1, N.R.2, N.R.3, N.R.4 and also of course the completion of transfer notes for plants, etc. The P. 3 forms for plant requirements and allocations are of course prepared, so far as possible, by the District Officer and forester, but the completion of these is done by the Divisional Officer and Accountant jointly.

Grants.—This Division has few grant schemes and the usual statements of schemes to be inspected for first and final payments during each season are passed to the District Officers.

Stores.—The entries in stores ledger are made by the shorthand typist after completion of the monthly account. She also prepares the advice note (A.34) notifying each forester of stores taken on stock each month. During July and August the District Officers are provided with lists showing stores on hand at previous stocktaking, stores taken on stock during year as per A.34 for each forest. The District Officers then take stock and enter deficiencies, etc., on the lists and return them to the office. The completed lists are checked against the office stores ledger and used for the preparation of deficiency lists for the Assistant Commissioner. Upon receipt of authority to " write off " deficiencies the stores ledger is balanced for the year. The foresters are then authorized to destroy, etc., broken and useless stores, " write off " deficiencies on their stock ledgers and are asked to submit their disposals certificates.

Returns.—Some of the information required for returns to Headquarters must first be supplied to the office by the districts. This applies particularly to inspection of firearms, F.W.H., fire fighting appliances, and in such cases the District Officers are reminded, about a month before the return is due, that the information will be required. This results as a rule in the information being in the office early enough for submission to Headquarters at the proper time. Planting progress reports are made up from the foresters fortnightly progress reports. Industrial staff returns are made up from information supplied by the foresters on special postcards.

Annual Report.—All the statistical information required for the Annual Report is prepared by the Accountant and also the notes on staff, particulars of acquisitions, etc. Notes on the technical work in this report are prepared by the Divisional Officer.

General.—An old but still serviceable flat duplicator, which was inherited, I believe, from the Coal Commission, has proved a very helpful piece of equipment. When circular letters to all foresters, etc., are required, it is found quicker to roneo them than type numerous copies, and each man is sure of getting a clear copy. If such letters can be held over until two or three different short letters are required, these can all be done on one stencil.

A roneoed list of forests on foolscap paper has been found convenient for innumerable purposes not the least of its advantages being that in reporting such things as planting progress and industrial staffs the uniformity of order of forests is ensured. Roneoed letters are sometimes provided to the District Officers for distribution to their foresters, etc.

While the general duties of the clerical staff are planned as indicated above, the staff is too small to have small watertight compartments. The typist and shorthand typists are all acquainted with the work that the others do and could, if necessary, be interchanged though, for the sake of the efficiency which comes through familiarity with a job, they are kept on the same work as far as is compatible with the smooth working of the office.

A. D. PALMER.

(ii) DIVISION SCOTLAND N.E.

The indoor staff consists of a Divisional Accountant, a clerical officer of recent appointment, a shorthand typist and a typist. The shorthand typist takes practically all dictation and, in addition, is responsible for the major portion of the general typing work. The typist is engaged mainly on filing, attends to the out-going post, stationery, typing of a copying nature and when necessary is called upon for general correspondence in rush periods. The clerical officer is engaged in the checking of pay lists, progress reports and time sheets, and prepares working sheets in connection with the allocation of labour charges. He compiles the information necessary for certain of the minor office returns, he also computes the plant transfer notes and attends to various other matters of a routine nature.

It has been found advantageous for the Accountant to commence duty earlier in the day than the other members of the staff, in order that the incoming post may be scrutinised and the work allocated without undue delay. The correspondence relating to accounts and other matters of a general nature are retained by him for action ; the remainder of the correspondence is discussed with the Divisional Officer. In the absence of the Divisional Officer, the Accountant deals with all correspondence, leaving only that of a purely technical nature. The Accountant prepares all agreements for forest workers' holdings and other devolved lettings.

The Cash Account.—A monthly statement of receipts and expenditure is rendered to Headquarters within one week of the close of the month, and the cash account is submitted by the 17th of the following month. It is therefore essential that the work of compiling the account be spread over the month as far as possible. All accounts for payment from the office are standard-headed when checked, and working sheets are prepared to show the allocation of labour charges when the examination of the pay-list is made after each payment of wages. When the final payment of wages for the month is made, the labour charges are totalled and the working sheets are ready for the insertion of other payments by the foresters. On receipt of the foresters' cash accounts they are checked, the vouchers standard-headed and entered on the working sheets, which should correspond with the total payments expended by the foresters. This ensures a rapid check at the end of each month and localizes any discrepancies in the forest account. Payment of accounts from the office is made fortnightly and the receipted vouchers are placed in a file cover, one for each forest, ready for insertion in the working sheet immediately the forester's account has been checked. The working sheet also records entries from composite vouchers which, if not properly recorded, are a fruitful source of trouble. The receipts are shown at the foot of the working sheet. The cash account is then ready for completion and the classified abstracts are prepared from the working sheets. The forest produce account, showing all sales and utilisations for forest purposes, is prepared and submitted with the cash account. Transfer invoices are then made out for all produce issued for forest use.

Estimates.—As the foresters are directly concerned in keeping expenditure within the amount of the estimates, it is considered they should take an active part in framing the estimates. The first step is the issue to foresters of a preliminary statement on which they record, in draft form, the amount of work to be undertaken, the rate per unit and the money required. The District Officer goes over the ground with the forester and the statement is finally completed. This form is brought to the office by the District Officer when all items are discussed by the Divisional Officer and District Officer and inserted in the estimates form for the Division by the Accountant. A copy of the classified abstract completed to show the total expenditure to date and the amount of the estimates is issued by the middle of each month to foresters and to District Officers and one copy is passed to the Divisional Officer for his personal use.

Grants.—A register of grants is kept in the office, a separate page being prepared for each planting season. This register details each approved scheme separately and is ruled in columns to record every stage in the progress of the scheme from the date of receipt of the application to final payment. The register shows at a glance the progress of each scheme, and is useful in the preparation of reminders to grantees if delay is experienced in reporting the completion of planting. Certificates for final payment are prepared in the office and issued with the files and maps to the District Officer when the inspection is due. It has been found a good thing to intimate to grantees, three years after the first payment, that inspection falls to be made in a year's time ; this gives the grantee sufficient time to arrange during the ensuing year for any beating up or other work necessary.

Stores.—It is remarkable how many different names can be given to a particular tool and this leads to complications at time of stocktaking unless steps are taken to ensure uniformity in nomenclature when articles are entered in the forest and office stores ledgers. To ensure uniformity and to facilitate the checking of stores it is the practice to issue an advice note (A.34) for all stores, whether purchased through the office or locally by the forester. The stores ledger is written up when this advice note is prepared, and entered by the forester on receipt of the advice note. After stocktaking each year a statement on A.64 is issued to the forester showing the stores on charge at the commencement of each forest year. This statement, after being checked with the forest stores ledger, forms the basis of the next year's stocktaking, and as one copy of each advice note is retained by the forester, discrepancies in recording stores at time of stocktaking are readily located. This, of course, applies to the recording of stores as apart from the physical stocktaking which is made periodically and at the end of each year. After stocktaking, and upon receipt of the necessary authority, the disposal of articles to be written off is witnessed by the District Officer and disposal certificates rendered.

Nurseries and Plant Supplies.—The checking of all nursery records, also the forest plant records, is done by the Accountant. Demand notes are completed by the forester, two copies being submitted to the office and one to the District Officer. The demand note is checked from the nursery stock books, which are compiled by nurseries to show stocks, categories and allocations. These books are used as a control throughout the plant movement season, the demand note being entered as it passes through the office. By this means the position of plant movements can be ascertained at any time and enables the Divisional Officer to deal expeditiously with reported surpluses or the re-allocation of remaining stocks to the best advantage in the case of unexpected deficiencies. All amendments are made by the Accountant and notified to District Officers and foresters on P.5. The completion of plant transfer notes is undertaken by the Accountant from the forest records (R.1). In the case of transfers to other Divisions, advice note T.12A. is not received and it is necessary to frame some other method of keeping a record of the transfer. A separate schedule is prepared for this purpose which, apart from recording the necessary information such as quantity, price, supplying nursery, etc., is a means of checking outstanding transfer notes which have not been returned receipted from other Divisions.

It has been found necessary to enter on advice note (T.12A) the cost of plants transferred, as the submission of the transfer note (T.12B) to Headquarters leaves the Division without a record of the value of the plants. This information is essential for checking nursery costings.

Annual Report.—The statistical information for the Divisional Report is prepared by the Accountant and the technical and other part by the Divisional Officer. It was the practice in the past to obtain a report from each forester which was submitted through the District

Officer who checked it and added his observations. Under the new system this has been discontinued and the District Officer is called upon to prepare a report in respect of each of his units. The present system may have its advantages but the framing of his own report undoubtedly led the forester to view the past year's work in perspective and to consider whether a change in future procedure should not be instituted.

General.—In outlining the methods adopted in dealing with the returns mentioned, an endeavour has been made to stress the additional methods not visualized by instructions, but which nevertheless form a necessary adjunct to speedy and smooth working.

G. M. Wilson.

ROOT DEVELOPMENT ON PLOUGHED GROUND AT ALLERSTON, 1933.

By R. E. Fossey.

Outline of the Work.

It was proposed, in the first place, to determine from the examination of plough furrows and specially dug pits to what extent the soil pan had been broken up by the different depths of ploughing and subsoiling, and if the portions remaining in situ had been modified by weathering ; also to note any changes in other soil horizons due to the treatments ; and, secondly, to observe any modifications in the extent and type of root system which appeared to follow from the changes in the soil, at the same time noting the effect of basic slag, and comparing trees of different age and type at the time of planting. Observations under the second head, which necessarily occupy a considerable time, can only be regarded as of a preliminary nature and giving a few very general indications. Work was first concentrated upon Scots pine ; a number of Sitka spruce and a few Japanese larch were then chosen for examination from treatments which it appeared would yield the most helpful results.

The Soil.

The following description of a typical profile from a pit in unploughed ground shows the conditions met with throughout the investigation, slight variations being found in the thickness of some of the horizons. The description may be noted in connection with those given in Mr. G. V. Jacks' paper, " A Study of Some Yorkshire Moorland Soils," published in *Forestry*, Vol. 6, No. 1, June, 1932, which indicate that the present work was undertaken in the normal type at Allerston and that the immature soils described by Mr. Jacks were not encountered.

Inches.	
0–1	Heather peat matted with roots.
1–5½	Whitish grey slightly humus-stained sand with silt, streaked and mottled with black humus (decayed roots) ; very compacted ; numerous small stones.
5½–5¾	Black peat or humus from decayed roots.
5¾–6	Brown hard iron pan.
6–12 +	Yellow brown sand with silt becoming lighter in colour below ; somewhat compacted and with some root remains, especially in the upper part, often in more or less horizontal streaks ; numerous small stones.

All horizons were quite dry, following several weeks with very little rain.

Shallow Ploughing.—With the plough in use up to P. 30, a furrow not more than 4 in. deep was usually opened. Three methods were tried, namely, a single furrow turned at 5-ft. intervals, three adjacent furrows turned at 5-ft. intervals from centre furrow to centre furrow, and complete ploughing.

With the first two methods, the surface 2—3 in. of material overturned from the furrows consists of the whitish grey sand, which is now quite loose, below which is the overturned heather peat and turf about an inch thick. This is either lying quite closely against the turf untouched by the plough, from which the profile continues exactly like the one described above for unploughed ground ; or it is lying partly against the adjacent overturned turf and partly in the bottom of the adjacent furrow, and in the latter case the typical profile is as follows :

Inches.	
0–3	Whitish grey sand with silt, quite loose. (The surface is still somewhat ridged but there has been good settling ; the ridges may be as much as 4 in. deeper.)
3–4	Overturned heather peat and turf with decayed plant remains. This lies closely against
4–6	Whitish grey sand with silt, very compacted.
6–6¼	Layer of decayed roots.
6¼–6½	Pan.
6½–12+	Yellow brown sand with silt becoming lighter below.

Thus there remains in the furrows a thickness up to about 2 in. of whitish grey sand still compacted, except for the uppermost quarter-inch or so where this is exposed and has therefore been slightly weathered. Between the furrows and overturned material there are, of course, lines of untouched ground. In the completely ploughed plots, conditions are essentially the same as indicated in the above profile description, practically all the overturned material lying where the adjacent furrow was cut. The direct effect of these methods of preparation, apart from the partial or complete inversion of the uppermost 4 in., appears to be merely a somewhat improved surface drainage ; the pan and the soil below, as well as a portion of the compacted leached layer above, remaining untouched. The illuvial horizon under complete ploughing was found to be moist, unlike the other horizons or this horizon elsewhere. (The illuvial horizon is the B layer, or zone of deposition below the leached A layer.)

Deep Ploughing.—With the plough used from P. 31 onwards a furrow about 8 in. deep has been obtained except where, as quite often, the share rides over stones. It follows, therefore, that the pan together with a small amount of the underlying brown horizon has been overturned except around some larger stones. Pieces of pan brought out by the plough and exposed on the surface have been further broken up by weathering and lie irregularly along the ridges in groups like broken mosaic. These and the brown sand give the ridges a predominantly brown colour, with whitish grey patches of varying size where the plough has not been able to cut so deeply, so that the appearance is quite different at a short distance from that of the shallow ploughed areas which show whitish grey ridges throughout.

Three methods have been tried : firstly, two adjacent furrows turned at 5-ft. intervals ; secondly, the same method of ploughing preceded by subsoiling ; and, thirdly, complete ploughing.

In the double-furrow methods, a not very much loosened layer of whitish grey sand usually about 5 in. deep (or less where settling has occurred) is topped by fragments of pan and the brown illuvial horizon, and overlies the inverted turf. From the first furrow, this almost always lies closely against the untouched turf where the vegetation was properly burned before ploughing, but occasionally a pocket of air is enclosed with the inverted turf arched above it. The profile then continues downwards as described for unploughed ground, except that where the subsoiler was used there is a practically continuous tunnel in the illuvial horizon varying irregularly in size up to about 8 in. from roof to floor and 5 in. from side to side; the roof of the tunnel is about 9 in. below the original surface. The tunnel was disclosed when roots were being traced by careful removal of the soil with the hands, but use of a spade caused the roof to fall in beforehand and its outline could then only be surmised. From the second furrow the overturned material lies partly against that from the first and partly in the bottom of the first furrow, again occasionally enclosing a narrow air pocket.

In the completely ploughed plots the overturned material is again in much the same position as that from the second furrow in the double-furrowed plots, giving typically the following profile:

Inches.	
0–2	Whitish grey sand with silt, compacted, with many fragments of inverted pan and some yellow brown sand with silt scattered irregularly over the surface, the latter sometimes to a depth of 1 inch over the pan (much settling has everywhere reduced the usual original 2 inches of illuvial material).
2–3	Overturned heather peat and turf with decayed plant remains. This lies nearly always closely against
3+	Yellow brown sand with silt, friable, becoming lighter and slightly compacted below.

The depth of the whitish grey sand with silt is only about 2 in. as a rule where the soil has been firmed round a tree, but commonly more elsewhere, and along the ridges up to 6 in. The surface of the leached layer is loosened somewhat by weathering where exposed.

In order properly to compare deeply ploughed with unploughed ground, a pit was dug from a completely ploughed plot (P. 31) across into a ride running parallel with the ploughing, thus exposing the two profiles side by side. It appeared that in the so-called complete ploughing a section a few inches wide had been missed and so retained its original position; this condition was found elsewhere in the investigation, but by no means in all cases, and too few excavations were made to enable a reliable estimate of the thoroughness of the ploughing to be given; it is perhaps unavoidable that small pieces should occasionally be missed. Where the plough has cut most deeply and overturned a fair depth of the illuvial material, the pan has remained in the fairly large pieces which the plough broke away, and has only become further broken where it lies on the surface as already mentioned. At the edge of the last furrow, the pan has been broken up for a distance of ½ to 1 in. inwards under the untouched surface; this was traced along for some distance from the pit, and is no doubt entirely due to the plough action and not to weathering. The leached horizon, now lying below the pan, is still quite compacted, but is certainly less tightly packed than this layer is before disturbance. It was also observed that after the long spell of dry weather the lower portion of the illuvial horizon, remaining in situ, was still quite moist, while the illuvial horizon under the untouched ground was quite dry as already mentioned. It has also been noted already that this horizon was somewhat moist under complete shallow ploughing, but under the deep ploughing it was even moister.

Root Growth.

The seedling Scots pine in Experiment 3, P. 28, were planted by dibbling; all the other Scots pine and the Japanese larch were planted with a vertical notch, and the Sitka spruce with a double T notch. Heights at planting as well as at the present time are taken from ground level, the buried portion of the shoot, in the cases of too deep planting, thus being excluded. It is unfortunate that no Scots pine was planted on the completely ploughed or subsoiled ground on this moor during P. 31 or P. 32, and P. 33 plants were not examined in such a limited study made so soon after the planting. Observations on the deep ploughing were, in fact, practically confined to the P. 31 planting.

As already pointed out, the material obtained from this study cannot justify the drawing of many definite conclusions. It indicates that the soil layer which creates most difficulty for tree establishment, in ground unprepared, or inadequately prepared for planting, is the very compacted leached horizon occupying almost all of the 4 or 5 in. between the peat and the pan, and not the pan itself. Planting by notching does practically nothing of itself to make this horizon more suitable for the growth of tree roots, so that direct planting with or without screefing involves a long check to the plant; even in such cases, however, a few roots may penetrate horizontally for a fair distance. Shallow ploughing effects some improvement, and the horizontal penetration of roots is in some cases remarkable, with corresponding improvement in shoot growth; basic slag still further increases the penetration (as well as the number of roots) in the case of Sitka spruce, but very little apparently in the case of Scots pine, though it is unfortunate that an apparent discrepancy in age in the pine plot makes a close comparison impossible. It is, however, of interest that this penetration is horizontal, even in some cases slightly upward, the roots frequently running in the peat or perhaps, in the case of shallow ploughing, just below the overturned turf. In the latter case rotten ends are sometimes found, where the root has entered too large an air space between the two turfs and has not been sufficiently vigorous to grow through it to a further supply of nutriment. Sometimes, too, on the less vigorous plants, roots begin to fail and to decay after growing a long way into the leached layer. The tendency to horizontal development is at least as marked in the Scots pine as in the Sitka spruce; it is possible that this would not be the case if the notched plants had been put in with the tap root pointing straight down, as was done with at least one of the dibbled seedlings. The adventitious roots of the one very badly planted Japanese larch examined (yet one of the few surviving trees in the plot) run just below the surface, one even coming up from a depth of 5 in. to do so. The relatively few deep going roots, which in the case of the larch and the spruce and some of the pine are more or less directly under the tree, but with others of the pine merely turn down as they approach a furrow and continue to slope down beneath it, seem to experience no difficulty in penetrating the pan if sufficiently vigorous to continue growth; no cases were observed of roots having grown satisfactorily down to the pan and having then rotted away, though in some cases the pan appeared to cause some deflection of the course taken.

The effect of deep ploughing is such that the quick cheap planting method is probably good enough if carefully executed. The roots of pine, which are still mainly in the leached horizon (now overturned but still somewhat compacted) and the peat, are able to spread very much more rapidly and in most cases show a number of active tips; these tips are extremely fragile, while the remainder of the root system is quite tough in marked contrast to the easily snapped roots of the directly planted trees. Here again the pines spread laterally and do not show a tap root, but many of the lateral roots slope downwards and sometimes after going more or less horizontally for some distance turn somewhat abruptly downwards, and this not usually because of the proximity of a furrow. When such roots reach the pan they pass through it apparently with little difficulty, though frequently they make a smaller angle with the horizontal while in the pan and resume their previous direction below, and occasionally they run a short distance on the pan surface before making their way through. Other roots are relatively superficial and spread chiefly in the peat and the spruce below the overturned turf; roots within the latter have a tougher exterior and very few side branches, even when these are numerous on other parts of the same roots; they very rarely rot away as described in the case of shallow ploughing, as they are vigorous enough to grow through normal air spaces; but where the turf has not been thrown over so as to lie properly, a fairly frequent occurrence where the heather was not thoroughly burned beforehand, quite a large air pocket may occur, and complete check was found in one or two cases (not only pine) to be due apparently to this alone. The effect of slag appears to have been to stimulate a somewhat smaller number of much more vigorous roots, with similar directional tendencies to those of control plants.

The spruce show the same tendency as the pine for some of the lateral roots to go somewhat more deeply, and behave in the same way in regard to the pan. Generally, however, the bushy nursery root system has survived and develops strongly in one direction, apparently according to the way it was inserted in the notch; it also sends one or two thin roots down directly beneath the tree, though adventitious lateral ones may eventually reach a greater depth. Side branches are usually very numerous on the lateral adventitious system, though roots of the nature of "sinkers" are practically absent. Slag appears to increase number as well as vigour of roots, but not to a greater extent than complete ploughing. Only relatively few roots have reached the tunnel formed by sub-soiling, and it is too early to pronounce on any effect that this may have on the root system; the subsoiling does not appear to have influenced greatly the shoot development of any of the three species examined.

Most of the plots of Japanese larch show such great variation between individuals that the choice of a single tree as a representative average is scarcely possible. Thus it is not safe to infer, as might be done from the data given, that complete ploughing without slag is less satisfactory than double-furrow ploughing and subsoiling with slag; the appearance of these plots is so irregular that even a tentative opinion on this matter, without assessment, cannot be given. As with the spruce, the effect of subsoiling is not yet evident in the development of the trees. There is a pronounced tendency for some spreading adventitious roots definitely to take the place of the nursery system (moribund owing to the almost invariable deep planting) by going downwards at a steep angle; they are thus more or less clearly separated from others that penetrate nearly horizontally. Perhaps if the planting had not been too deep the nursery system would have provided all the deep going roots. It is not deep planting which is responsible for the much poorer growth in some cases than others, for some of the best grown trees were inspected and found to have been inserted equally far. It does, however, appear that, irrespective of age, a tree that is tall and lanky when planted is less satisfactory than a shorter healthy one, even when the latter is badly planted; the evidence of the data given was supported by inspection of the shoots of other plants in the plots which came under notice. The data for the pine might be taken as pointing in the same direction; those for the spruce give no information on the point.

No microscopic investigation of mycorrhiza was made, but it was not observed above the pan except in small pockets of humus very occasionally found in the leached layer, and also practically on the surface of the pan (that is to say, in the layer of humus from decayed roots of heather, etc.). It was frequently found below the pan and even sometimes within the pan itself; the latter being especially remarkable in the case of the Scots pine 1-yr. seedling (beaten-up plant) directly planted, Experiment 3, P. 28, which had a particularly good root system and of a form unlike that of any other tree examined. Other plants on which it was specially observed were the good 1-yr. pine seedling on the double-furrowed ground in Experiment 13, P. 31, and the slagged spruce and larch on the double-furrowed subsoiled ground, Experiment 11, P. 31. It is curious that it should not be equally plentiful on some of the other trees on the deeply ploughed ground.

Mr. Guillebaud makes the following comments on Mr. Fossey's report:—

This investigation was not intended to be more than a trial run.

It was hoped to gain experience in the technique of the work and also to get some idea as to the points to which further enquiry should be directed.

1. Examination of the data shows that only one of the roots of Scots pine planted on unploughed ground was longer than 12 in. and only one root, and that probably due to exceptional circumstances, penetrated the pan layer, on the other hand even the shallow ploughing made a great difference to the root spread, thus three plants had an average of seven roots longer than 12 in., while the surprising depths of 18 and 21 in. below ground level were reached by some of the roots. A depth of 21 in. means that the root had penetrated well over a foot into the brown soil below the pan; this makes us revise our views as to the obstacle presented by the pan layer. The fact that six roots on two plants should have pushed through the pan shows that this is not a case of a single exceptional root and Mr. Fossey expressly stated in his report that these deep going roots appear to be functioning normally. The case of the 1-yr. seedling pine planted only three years ago on deep ploughing is interesting. Four roots on this plant had penetrated the pan, the deepest going down to 15 in. Reference to the data for the shoot growths of the different plants shows that deep going roots are usually correlated with vigorous shoot growth. Still more interesting is the fact that Sitka spruce roots are capable of penetrating the pan. This was observed on two plants, but it is probably significant that these had both been treated with slag. The maximum penetration where there was a pan was 12 in. but on the complete ploughing of P. 31 one root was traced to 19 in. below ground level. Japanese larch also appears to find little difficulty in putting its roots down through the pan for no fewer than nine such roots were found (five trees examined).

2. Basic slag appears to increase substantially both the number and length of main lateral roots in all three species. Other things being equal, the plant with the longest and most branched root system should do the best, it is to this stimulus to root development that at least part of the beneficial effect of slag applications must be due.

3. The observations on root activity are of interest. The work was done in the latter half of September, and it was found that roots of all the direct planted Scots pine were dormant while there were some signs of activity on the ploughed ground. The Sitka spruce direct planted or on shallow plough were mostly inactive, but on deep ploughing active new root growth was in progress.

4. The evidence above ground (apart from that given in this report) distinctly favours complete ploughing as compared with ridge ploughing, but the root data would have to be amplified considerably before any comparison of development below ground could be drawn.

5. The emphasis which Mr. Fossey places on the importance of good vertical notching of pine may or may not be justified on the data he has provided, but it certainly seems a point worth following up, both at Allerston and elsewhere where ground of this type is ploughed. It must be difficult to keep a notch open when planting on to a plough furrow,

and it is quite likely that many of the plants have their roots bent up at the bottom of the notch ; such plants may not grow as well as if their roots had been kept in a vertical position. Experiments on this point will be carried out in P. 34.

6. The permanence of the channel formed by the subsoiler is interesting. This should help drainage and probably also the penetration of deep going roots.

7. The observation that the brown soil horizon (the so-called "illuvial" horizon) was most moist where the ground had been deeply ploughed, moist under the shallow ploughing and dry where the surface was undisturbed, is very significant. It shows that it is the surface layer of the soil with its covering of raw humus which prevents free upward or downward movement of the water and not primarily the pan.

To sum up the work as far as it has gone. It is evident that the surface layers of these poor calluna soils are, in their natural state, unfavourable to root development. Disturbance of the surface by ploughing leads to a great improvement in root growth and appears to encourage deep-going roots. Although the pan layer does not seem to be a major obstacle to root growth, it will presumably be advantageous to plough deeply in order to increase the depth of moved soil and also to facilitate movement of water in the brown soil horizon.

EFFECT OF FACTORS OTHER THAN TEMPERATURE ON FROST DAMAGE.

By T. R. Peace.

During the past four years a large number of experiments on frost damage have been carried out at the Imperial Forestry Institute, Oxford, using a refrigerating chamber and small trees in pots. Many of these experiments have been directed to finding the critical temperature, which was taken as the highest temperature at which half the number of plants used was damaged, for various species of trees of silvicultural importance. The results of this part of the work have been published (*Oxford Forestry Memoir*, No. 16). It was found that the critical temperature was at its lowest in January, rose throughout the spring, the rise being particularly rapid during the period when growth is starting, and reached the summer level at the end of May. From September it falls again to the hardy winter level. A number of experiments have however been carried out on the effect of other factors such as wind and rate of freezing on the amount of frost damage, and the results of these are discussed shortly below.

A large number of experiments have been carried out on the effect of wind and humidity on frost damage. To aid in this work a large box was constructed, in which the air could be circulated at high speed by a fan, and the humidity of which could be lowered by the use of calcium chloride as a drying agent. Young trees were subjected to frost at different humidities and different air speeds. No evidence could be found from these experiments that humidity had any effect on the amount of damage to the plants. Wind on the other hand did have some effect. Of the 36 experiments carried out, 19 showed no difference between the lots at different air speeds, while in 17 there was some evidence that the higher the wind the worse was the damage. In many cases the difference due to the wind was very slight. If anything larch, even when in leaf, was less affected by wind than the other species tried, but the number of experiments was insufficient for this to be stated with certainty. The effect of wind seems not to depend on the time of year, and therefore not on the state of growth of the plants.

Experiments were carried out to test the effect of different treatments prior to freezing. The plants were usually exposed to these for a period of 4 to 6 days, and the treatments were more or less confined to different temperatures and combinations of temperatures. In 8 out of the 10 experiments made, exposure to low temperatures, freezing point or just above, before freezing was found to harden the plants, while in 7 out of the 10 exposure to warm temperatures, 70 deg. F., or so, was found to increase their susceptibility. In contradiction to the work of Harvey (*Journal of Forestry*, xxviii, 1, p. 50, 1930) on elm plants, it was found that alternation in high and low temperatures before freezing gave more or less the same result as continuous exposure to medium temperatures.

Harvey found that this treatment hardened the plants more thoroughly than continuous exposure to low temperatures. It is of interest to note that the experiments that gave no effect were in January and May, whereas those showing a hardening and softening effect were in February, March and April. It seems possible that before February the plants are too dormant, and after April in too active growth to be affected. One of the most interesting experiments was carried out on Douglas fir in February. The death of buds as a result of subsequent freezing was markedly increased by five days exposure to 70 deg. F., although the buds showed no visible reaction to this treatment.

The effect of four or five freezings above the critical temperature on the plants, and on their subsequent reaction to freezing below the critical temperature was investigated. In four out of seven experiments there was no effect at all; in one case damage was caused by four or five freezings above the critical temperature, when one, two or three caused none, but there was no effect on the damage in the final freezing; in another the preliminary freezings caused slight hardening; and in a third they slightly lowered the resistance of the plants. Repeated freezing above the critical temperature cannot be said therefore to have any important effect on the plant.

The effect of repeated freezing below the critical temperature was very different. Only two experiments were conducted on this point, but in general the more often the plants were frozen and thawed the worse was the damage, even though the total period of the freezing was less than that of the controls which were left in continuously.

In seven out of nine experiments it was found that fast freezing increased the damage as compared with slow. The effect in several of these experiments was very slight, and the remaining two showed no difference. In the experiments to ascertain the critical temperatures for different species at different times of year, carried out in the refrigerator, fast freezing had always been used, and it is possible that the critical temperatures might, in some cases, have been slightly lower had the freezing been slow.

The effect of fast thawing was not as definite as that of fast freezing. Out of 25 experiments, 13 showed more damage with fast thawing than with slow, while in 12 there was no difference. The rate of thawing seemed to affect evergreen conifers more than deciduous conifers or broad-leaved trees. In a number of experiments the influence effect of wind during thawing was tried, but this appeared to have no effect. In the rate of freezing and thawing experiments there was no evidence that the time of year had any effect on the result.

As other experiments supposed to be comparative had been carried out regardless of the time of day, and as the metabolic activity of a plant varies throughout each twenty-four hours, a series of freezings at the same temperature were carried out throughout the complete day and night. This was done on two occasions, and on neither did the time of day appear to have any effect on frost damage.

A number of experiments were conducted to find the minimum time in which frost damage could take place, and to what extent it increased with the time of exposure to frost. These experiments are not yet complete, but it is clear that some damage can be done in as short a period as five minutes, that the amount of damage increases rapidly up to twenty minutes or so, and that after that the amount of damage rises very slowly with the length of exposure, so that differences in damage are only noticeable if plants exposed to very different periods of freezing are compared.

In connection with the question of spray damage in frosty weather, work was done on the effect of spraying on frost damage in the refrigerator. In seven out of eight experiments, spraying immediately before or while freezing increased the subsequent damage. In the same way it was several times noticed that plants used in the refrigerator still wet from rain were slightly more damaged than dry plants, though this was not invariably the case. A number of subsidiary observations were made, but they are based in each case on the results of only two experiments. Sulsol and amberene solutions increased damage in the same way as water. Glycerine appeared to increase the damage to a rather less extent than water. Spraying just before removal from the refrigerator did not increase the damage, but did not minimize it in any way.

A number of experiments were carried out to test the effect of re-potting just before freezing, of root pruning, and of drought on frost damage. In no case was drought found to have any effect. Repotting increased the damage in one case but failed to do so in three, and root pruning increased it in one case, but failed to do so in two. It would appear therefore that lining out and the damage to roots associated with it are unlikely to have much effect on frost damage, and the fact that in some of our experiments the plants had not been very long potted should not have had any effect on the results.

It seems unlikely that any of the factors discussed above can rival temperature as the most important cause of frost damage. A raising or lowering of the critical temperature by a degree or two is all the difference that they are likely to make. Thus the effect of the factors is only apparent if the experiment is carried out at or near the critical temperature; for if the temperature is too high the effect of the factor, even if adverse, will be insufficient to cause damage; and if the temperature is too low the damage will be too severe for the effect of the factor to be apparent. It is proposed during the present season to carry out experiments designed to express the effect of these factors by the amount they raise or lower the critical temperature.

SPRAYING AGAINST MERIA LARICIS, 1933.

By T. R. PEACE.

In the spring and summer of 1933 spraying experiments against this disease were carried out at four nurseries. Four experiments were done in duplicate, Nos. I and IV at Rhinefield in the New Forest and at Hamsterley in Durham, and Nos. II and III at Nagshead in the Forest of Dean and at Fairoak near Tintern. All the experiments were on beds of seedlings in their second year. The experiment at Hamsterley was unsuccessful owing to extremely light Meria infection on the controls (Meria infection was slight in most nurseries in 1933, probably owing to the dry weather). At Rhinefield there was considerable evidence that spraying controlled the disease, 1½ per cent. Amberene applied weekly being particularly striking, since it gave almost complete protection from the fungus. Amberene of the same strength applied fortnightly or every three weeks also gave quite good control, but monthly sprayings were not satisfactory. Spraying with various strong fungicidal solutions at the beginning of March proved to be of no value unless followed by further sprayings later on. The relative freedom from Meria of some of the sprayed plots was not, as at Nagshead, reflected to any great extent in their growth, though that in the plots sprayed weekly was rather better than in any other. At Fairoak the experiments were a failure owing to the extremely varied density of the beds, and the lack of infection. At Nagshead the treatments may be arranged as under:

Very successful :—

- 5 per cent. Amberene in early March followed by 1½ per cent. Amberene fortnightly.
- 1½ per cent. Amberene fortnightly.
- 2 per cent. Amberene fortnightly.
- 1 per cent. lime sulphur fortnightly.
- 1 per cent. Sulsol fortnightly.

Moderately successful :—

- 1 per cent. Amberene fortnightly.
- 0·7 per cent. liver of sulphur fortnightly.
- 1 per cent. precipitated sulphur plus 0·2 per cent. Caseinate spreader fortnightly.

Unsuccessful :—

- Shirlan.
- Sulphur resin.

The freedom from Meria was reflected in increased growth, and at the end of the season some 600 plants from each of some of the more successful treatments and from the controls were assessed. The plants were grouped according to height into four classes, less than 6 in., 6-12 in., 12-18 in., and 18-24 in. There were very few plants in this last class.

Those with very defective root systems (mostly owing to chafer), were neglected. For costing purposes the three taller groups have been placed together, thus leaving the groups, less than 6 in. and more than 6 in. high. The larger plants were given the arbitrary value of 12*s*. 6*d*., and the smaller that of 5*s*. per 1,000, it being assumed that more than 50 per cent. of the smaller plants would be culls in so good a crop. On this basis the value of 10,000 plants is worked out for the various treatments and for the controls. From this, and from the data for the number of plants lifted and the area which they filled, the increase of value over the controls for 100 sq. yds. of bed is calculated. The cost of spraying this area of bed can be worked out (the sprays were applied at 4 galls. per 100 sq. yds., except the 5 per cent. Amberene, which was at 5 galls. per 100 sq. yds.), labour being included at 0·2/*s*. per spraying per 100 sq. yds. This amount is substacted from the increased value to give the true increse of value due to the spraying. The true increase in value is given for both 100 sq. yds., and 10,000 plants. Finally, it is expressed as a percentage increase on the value of the controls.

Experiment II.

Average number of plants lifted in each treatment 602.
Average area lifted to get this number 1·28 sq. yds.
Therefore number of plants per 100 sq. yds. 47,000.
Treatments assessed :—

1½ per cent. Amberene fortnightly. No. 2.
1 per cent. lime sulphur fortnightly. No. 4.
1 per cent. precipitated sulphur + 0·2 per cent. Caseinate spreader fortnightly. No. 6.

Treatment.	No. 2.	No. 4.	No. 6.	Controls.
Percentage of plants above 6 in.	69	66	62	52
Percentage of plants below 6 in.	31	34	38	48
Value per 10,000 plants, in shillings ...	101·8	99·5	96·5	89·0
Increase of value over the controls, per 100 sq. yds. of bed	60·2	49·4	35·2	—
Cost of spraying per 100 sq. yds.	3·9	2·2	3·5	
Net increase of value per 100 sq. yds. ...	56·3	47·2	31·7	—
Net increase of value per 10,000 plants ...	12·0	10·0	6·7	—
Percentage increase of value	13	11	8	—

Experiment III.

Average number of plants lifted in each treatment, 613.
Average area lifted to get this number, 1·87 sq. yds.
Therefore number of plants per 100 sq. yds, 32,780.
Treatments assessed :—

5 per cent. Amberene at the beginning of March, followed by 1½ per cent. Amberene fortnightly. No. 1.
0·7 per cent. liver of sulphur fortnightly. No. 5.
1 per cent. Sulsol fortnightly. No. 6.

Treatment.	No. 1.	No. 5.	No. 6.	Controls.
Percentage of plants above 6 in.	84	69	73	50
Percentage of plants below 6 in.	16	31	27	50
Value of 10.000 plants, in shillings	113·0	101·8	104·8	87·5
Increase of value over the controls, per 100 sq. yds. of bed	83·6	46·9	56·7	—
Cost of spraying per 100 sq. yds.	5·5	4·2	5·6	—
Net increase of value per 100 sq. yds. ...	78·1	42·7	51·1	—
Net increase of value per 10,000 plants ...	23·8	13·0	15·6	—
Percentage increase of value	27	15	18	—

The figures of value in the above tables are expressed in shillings and tenths, not shillings and pence, for convenience in calculation.

Unfortunately, only two plots were used for the assessment of each treatment, some 300 plants being taken. Owing to this fact the results are not very amenable to statistical treatment, and, when analysed, none of the results was found to be statistically significant. Nevertheless, the difference was easily visible to the naked eye, and may I think be safely regarded as significant.

For comparison somewhat similar figures for a spraying experiment carried out in 1932 are given. Here the basis of assessment was somewhat different. Plants 7 in. and over are valued at 12*s*. 6*d*. per 1,000, plants between 4 and 7 in. at 8*s*., and plants less than 4 in. regarded as culls. The quality of the plants in these beds was very poor, and while the actual increase in value is no higher than in 1933, the percentage increase is, as would be expected, very much greater.

1932 Experiment.

Average number of plants lifted in each treatment, 629.

Average area lifted to get this number, 2·0 sq. yds.

Therefore number of plants per 100 sq. yds., 31,450.

Treatments assessed :—

A. 15 per cent. Amberene in early March followed by 1 per cent. Sulsol fortnightly.

B. 15 per cent. Amberene in early March followed by 2 per cent. Amberene fortnightly.

Treatment.	A.	B.	Controls.
Percentage of plants above 7 in.	5	7	1
Percentage of plants between 4 and 7 in. ...	31	27	17
Percentage of plants below 4 in....	64	66	82
Value of 10,000 plants, in shillings	31·0	30·3	14·8
Increase of value over the controls, per 100 sq. yds. of bed	51·0	48·7	—
Cost of spraying per 100 sq. yds.	10·1	9·4	—
Net increase of value per 100 sq. yds.	40·9	39·3	—
Net increase of value per 10,000 plants... ...	13·0	12·5	—
Percentage increase of value	88	84	—

These results do seem to indicate that spraying against Meria may be regarded as paying for its cost in increased quality. Opinions vary as to what is the best size for a 2-yr. seedling, and it may be argued that increase in size does not mean increase in value; but there can be no question that the very small plants are of less value, if only because they must spend so much longer in the nursery before being of plantable size, and if spraying lessens the proportion of these, as it appears to do, it should increase the value of the crop. Apart from the direct consideration of the effect of spraying on the crop sprayed, it must be remembered that in a nursery kept free from the disease there will be fewer losses from Meria in the one year beds, where Meria kills much more frequently than in older beds, and where spraying does not seem to be a practicable proposition.

SOIL AERATION IN ESTABLISHING PLANTATIONS.

(With special Reference to Ploughing.)

(Silvicultural Circular No. 12 issued to all Technical Officers, November, 1933.)

Experience has gradually been accumulating of the importance of aeration of the soil (including peat) in promoting the establishment of young trees. Recognition of the need for more efficient drainage, especially in peat areas, was the first step; mound and turf planting of spruces the second, and deep ploughing with heavy tackle the third. Only in the case of heavy clay soils with broadleaved species has soil cultivation failed to give appreciable results in increasing the rate of establishment and growth of young trees. Some of the results obtained with close drainage and mounding by the Research Branch at Achnashellach (on morainic deposits) and by the ploughing on sandy boulder till at Teindland (P. 27) are really remarkable.

The experimental plough from Teindland was used on a small area of difficult wet heathland at Ordiequish for P. 28; this was unsuccessful at first owing to lack of drainage. Then followed relatively shallow tractor ploughing of heathland for P. 28 Halwill, and for P's. 29 and 30 at Allerston; in neither case have the results been very striking. Our first large scale deep ploughing with heavy machinery was commenced at Allerston in April, 1930. The outfit consisted of a "Caterpillar Twenty" with various types of ploughs and a Killifer sub-soiler. Typically the ground was flat and the vegetation heather and *Erica tetralix*, with the usual accompaniment of thin peat and slime; the top soil was stony but moderately loose with an iron pan fairly uniformly distributed at a depth of 5 to 7 in.; occasional small boulders were met with. Difficulty arose in getting ploughs strong enough to stand up to the work; nevertheless, over 800 acres had been dealt with by the end of 1931 at an all-in cost of about 27*s.* 6*d.* per acre. The plough succeeded in breaking the pan over a good proportion of the furrows on this area and piled up a high ridge which quickly became well aerated.

In July, 1931, a second and similar outfit was purchased; this worked first at Wareham, where it operated with great success on the sands and gravels and in the damp sandy-clay bottoms at an all-in cost of 22*s.* 3*d.* per acre which has since fallen to between 16*s.* 11*d.* and 21*s.* The two outfits have since been continuously employed preparing ground for planting (Slaley, Ampleforth, Rosedale, Thetford, Ringwood, Ferndown, Clipstone, Wilsey Down, Caio and Brechfa) or ploughing fire lines at these forests and Bramshill; the total area ploughed to date in England and Wales amounts to nearly 3,000 acres, and a further 150 acres have been subsoiled only.

In the case of Brechfa the ploughing has been partly on high-lying moorland with 6 to 18 in. of peat carrying calluna, scirpus and *Erica tetralix*, with some molinia and eriophorum; by ordinary methods of draining and turfing this would have been very difficult and expensive to afforest; the cost of the ploughing did not exceed 25*s*. per acre inclusive. Costs with the Commission's Caterpillar equipment have varied at other forests from 13*s*. 10*d*. (Ringwood) and 14*s*. 9*d*. (Thetford) on the sands and clays to 33*s*. 1*d*. (Allerston) and 34*s*. 6*d*. (Clipstone) where operations are hindered by compact gravels, boulders and stumps. It was found at Allerston in 1932 that subsoiling alone may cost 40*s*. per acre where many boulders and stumps occur, and the total cost of subsoiling and ploughing in ground too difficult for the plough to tackle direct averaged 45*s*. 1*d*.

The effect of ploughing upon badly drained leached soils is already apparent in a number of areas. Deep cultivation, carried out so as to affect at least half the ground surface, has improved drainage in a remarkable way, though this must not be taken to imply that ploughing obviates the necessity for a system of main drains; it also changes the general character of the vegetation. In some cases (Wilsey Down) fine grasses have replaced the former moorland type of vegetation; in others (Teindland and Allerston) the chief result has been to promote a healthy growth of heather on ground which previously carried a sickly-looking patchwork of dwarf heather, scirpus, lichen, etc. The take on deeply ploughed ground has usually been satisfactory, even when planting has immediately followed ploughing. The appearance of the plants after three years is generally promising.

During the present year, a Scottish firm of contractors has developed a Fordson-special plough outfit which has done excellent work at the Forest of Ae (Closeburn). The ground was formerly classified as unplantable, being mainly heather-scirpus peat on somewhat uneven moraine. Scattered boulders a foot or more in diameter were encountered and successfully dealt with. This point is important because the capacity of the Caterpillar outfit to deal with boulders is strictly limited (*e.g.*, at Wilsey ploughing had to be abandoned). Apart from the work described, much shallow ploughing has been done in the eastern counties and the North-eastern Division, mainly in lieu of screefing, but it is clear from the work done at the Forests of Brechfa and Ae that the usefulness of ploughing is by no means confined to heaths, breckland and old arable or pasture land, and there is no doubt that ploughing could be used with great advantage in a number of forests (e.g., Clocaenog, Kielder) and over a wide range of conditions, especially if the mechanical difficulties of operating on uneven ground and on soil with small boulders can be successfully overcome. The Fordson-special plough outfit appears to promise one solution of these difficulties and should be fully tried out. Another possibly useful implement which has recently been put on the market is called the Gyrotiller; this is being tested at Cannock Chase.

USE OF BASIC SLAG IN PLANTING OPERATIONS.

(*Silvicultural Circular No.* 13, *issued to all Technical Officers, December*, 1933.)

In this memo. Mr. Guillebaud has summarized experimental and Divisional experience.

Putting aside the question of the effect of repeated applications of slag over considerable periods of time, the main conclusions with regard to single application are as follow :—

(1) There is little or no effect with the better types of peat, on which spruces normally start well enough.

(2) On the worst types of peat spruces are not brought permanently out of check.

(3) On intermediate types spruces are stimulated and grow well to begin with, but we are still in the experimental stage in the sense that it is not certain that the trees will form canopy without a second period of check. Given a fair proportion of fine grasses (*Aira flexuosa* and *Agrostis*) in the vegetation, the probability is that the plants will not go back.

(4) Japanese larch responds more effectively to the use of basic slag than other conifers and the use of slag is justified when planting thin peat on slopes even where scirpus is dominant, provided that there is an admixture of other species (such as molinia, bog myrtle *Carex* sp., *Nardus*, etc.)

(5) On calluna heaths there is a marked stimulus to the plants especially on ploughed ground, but here also we are still to some extent in the experimental stage.

The net result to date appears to be that the use of slag enables us to extend somewhat the zone of plantable, at the expense of doubtfully plantable, land. It is not yet possible to define precisely the limits of this extension.

Use in large-scale Operations.

1. For the present, in forming new plantations of either Sitka or Norway spruce land should not be planted which will not produce a successful plantation without the use of slag.

2. On certain types of poor peat land (see (4) above) the use of slag on Japanese larch is permissible, but areas so planted should not exceed 20 acres annually on any one operation.

3. Existing plantations which have been made on turfs may be slagged, if it is apparent that there will be a prolonged check.

4. In some cases where it is certain that slag will be beneficial, it may be applied to beat up plants. It would appear that such cases are not numerous.

R. L. R.

Extensive plantation experiments have been carried out with basic slag since 1924 in both England and Wales and Scotland. Most of these deal with poor or bad soil types but a certain amount of information is available as to the effect of basic slag on moderately easy ground. The Research Branch data are amplified to some extent by Divisional experiments, notably in Scotland, S.W. Division.

No attempt has been made to distinguish between the effect of basic slag when applied, at the time of planting, to the roots of the trees as compared with application to the surface of the soil round the base of the plant either immediately after planting or within one or two years of the date of planting. We have no definite experimental data on this point, but there does not seem to be much in it. In both cases a response above ground does not appear until the second growing season after application and the order of response appears to be very much the same in both cases, given equivalent doses of basic slag. While this may hold good in experimental work where the manure is applied very carefully, in large scale work there is a common tendency in top dressing to dump the slag in small heaps at the base of the plant. These become crusted over and can be found apparently unaltered many years after the slag was applied. Unless the slag is thinly sprinkled round the plant, application to the roots at the time of planting is likely to be more effective, for a given quantity of slag.

The available information may be summarised as follows :—

I. Peat Soils.

1. *Turf Planting. Basic Slag applied at Time of Planting or very shortly after Planting.*

(i) *Grass-Juncus and Grass Types (other than Molinia).*—Beddgelert No. 5, P. 27. Growth of S.S. and N.S. without slag has been excellent. Little sign of response to the manure.

(ii) *Molinia Types.*—There are corners of molinia ground in some of the experiments. Growth of the spruces is generally satisfactory without slag.

(iii) *Calluna-Molinia-Erica, often with subordinate Scirpus.*—There are several areas on this type which have been slagged at Glenduror, growth with slag appears to be generally satisfactory, *e.g.*, S.S. in P. 27 now averages 36 in. in height with a mean shoot of 9 in. N.S. planted in P. 26 and slagged in P. 27 has a mean height and shoot of 24 inches and 4 inches respectively. There appear to be no controls.

(iv) *Eriophorum Types without much Calluna or Vaccinium.*—At Dalbeattie an area was planted in P. 28 with S.S. Unmanured plots are as good as the manured. The same applies to ground of this type in Beddgelert No. 5, P. 27. S.S. are also growing well without slag in North Tyne No. 1, P. 27.

(v) *Eriophorum Types with Calluna and ± Vaccinium, but with little or no Scirpus.*—S.S., S.P., and J.L. planted without slag in North Tyne

No. 7, P. 28. The S.S. and S.P. are coming out of check but J.L. are still checked.

On somewhat better ground of the same general type in North Tyne No. 14, P. 30 N.S. and S.S. without slag are as good as the manured plants. In another experiment at North Tyne, No. 12, P. 29, on eriophorum-calluna-vaccinium the following shows the position after 4 years' growth :—

—	Sitka Spruce.		Pinus Contorta.	
	Total Height.	Shoot.	Total Height.	Shoot.
	In.	In.	In.	In.
Unmanured ...	11·3	1·5	9·3	4·2
1-ounce slag ...	16·1	2·8	10·9	5·4

The basic slag is helping the S.S., but it may be only a question of time before the control plants get away, the *P. contorta* are doing practically as well without manure. N.S. was planted on land of this type at Glenduror in P. 27, with slag, present height is 18 in. and shoot 3 in. Plants are improving in colour. No control. S.S. on a somewhat similar but better type planted in P. 27 with slag at Glenduror : present height 30 in., shoot 7 in.

(vi) *Scirpus Types rich in Eriophorum and Aira flexuosa, or in Molinia, without much Calluna or Erica.*—Glenduror P. 29. Spruces. Growth with slag is described as very good, and the D.O. states that the slag has helped the plants to overcome any serious check. There is no mention of a control.

D.O. states that slag put on luxuriant scirpus-molinia peat at Glenbranter was unnecessary and had no marked effect on spruces.

(vii) *Scirpus Types rich in Eriophorum, Erica Tetralix and Molinia.*—S.S. planted on ground of this type at Beddgelert showed a marked response to the application of basic slag, *e.g.*, Experiment 5, P. 27, where the position at the end of 1932 (6 years' growth) was as follows :—

Treatment.	Total Height.	Shoot Growth. Percentage Distribution in Shoot Classes.			
	In.	0–5 in.	6–7 in.	8–10 in.	Over 10 in.
No manure	16	98	2	—	—
1 ounce basic slag ...	37	18	19	41	22

The unmanured plants were still in check while the manured plants gave promise of becoming established.

(viii) *Scirpus rich Types with much Erica Tetralix and stunted Calluna.*—(*a*) *Basic Types, i.e., Peat accumulated in Depressions.*—Experiment 7, P. 27 at Beddgelert is situated on one of the best varieties of this type, *i.e.*, one with dominant scirpus but with much eriophorum and little calluna. Species, S.S. After 5 years, the control plots were still mostly checked while the manured plants were making relatively good growth. The assessment showed that 95 per cent. of the plants in the control were putting on shoots of less than 2 in., and only 2 per cent. had shoots of 6 in. and over, while the corresponding figures for the manured plots were 22 per cent. and 30 per cent. respectively.

The poorer and more typical ground of this scirpus-calluna type is well exemplified in the large Lon Mor bog on Inchnacardoch Forest. Here many experiments have been carried out with different species.

Sitka Spruce.—Experiments in which basic slag was used date from 1925 onwards. The ground in general varies in quality with the distance from the slopes above the bog. Even though these slopes are of scirpus-clad moraine over quartzite the ground near its foot is better than that in the centre and near the slight ridge which forms the south-castern boundary of the bog. The earlier experiments (P. 25-P. 27) were mostly on the worst type. The general results on the worst ground may be stated as follows. No response in the first year ; a definite improvement in the second year ; the effect reaches its peak in the third year when shoots of from 6 to 10 in. are put on by a small proportion of the plants, the average shoot being from 3 to 4 in. In the fourth year growth falls off, the average shoot being about 2 in., in the fifth and subsequent years the plants revert to a more or less completely checked condition but still carry a fairly large amount of foliage, the needles being of medium length and more or less normal colour. The future of these plants is wholly uncertain, they may eventually recover and start to grow or they may go more and more back and finally die. Unslagged control plants are completely in check and are much poorer than those which received the manure.

Another phosphatic manure, Semsol, may be mentioned here, as in one experiment, No. 43, P. 28, it has given better results than basic slag and has maintained growth up to the 6th year.

The assessment at the end of 5 years' growth gave the following data :—

Treatment.	Average Height. In.	Average Shoot. In.
Control—unmanured	7	$<0\cdot1$
2 ounces basic slag	14	1·4
3 ounces Semsol	20	4·1

The data show that the control plants are not growing at all in height, the plants treated with basic slag are going back, while growth in the Semsol treated plots so far is being maintained though it is doubtful if it will continue at the present level. By reslagging it may be possible to get S.S. into canopy on the better facies of this type of peat, but the experiments have not been going long enough to be definite on this point. In Experiment 74, P. 29, Inchnacardoch, a second dose of slag applied the year after planting maintained the average shoot growth at the end of 4 years at a level of 6 in. as compared with the average of 5-in. shoots in the case of plants over slagged; the difference is not really appreciable. The peat here is of rather better type, but it remains to be seen how long satisfactory growth will continue. In another experiment on worse peat (12, P. 25) redressing has had virtually no effect in bringing the plants out of check.

The results may be summed up by stating that the effect of basic slag applied to S.S. on the Lon Mor type of scirpus-calluna peat appears to be only transitory as far as shoot growth is concerned. The future development of the plants is still problematical.

Norway Spruce on Basin Peat.—Mr. Murray has supplied two interesting cases from Inverliever. In the first of these the ground was planted in P. 23 with 2 oz. of basic slag per plant. Growth was good until 1926 when check began; in 1927 some drains were deepened and part of the ground re-slagged. Position is as follows (after 10 years' growth):—

Sections.	Height of Plants.	Current Shoot.	Condition.
	In.	In.	
1	Drains not deepened: one application of slag.		
	20	2	Healthy.
2 and 3	Drains deepened: two applications of slag.		
	44	7½	Very healthy.
	34	6¼	,,
4 and 5	Drains deepened: one application of slag.		
	20	1¼	Healthy.
	14½	2	,,
6	Drains deepened twice: two applications of slag.		
	46	9¾	Very healthy.

In this case re-slagging combined with opening out some of the original turf drains bids fair to get the plants out of check, but there must still be some uncertainty as to the future.

The second experiment at Inverliever was planted in P. 26 and slagged immediately after planting. Drains were close and deep. The slag was effective for about three years, but the current shoot growth ranges from ¾ to 2 in. and the plants are mainly yellowish.

Very little N.S. has been planted on the Lon Mor peat bog but what there is is checked and unpromising in spite of the use of basic slag.

Japanese Larch on Basin Scirpus Peat.—There are only a few plants of this species on the scirpus peat of Lon Mor. The plants responded well to the application of basic slag; after 6–7 years the effect is still observable and they are decidedly more promising than either S.S. or N.S.

Pinus Contorta on Basin Scirpus Peat.—These have been planted over an area of several acres on the Lon Mor in an experiment dealing with methods of turfing and draining. All the plants received slag at the time of planting, so there is no direct evidence as to the effect of the manure. The plants, after 6 years' growth, were still vigorous and have not checked to the same marked degree as the spruces.

(*b*) *Climatic or Slope Peats—Scirpus Types.*

Sitka Spruce.—Broadly speaking, the reaction of S.S. on this type of ground to the application of basic slag is very similar to that on the Basin types. The effect in the second and third years is perhaps a little more marked, but as a rule growth falls off again quickly in the fourth and fifth years after slagging. The unmanured controls in all cases remain completely checked. There is a complete lack of evidence as to the ultimate recovery of either the manured or unmanured plants; the manured plants, although more or less checked after 5 or 6 years' growth, have more foliage, longer needles, and a much more extensive root system than those which received no manure.

Japanese Larch.—There are manuring experiments with J.L. on slope peats at Inchnacardoch, Achnashellach, Glen Righ and elsewhere. The outstanding experiment is No. 9, P. 28 at Achnashellach, where alternate manured and unmanured strips of J.L. run along the foot of a slope; the ground is towards the good end of the series of scirpus types. Drainage was intensive, turf drains being only 12 ft. apart. After 6 years the manured plants average 5 ft. 4 in. in height, with a mean shoot of 18·0 in., as compared with 2 ft. 2 in. height and 4·0 in. shoots in the control sections. In most places the manured plants are already in canopy, and there is no sign of any check setting in.

Another experiment, 7 C, P. 28, on rather poorer ground at Achnashellach, has given generally similar results: manured plants 4 ft. high and 12·4 in. shoot, controls 2 ft. high and 3·5 in. shoot.

At Inchnacardoch basic slag has produced equally definite results, *e.g.*, No. 36, P. 27, was top dressed after one season's growth and part also again manured in the second year. Control plants average 18 in. high with 1 in. shoots. Plants top dressed once are 32 in. high with 5 in. shoots. Those top dressed twice are 47 in. high with 7 in. shoots. Again, in No. 62, P. 28, where the plants were top dressed the year after planting, the growth at the end of the fourth year was :—

	Height.	*Shoot.*
	in.	in.
Control ..	15	2·3
Slagged	40	9·8

These data for J.L. give far greater promise of successful establishment with the aid of basic slag than is apparent in the case of the spruces. Without basic slag the success of J.L. on the slope scirpus types is problematical and probably at least ten years of check must be reckoned with. Basic slag reduces the death rate appreciably and can, as we see at Achnashellach, bring the crop into canopy in as short a space as only 6 years.

Pinus Contorta.—This species was planted in manurial trials in P. 28 both at Inchnacardoch and at Achnashellach, and in both areas shows a marked response to basic slag, *e.g.*, at Inchnacardoch (in No. 62, P. 28) after 5 years the manured plants averaged 2 ft. 6 in. in height with shoots of 8·8 in., as compared with 17 in. in height and 4·8 in. shoots in the control. Present indications are that P.C. without slag grows more freely on the slope peats of the scirpus type than any other species, and though on the worst types it may be desirable to apply basic slag it seems possible that on the rather better types it may establish itself unaided except by turfing with intensive drainage.

Alnus Oregona.—This species has been planted in P. 30 and P. 31 in the heavily drained and closely spaced turf groups on slope peat at Inchnacardoch, basic slag being used. It grew well in the second year, and after 4 years is still making good progress. The P. 33 shoots of a number of plants measured each year averaged 17 in. There are no unmanured controls, but judging by experience in N. Wales the trees are not likely to start well without the aid of basic slag.

2. *Turf Planting. Basic Slag applied several Years after Planting, when it is apparent that the Plants are in a State of Check.*

The evidence as to the effect of delayed application of basic slag to turf planted trees is somewhat limited. Probably the most definite results have been obtained by Sir John Stirling-Maxwell at Corrour, when slag was applied broadcast at rates varying from 10 cwt. to 30 cwt. per acre to S.S., which had checked on scirpus types after an initial dose of slag some 6 to 10 years previously. These fairly heavy broadcast dressings have been generally successful in getting the trees out of check, and in many cases the plants now appear to be established. No analogous cases on Commission areas are known to the writer, for one thing our turf planted areas are mostly too young to provide strictly comparable conditions. Again, as a result of an investigation recently carried out at Inchnacardoch into the root structure of S.S. and other species turf planted with and without basic slag, it appears probable that the broadcasting of basic slag would have a much greater effect on plants which had received a dose of slag on planting than on plants which got no manure originally. In the one case a well developed surface root system exists, capable, presumably, of utilising the slag while in the other the root system is virtually restricted to the turf itself. (These remarks apply primarily to the scirpus-calluna peat types.)

3. *Direct Planting.*

There are extensive areas of peaty soils on some of the Commission's areas, notch planted in the early days (P. 21 to P. 27) with S.S. or N.S., and still for the most past checked. Basic slag has been applied on an experimental scale to a number of these plantations, but not as a rule with any very striking results. A better colour certainly is the usual result, and slightly improved growth, but seldom anything more.

On moderate types of ground drainage is normally all that is necessary to get spruce out of check, while on the bad types unless an improvement in the vegetation can be brought about by intensive drainage, the additional application of basic slag is not likely to be effective.

II. Mineral Soils with a Calluna-rich Vegetation (less than 6 in. Peat).

(i) *Calluna Types with a fair Admixture of fine Grasses.*—(*a*) *Effect of Basic Slag applied within a Year or so of Planting.*—Almost the only experiment on this type is No. 1, P. 29, at Hamsterley, where S.P., P.C., J.L. and E.L. were planted at an elevation of nearly 1,100 ft. Basic slag has had a marked effect upon the growth of the two larches—much more so than in the case of the pines. After three years the position was as follows :—

—	Japanese Larch.		European Larch.	
	Control.	Slagged.	Control.	Slagged.
	In.	In.	In.	In.
Average height ...	5	13	11	18
Average shoot ...	1·4	7·1	2·0	5·1

The experiment has not run long enough to be of much value, but the poor growth of the unmanured plants will be noted. By analogy with results on other vegetation types it would seem probable that the manured J.L. will now go ahead. One further point of interest is that losses were considerably lower in the slagged larch plots. It is a common experience that a proportion of larch plants planted on calluna ground hang on for a year or two and then die, an application of basic slag at the time of planting saves the majority of these weakly plants.

(*b*) *Effect of Basic Slag applied several years after Planting.*—An area of N.S. planted at Kerry Forest in P. 25 was top dressed with 4 oz. of basic slag in 1929. The site was very exposed and the trees show marked evidence of wind-blast. The slagged plants are not appreciably better than the controls, and both are growing at the rate of about 3½ in. to 4 in. per annum.

A similar experiment at Llanover on N.S. and S.S. planted in P. 25 also gave negative results as regards the effect of basic slag, although in this case the S.S. have emerged from check and are now growing quite normally. Examination of the shoots showed that the S.S. were more or less in check up to 1929 and that normal growth began in 1930 all over the area. The N.S. are still checked and the slag seems to have little effect on the treated plants.

At Halwill, however, basic slag has had a definite effect upon N.S. and S.S. planted in P. 23 on a gorse-heather-molinia type. (This is really a separate type but for convenience is considered here under calluna-fine grasses.) 4 oz. of slag were applied in 1929. The present position is as follows :—

Treatment.	Sitka Spruce.		Norway Spruce.	
	Mean Height.	Mean Shoot.	Mean Height.	Mean Shoot.
	In.	In.	In.	In.
Control	12	0·6	12	0·6
Slagged	31	6·2	27	6·0

After 10 years' growth the control plants are still in check while the slagged plants have every appearance of getting away. The slag has affected the vegetation, improving the growth of the gorse which now tends to dominate the heather, in the control sections the heather is holding its own with the gorse.

(ii) *Calluna Types without fine Grasses.* (*a*) *Planted on the natural Surface. Effect of Basic Slag applied within a Year or so of the Date of Planting.*—Such experiments as there are are too young to consider at present.

(*b*) *Planted on the natural Surface. Effect of Basic Slag applied several Years after Planting.*

At Cynwyd N.S. was planted in P. 26 in a moderately exposed site at 1,400 ft. elevation. Alternate strips were slagged in 1929. The slag has slightly improved the general appearance of the plants but the effect on growth has been inappreciable as may be seen from the following data :—

	Mean Height.	*Mean Shoot* (1933).
	In.	In.
Control	14	1·1
Slagged	14	1·4

The influence of the slag was more marked two years ago so the effect appears to be already wearing off.

At Allerston slag applied to S.S. planted about P. 24 and in check has been wholly without result.

Having regard to the peculiarly tight surface of most of the poorer calluna soils it seems quite possible that the apparent ineffectiveness of basic slag applied as a top dressing may be due to the holding up of the slag on the surface. Better results might be obtained if the surface crust were broken to allow the slag to penetrate into the soil.

(c) *Ploughed Ground.*—Basic slag applied within one or two years of planting.

The oldest experiment is that at Allerston (No. 6 P. 28) part of which was top dressed with slag at the rate of 2 oz. per plant, slag applied two years after planting.

Position at end of 1932 was as follows :—

Treatment.	Scots Pine.		Corsican Pine.	
	Height.	Shoot.	Height.	Shoot.
	In.	In.	In.	In.
Control	14	2·2	10	3·0
Slagged	18	4·6	16	6·1

Treatment.	Japanese Larch.		Sitka Spruce.	
	Height.	Shoot.	Height.	Shoot.
	In.	In.	In.	In.
Control	10	1·7	16	2·4
Slagged	16	4·4	22	4·9

Growth of all species has been relatively slow and it is too soon to prophesy as to the lasting qualities of the stimulus provided by the slag. An examination of the roots has shown, especially in the spruces, a much increased root development where slag had been applied, the roots also of the slagged plants were actively growing while the control plants were dormant (examination made in September, 1933). In other experiments with basic slag at Allerston, in P. 29 and P. 30, improved growth of the following species was obtained : E.L., J.L., S.P., P.C., S.S., G.alder and Birch.

At Harwooddale near Scarborough, Ringwood in Hampshire and Wareham in Dorset, all species of conifers tried have responded to the application of basic slag on ploughed or dug-over ground. The effect is particularly marked on seedlings. None of these experiments has been running for more than three or four years. At Teindland Forest extensive experiments have been carried out with basic slag on ploughed ground or in dug-over groups. There is a definite tendency on the part of the spruces to slow down in growth again and become yellow after the first effect of the slag has worn away. The effect on the pines is more persistent, P.C. being outstanding in this respect. Here again the experiments have not been going long enough to enable any final judgment to be made.

Summary.

Basic slag appears to have relatively little effect upon the growth of plants planted on the better types of peat and of mineral soil. Used on really bad (scirpus-calluna) peat types the effect is very marked for three or four years, but what happens after that depends largely upon the species. The spruces as a normal rule go back into check, but so far not into the same hopeless-looking check as the unmanured control plants. Root investigations indicate that the slagged plants have a much better developed root system and they may ultimately decide to grow and form canopy. On present evidence the process, if it ever takes place, is likely to be a slow one. Japanese larch and *Pinus contorta* show a more sustained response to basic slag and in one case (Achnashellach, 9, P. 23) canopy has actually been formed in 6 years from the date of planting. The control plants in this area are not thriving and there is some justification for the conclusion that the basic slag has made a crucial difference. This stage has not been reached with any of the *Pinus contorta* plots on bad peat types. At present it is impossible to say (*a*) whether the effect will be lasting, or (*b*) whether the unmanured controls may eventually establish themselves. Between the two extreme types of peat soils there is no doubt an intermediate class where the addition of slag may reduce a period of check from say 10 to 15 years down to only 2 or 3 years. Probably a complex of locality factors is involved and it is likely to be some time before most of these types can be recognised with any certainty.

The relative advantages of slagging at the time of planting (slag placed at the roots), shortly after planting, and several years after planting, are not known with any certainty where turf planted trees are concerned. In each case a definite response is more or less assured (on bad peat types). On the whole, use at the time of planting is likely to be the most economical method, but against this can be set the possible use of slag on ground which does not really require it. The top dressing of plants direct notched on peat does not appear to be generally effective.

As regards the mineral soil types, the species which are most liable to check on Calluna-Fine Grasses are the larches and spruces. Existing experiments on this type of ground are rather few, but the evidence suggests that a certain amount of beating-up might be avoided by the use of slag at the time of planting and also that the check period can be appreciably lessened. In one case the top dressing of plants severely checked on a Gorse-Heather-Molinia type has been successful in bringing these out of check. The experiments on the poorer types of calluna ground whether ploughed or unploughed are still at a stage at which any final judgment would be premature. The reaction of the different species to applications at the time of planting is much the same as on the poorer peat types, *i.e.* the spruces make a good start and then tend to go back, while in the case of Japanese larch and the pines the stimulus lasts longer and so far the plants are retaining most of their increased vigour.

The top dressing of spruces checked on unploughed calluna ground has not been effective, and it is suggested that the slag is unable to penetrate the crust which so often forms on the surface of these soils.

The relation of effect produced to quantity of slag used has not been discussed in the body of the report. The normal application at the time of planting has been 2 oz. of slag per plant. In some of the experiments 1 oz. only was used, the initial stimulus appears to be about the same with both doses but there is some evidence to suggest that the effect of the larger application may be more lasting. Recently several experiments have been laid down dealing with this question.

Within the last three or four years another form of phosphatic manure, Semsol, has come on the scene. Semsol is a proprietary manure consisting apparently of a mixture of superphosphate and rock mineral phosphate and sells for about the same price as basic slag. Applied direct to the roots it is not as safe a manure as slag and its use has led to appreciable losses, especially with Japanese larch on mineral soils. Its effect appears to be a good deal milder on peat, even when applied direct to the roots ; it is quite safe when used as a top dressing. The action of Semsol appears to be more rapid than that of basic slag, *e.g.*, at Glenshiel where spruces showed a definite response in the first growing season after treatment, the effect on the growth of spruce on peat soils is also greater and more lasting. On present evidence Semsol appears a likely substitute for basic slag as a means of stimulating the growth of trees on peat soils of the scirpus types.

COST OF PLOUGHING BY TRACTOR.

By S. J. Honywill.

Two "Caterpillar Twenty" tractors are now employed in England and Wales, the first having been purchased in 1930 and the second in 1931. Some notes on the first tractor and the technical aspects of the work are given in an article by Mr. A. H. H. Ross, which appeared in this Journal in 1931. Particulars of costs, etc., from 1930 to 1933 are given below; these are based on fortnightly returns showing quantity of work, time occupied and expenditure on wages and petrol.

Tractor No. 1 was employed solely at Allerston until the commencement of 1933, when it was moved to other forests in Division 1, and in July to Division 5. Tractor No. 2 has been employed mainly in Division 6, but also in Divisions 3, 4 and 5. Altogether, 2,800 acres have been ploughed for planting, and in addition the tractors were engaged for considerable periods on miscellaneous work such as ploughing fire lines, ploughing arable land in holdings and nurseries, and also in hauling timber.

The rate of ploughing (tractor actually working) varied from 1·78 to 4·78 hours per acre for Tractor No. 1, and from 1·52 to 1·91 hours per acre for Tractor No. 2. In the case of Tractor No. 1 the maximum time stated includes double treatment for some areas, such as sub-soiling or removal of stumps preparatory to ploughing.

To obtain costs per acre ploughed for planting (miscellaneous work was not costed), all expenditure was first charged against the time employed in working the tractor (omitting time spent on maintenance, etc.), and the unit cost per hour thus obtained was multiplied by the time taken in ploughing one acre. In addition to wages and petrol applicable to individual forests, expenditure includes costs which are spread over all forests at a flat rate for the year; such costs comprise general charges for travelling, etc., repairs, and depreciation (33⅓ per cent. for tractors and 50 per cent. for ploughs).

Costs naturally show a wide variation, according to the nature of the ground and range from 24*s.* to 52*s.* per acre for Tractor No. 1, and from 12*s.* to 25*s.* per acre for Tractor No. 2. In the case of Tractor No. 1 it is understood that exceptionally difficult conditions were encountered at Allerston, where some areas were very stony or had many stumps to be removed, making ploughing a slow and laborious operation and involving extra assistance and more wear and tear on tackle. Fair averages would appear to be 16*s.* per acre for moderate conditions, and 45*s.* per acre for very difficult ground. Mr. Hopkinson reports that even at the latter figure, tractor ploughing is not more expensive than deep cultivation of indvidual plant holes, and the result is incomparably better.

The " all-in " cost of the tractors averaged 50*s.* per day, made up as follows :—

	s.
Wages (driver and assistants)	12
Petrol and oil	11
General charges	3
Repairs ..	13
Depreciation	11
Total	50

The cost stated is for a day of eight hours, of which 56 to 64 per cent. was occupied in working the tractor, 6 per cent. in running light, 21 to 27 per cent. in maintenance (oiling, cleaning and minor repairs) and 9 to 11 per cent. was due to lost time.

EXPERIMENTS ON DENSITY OF BEDDING OUT.

By W. G. GRAY.

During the past season two experiments were carried out in Kennington Nursery to compare various densities of bedding out normal 2-year seedlings of Sitka spruce and 1-year seedlings of Scots pine. Observations were made of their general development and survival after one year, the plants being lifted during October, after growth had been completed. The results of the experiments are given in the following paragraphs.

Two-Year Sitka Spruce.—Four treatments were studied as under:—

(*a*) Seedlings were bedded out in the usual way at 1 in. within and 6 in. between the lines.

(*b*) 100 seedlings were bedded per row of 3½ ft. (28 per lined foot), the distance between the rows being 12 in.

(*c*) 250 seedlings were bedded per row of 3½ ft. (71 per lined foot); otherwise as for B.

(*d*) 500 seedlings were bedded per row of 3½ ft. (143 per lined foot) otherwise as for B.

Bedding out took place on 22nd March; seedlings of uniform size only were used. Abnormally dry conditions followed, which, it is of interest to note, had no serious effect even in the heaviest density, and there were very few deaths due to this cause.

The effect of competition during the growing season resulted in shedding of the lower needles, which increased in intensity with the density of the seedlings. Treatment A was not affected in this way; the Grade II plants only in B were affected; while in C and D Grades I and II were affected, D markedly so. The development of side branches, especially in the Grade II plants, was greatly restricted by density, this being most marked in C and D. Lateral root development was almost prevented in C and D, and a much deeper root system than that produced in normal practice was obtained.

A summary of results is given in the following table:—

	Treatment.			
	A.	B.	C.	D.
	Per cent.	Per cent.	Per cent.	Per cent.
Grade I plants	88·5	80·0	48·5	19·5
Grade II plants ...	6·5	15·7	36·2	30·7
Culls	3·1	3·9	14·6	28·8
Deaths	1·6	0·3	0·6	20·7

The number of Grade I plants which each treatment would produce per 100 ft. of line is as follows :—

—	A.	B.	C.	D.
Number of Grade I plants	1,057	2,285	3,457	2,800
Percentage of number bedded out	88·5	80·0	48·5	19·5

One-Year Scots Pine.—The four treatments studied were as under :—

(*a*) Seedlings were bedded out in the usual way at 1 in. within and 6 in. between the lines.

(*b*) 200 seedlings were bedded per row of 3½ ft. (57 per lined foot), the distance between the rows being 12 in.

(*c*) Similar to B, but 400 seedlings were bedded per row of 3½ ft. (115 per lined foot).

(*d*) Similar to B, but 800 seedlings were bedded per row of 3½ ft. (228 per lined foot).

Bedding out took place on 23rd March; seedlings of uniform size only were used. The drought conditions which followed caused deaths which increased with the density and were pronounced in C and D. As growth advanced it was observed that the length of needles was shorter in C and D, while A and B were not affected in this way. Side suppression in C and D killed the lower needles, but B was only slightly affected in this way, and A was not affected. The root development was very similar in both A and B, but was suppressed and had a much deeper habit in C and D.

The following table summarizes the results :—

	Treatment.			
	A.	B.	C.	D.
	Per cent.	Per cent.	Per cent.	Per cent.
Grade I plants	75·0	46·5	26·25	10·75
Grade II plants ...	7·75	18·25	12·0	6·0
Culls	7·7	26·7	25·2	12·5
Deaths	9·5	8·5	36·5	70·7

The number of Grade I plants which each treatment would produce per 100 ft. of line is as follows :—

—	A.	B.	C.	D.
Number of Grade I plants	885	2,657	2,971	2,400
Percentage of number bedded out	75·0	46·5	26·2	10·7

Summary.

1. A moderate amount of crowding during bedding out does not appear to be injurious to 1-yr. seedlings of Scots pine and 2-year seedlings of Sitka spruce.

2. Densities of 30 seedlings per lined foot with Sitka spruce and of 60 seedlings per lined foot with Scots pine can be used with safety provided the seedlings remain bedded out for one year only. The use of these densities does not lead to any increase in deaths, and only in the Scots pine to any marked reduction in the precentage of Grade 1 plants. In Scots pine bedding out at the rate of 60 seedlings per foot could only be recommended where there is a shortage of ground available for lining out.

3. Greater densities lead to reduction in the number of good plants, and to more numerous deaths and are not to be recommended.

4. With a space of 12 in. between the lines a density of 30 seedlings per foot gives a slightly higher outturn of Grade 1 plants of Sitka spruce per unit area as compared with normal bedding out, while a density of 60 per foot in Scots pine leads to a considerable increase in the number of good plants. By reducing the distance between the lines the production of good plants per unit of area would be materially increased.

COMMISSION'S LIBRARY: JOURNALS AND NEW BOOKS.

The following lists comprise (1) the more important Journals regularly taken into the Library at Headquarters and (2) books on forestry and allied subjects acquired during the past year :—

Periodicals.

Forestry (S.F.G.B.).
Quarterly Journal of Forestry (R.E.F.S.).
Scottish Forestry Journal (R.S.F.S.).
Nature.
Journal of Animal Ecology.
Journal of the Central Landowners' Association.
Journal of the Land Agents' Society.
Review of Applied Entomology.
Empire Forestry Journal.
Illustrated Canadian Forest and Outdoors.
Indian Forester.
American Forests.
Journal of Forestry (U.S.A.).
Der Deutsche Forstwirt.
Zeitschrift für Forst und Jagdwesen.
Zeitschrift für Weltforstwirtschaft.
Tharandter Forstliches Jahrbuch.
Allgemeine Forst und Jagd Zeitung.
Forstwissenschaftliches Centralblatt.
Forstliches Rundschau.
Zeitschrift für angewandte Entomologie.
Centralblatt für das gesamte Forstwesen.
Schweizerische Zeitschrift für Forstwesen.
Revue des Eaux et Forêts.
L'Alpe.

Books.

Methods of Statistics (pp. 222), L. H. C. Tippett.
Shrubs and Trees for the Garden (pp. 576), A. Osborn.
Landscape of England (pp. 67), C. B. Ford.
Nature Photography, O. G. Pike.
The Drama of Weather (pp. 270), Napier Shaw.
British Birds in their Haunts, C. A. Johns.
Protection of Woodlands (pp. 223), G. W. St. Clair-Thompson.
Introduction to the Scientific Study of the Soil (pp. 208), N. M. Comber.
Outline of Forest Pathology (pp. 543), E. E. Hubert.
Forests of India (3 Vols.), E. P. Stebbling.
Chemical Utilization of Wood (pp. 151), H. K. Benson.
Manual of the Timbers of the World (pp. 672), A. L. Howard.
Forestry Almanac (pp. 484), American Tree Association.
Wurzelstudien an Waldbäumen (pp. 121), H. H. Hilf.
Enquête Internationale sur les Incendies de Forêts (pp. 457), Intl. Inst. of Agriculture.

TEMPORARY TRANSPLANT NURSERIES.

By W. Hodgson.

After eighteen months' experience of moorland planting it has very forcibly occurred to me what a great advantage a temporary transplant nursery would have been, and this brings me to the conclusion that wherever a new area is to be planted a nursery of this type should be formed if at all possible. With the exception of a few isolated cases this could easily be brought about as most areas have small holdings and surely a piece of land suitable for a nursery could be found.

Some of the chief advantages of such a nursery are given below, not perhaps in order of importance, but just as they occur to me. Firstly, during the planting season the forester finds it easy to get his supply of plants when most needed to suit the weather conditions, etc. I feel justified in saying that at present the forester without his own nursery has difficulty in obtaining his plants at the right time, for he has first to notify his District Officer who is of necessity much away from his office. From him a demand note has to be forwarded to the despatching foresters, who in turn in all probability still have the plants to lift. Then if sent by goods train it usually takes from 4 to 9 days for delivery. Should the plants have to come from an outside Division the demand note has to be forwarded by the District Officer to Headquarters where it is probably delayed another few days and by the time the forester receives his plants hard frost may have set in and the plants have to lie about under very bad conditions for another week or perhaps longer, before being finally planted. This also means that in a number of cases the whole of the planting is delayed, and to make up for lost time the work has to be rushed through. A forester who has his own nursery lifts the plants as required, thereby saving time which is so valuable when conditions are favourable for planting during the short planting period. Apart from the saving in cost of transport I feel justified in saying that 50 per cent. of the deaths during the following summer could be prevented.

Another advantage worth consideration is that the plants are acclimatised to the district in which they are going to find their permanent home. It sometimes occurs when there is a shortage of plants in a northern Division and a surplus in a southern Division plants are transferred from the south to the north which is a drawback, as plants can never be expected to do so well after being brought from a warmer district.

I do not for a moment contend that seedlings should be raised in these nurseries, but if seedling nurseries could be formed in favourable districts and the seedlings distributed to these transplant nurseries it would greatly help to regulate the supply and do away with the continued shortage of transplants, particularly spruce, as experienced at the present time. For instance the forester knows his planting programme two years in advance and orders the number of seedlings he will require plus a certain percentage to allow for losses. Should the losses in the first year's lining-out be greater than anticipated, these can be made up during the following year, as from experience so far I am all in favour of 2 + 2 transplanted spruce. If each forester had his own transplant nursery he would reap the benefit of all the good plants raised whereas it often happens that the poorest plants are sent out from other nurseries.

As regards transport it is obvious that seedlings would take much less handling than the same number of transplants and the cost of lining-out per thousand should not be any higher than under the present system. The only extra expenditure would be the formation of these nurseries which I do not think should be a very heavy item as the land could be ploughed before being fenced in. After fencing and ploughing the only extra outlay would be a few lining-out boards, spades and hoes, the cost of which I feel sure would be more than justified by the saving in transplant expenses and the reduction in the cost of beating-up. In conclusion I may say that a transplant nursery on a new area would add a little variety to the work of the forester which is apt to consist mainly of fencing, draining, planting and cleaning.

A WIRE NETTING SUSPENSION FOOTBRIDGE.

By W. T. Smith.

When selecting the site for a footbridge there are always three main considerations: (*a*) a place where the bridge can be erected at the least cost; (*b*) where there is good access to it; and (*c*) where it will provide the most direct route to the point it is desired to reach beyond the river or stream.

It is very rare that all these three lend themselves to our advantage and with ordinary types of footbridge the first is usually the determining factor, but the third point is also important and the recently-erected wire netting suspension footbridge at Ennerdale seems to meet the case. A bridge of this type, 60 yards long, does not cost much more than one of 40 yards; likewise a bridge 30 yards in length would not cost much more than one of 8 or 10 yards, so that a much wider range of choice of situation is provided.

The river which flows through Ennerdale Forest, like many other rivers in hilly districts, passes over an alluvial flat in the last stages of its course before entering the lake, and as may be expected the river bed is a considerable width all along this level stretch adding much to the difficulty of bridging and it was at this place that a footbridge was required. A site was chosen where there is an island in the middle of the river to facilitate the erection of the centre supports. Two stout larch posts spaced 2 ft. apart were firmly set and stayed at each side of the river for straining purposes, the posts on the southern side of the river being situated on a bank 8 ft. above the usual water level; a strong crossbar (to which the netting was later attached) was bolted to those two strainers at ground level, leaving 3 ft. 6 in. above for the erection of the handrails.

The northern river bank is only 2 ft. above water level, so to give the bridge ample clearance at times of high flood the crossbar at this end was fixed 4 ft. above ground level again leaving 3 ft. 6 in. of the straining posts above the crossbar, for the erection of the handrails. The central support on the island consists of four upright larch posts, forming a rectangular trestle 6 ft. by 2 ft. (inside measurement), and the lower ends of those posts are well secured 4 ft. underground. As the island is only 2 ft. above water level, the crossbars which support the bridge on the centre trestle were placed 5 ft. above ground level, thus the gradient which is caused by the southern end being 2 ft. higher than the northern end is distributed over the whole length of the bridge. Two of the posts in this trestle extend 3 ft. 6 in. above the crossbar to support the handrail and in addition to the two crossbars, two strong battens were bolted to the other two sides of the trestle just below bridge level to keep the whole structure firm and compact; this completed the erection of the supports.

Sixty-two yards of sheep netting (4-in. mesh) No. 15 gauge and 42 in. wide was doubled over longitudinally, thus giving double-strength netting 21 in. wide; one end was securely fastened to the crossbar attached to the strainers on the southern bank, and the remainder was stretched over the crossbars on the central support, then finally strained and secured to the crossbar attached to the straining posts on the northern bank, thus covering a distance of 60 yards by two spans. Six strands of No. 8 gauge fencing wire were then laced through the netting (a double strand along each side and two singles in the centre); the double strands were fixed to the straining posts and the singles to the crossbar on the southern side of the river, then all were strained from the northern side (of course the straining levers were left on the wire for more than a week before being finally tightened up), and again the double wires were fixed to the straining posts and the singles to the crossbar; all the wire and netting was tarred before any covering was placed on top. The final surface is composed of boards (creosoted), 2 ft. 6 in. by $\frac{3}{4}$ in., placed transversely an inch apart and secured to the wire foundation by staples from the underside; the boards being 2 ft. long allows them to overlap the wire by $1\frac{1}{2}$ in. at each side.

A handrail is fitted on each side of the bridge consisting of double strands of No. 8 gauge wire; these are fixed 3 ft. 3 in. above the level of the bridge and are attached to the outsides of the straining posts and central trestle, thus keeping them approximately 3 ft. 6 in. apart. These handrails are also attached to the bridge at intervals by wire droppers: this gives additional strength to the bridge and also keeps the handrails down at 3 ft. 3 in., even when the bridge is sagging under the weight of passengers. To prevent side swing being caused by gales, guy wires were attached on both sides to the centre of each span, and fixed to posts set on the island 8 yards out from the centre of the bridge, thus safeguarding it from gales from either side. As the northern end of the bridge is several feet above ground level, it was necessary to erect steps up to it.

The total cost was as follows:—

	£	s.	d.
Timber	5	7	2
Fencing wire, sheep netting and bolts and staples	2	11	2
Haulage expenses	1	0	6
Labour	6	10	0
Total	£15	8	10

This bridge has been used regularly for three months and is proving highly satisfactory; it has not been tested as regards snow, but all other extremes of weather have been experienced and successfully withstood. Considering the length of the spans between supports the vibration when crossing is remarkably small, as a proof of this I have ridden a bicycle over it; of course this was merely to ascertain if this type of bridge would be suitable for forest cycle tracks. Should any readers be thinking of putting up a footbridge the type described in this note is recommended as being thoroughly efficient and economical.

PLANTING OF SCREE.

By J. Liddell and W. T. Smith.

The presence of patches of scree on areas acquired by the Commission in hilly or mountainous districts presents a difficult problem in the attainment of what is sometimes said to be the silvicultural ideal—uniformity of stocking. Particularly is this the case at Ennerdale, where the whole area is studded with irregular patches of scree, varying in extent and nature. The question may be asked—what is scree? Scree is an accumulation of rubble, stones and boulders, which in the course of centuries have been broken off the craggy hilltops, rolled down the slopes, and finally come to rest in irregular heaps.

Ennerdale scree, which is composed of igneous rocks containing a high percentage of silica, may be divided into three main types :—

(I) *Fixed Scree.*—Composed of smaller stones and rubble, with pockets of soil here and there, and generally found on the lower slopes of the mountains up to 1,000 ft. contour.

(II) *Fixed Scree.*—Composed of huge boulders, often several tons in weight, having no soil near the surface. This type of scree is to be found in the valley bottoms—the greater momentum of the heavy boulders carrying them to the foot of the slopes before finally coming to rest.

(III) *Moving Scree.*—Heaps of rubble and flat, slate-like stones which move at the slightest touch and generally with soil near the surface. These are usually found on the highest slopes and in the shallow ravines where mountain streams form cascades in times of flood. Type (II) scree can be definitely classed as unplantable, while there may be possibilities of planting Type (III) if it can be fixed, or individual plants placed in it protected by placing one or more large stones on the high side of each plant to prevent the latter being covered, but even so such planting would need constant attention.

At the suggestion of the Chairman an experiment was commenced in April 1933 in Type (I) scree. The compartment chosen is at an elevation of 700 ft. with a southerly aspect, and is exposed to east and west winds blowing up and down the valley. It was originally planted in P. 28 with S.S., the height of the trees being 2 ft. 6 in. to 3 ft., just high enough to show, disadvantageously, the ugly gaps caused by the scree. The idea followed was that of planting each plant in cardboard pots or containers and then placing the pots on likely crevices in the scree. The plants used were 3-yr. S.S. seedlings in three types of pots, viz., Plot A waxed cream or milk containers; Plot B, unwaxed containers (both these types being of the pint size); and Plot C, home-made, bottomless containers of stout cardboard (rather bigger than in Plots A and B). The soil used in the pots was obtained near the site of the plots and was poor in quality.

Two measurements were made in the autumn of 1933, and the results were as follows :—

Plot.	August.			
	Death Percentage.	Height Growth (inches).		
		Maximum.	Minimum.	Average.
A ...	2	3·25	0·75	1·75
B ...	2	3	0·5	1·6
C ...	24	2·5	0·3	1·5

Plot.	December.			
	Death Percentage.	Height Growth (inches).		
		Maximum.	Minimum.	Average.
A ...	5·5	3·4	0·75	1·8
B ...	6·5	3	0·5	1·6
C ...	24	2·5	0·5	1·9

It will be observed from the above that height growth practically ceased after August in Plots A and B and also that there was after this date an increase in the percentage of deaths, while in Plot C appreciable growth was made and no more deaths were recorded.

Taking into consideration the very dry weather conditions of 1933 summer all the plots have done remarkably well and all the living plants look healthy and are of a good colour. The higher death percentage in Plot C might be due to the following causes :—

(1) Pots being bottomless would not retain any rain-water which fell before the drought.

(2) Moss used as packing at the bottom of the pots, would on becoming dry, act as an absorption pad.

(3) The presence of ants on the area and particularly in this plot.

All the pots were still intact at the last assessment, but looked as though they would soon become rotted and likely to burst in the near future.

Without being unduly optimistic, and allowing for the fact that the real testing time for this experiment will be during the next two or three years, the results to date are distinctly encouraging, especially in view of the severe test already put upon the seedlings by the drought of last year. It will be appreciated that, if the objects of the experiment are attained only to the extent of even 40 per cent. of a normal stocking on these scree areas, provided there is a reasonably equal distribution, something worthy of the endeavours will have been attained.

DAMAGE BY STARLINGS.

By W. D. Russell.

Starlings, while spending spring and summer in pairs or small groups. congregate and roost in flocks during the winter. Many are said to migrate to warmer climates in the south, but large numbers gather in Devon and Cornwall, and are a common feature of the landscape, both in town and country. Generally, starlings begin to gather and to roost in flocks about the middle of October. As a rule, they disperse in March. If left undisturbed, they will occupy the same roost for three, and in some cases, up to five years. By which time the ground has become so filthy and so many trees have succumbed that the plantation ceases to afford suitable shelter and the birds then select another roost. Their preference seems to be for plantations of evergreen conifers in the thicket stage, from 10 to 15 years old. They favour Norway and Sitka spruce, but also roost in Douglas fir. They have been known to roost in larch, but generally only when driven from nearby evergreen plantations. Larch seems to suffer but slightly, while the spruces succumb fairly readily and Douglas fir rapidly.

Direct damage, such as broken leaders and branches is not great. The deposition of excreta on needles and branches is the main cause of death. A common sight in " starling roosts " is a tree completely defoliated, except for the leading shoot and the uppermost whorls of branches, with possibly a few tufts of needles still remaining on the extreme ends of some of the lower branches. At the same time the floor of the plantation becomes covered with a filthy and sour mat of dead needles and excreta, which probably contributes to the death of the trees.

The main protective measures so far applied are to drive the starlings from the plantation and prevent them roosting. It is comparatively easy to drive them from wood to wood, but much more difficult to drive them from the district. No doubt, extreme persistence in preventing roosting would achieve this, but the cost would be high by present methods.

The flocks begin to arrive about an hour before dusk and continue until about an hour after dusk. During this period, men are given something with which to make a noise, such as a tin and stick, two pieces of board or guns, and are kept walking in line back and forth through the plantation. At the same time, smoke fires are lighted, wherever safe, to windward. Smoke and noise have been found more effective than shooting. Another method that has proved fairly successful in preventing roosting is to clean and brush the plantation. While this is a comparatively slow process and not always practicable, it is the only preventive measure which has given any success. Bird scares of the usual types have proved absolutely useless.

For the past ten years or so starlings have been particularly numerous in the south-west. The extent of damage to plantations has not been recorded, but it is believed that it has not become serious yet. There is no doubt that it is on the increase. Up to date, no roosts have been found in the Commission's plantations, although there are several hundreds of acres now in the thicket stage. In view of the extent of the planted areas one can visualise a fair amount of trouble and expense in applying protective measures, should starlings eventually select any of the Commission's plantations as their winter habitation. The greatest trouble so far experienced has been on private estates in North Devon, particularly in the valleys of the Rivers Taw and Torridge. Instances are known in South Devon and in Cornwall, near Bodmin Moor.

BADGERS.

By R. Carnell.

Not much attention has been paid to the badger or as to whether this animal (allied both to the bears and weasels) can be placed in the list of animals harmful to forests. My experience is that, indirectly, it can cause a great deal of damage. The area here (Bruton Forest) was ring-fenced against rabbits, and every morning it was found that badgers had dug under the wire in from four to eight places during the night. Besides devouring the rabbits that had been snared or trapped they left the way open for rabbits to get into the plantation and daily inspection of the fence became a necessity.

Several methods of catching the badgers were tried. At first a long snare similar to that used for rabbits was made with not less than 36 strands. An ash or larch pole about 12 ft. long was put deeply into the ground about 4 ft. from the run of the badger, the small end was bent towards the run and brought as near as possible to the ground and pegged down. The snare was then attached and placed in the run as would be done for a rabbit, allowing of course for the difference in height. The badger was expected to get into the snare and in its struggles pull the spring-pole from under the peg ; it was thought that the pole would then spring up and hang the badger instantly. In practice the badger got into the snare but the spring-pole did not throw the animal high enough and with its hind feet on the ground it was an easy matter for it to bite through the 36 strand wire.

Owing to the pole losing its spring as related above, the following was tried. A favourite place where the badger dug its way through the fence was selected, and two spring rabbit traps were strongly wired and buried each side of the fence. Next morning all four traps were found to have been thrown and traces of fur left in them showed that the badgers had rolled them over.

The burning of sulphur candles in badger holes as an attempt to suffocate them has also been tried ; while this method will probably shift them they will most likely go to another hole near by.

The best means of keeping down badgers was that carried out in co-operation with the neighbouring estate, and going to the badger holt itself dogs of terrier size were sent into the hole to keep the badger occupied while the work of digging up to the animal proceeded. In this way in a few hours four badgers were caught and killed, making a total of eight caught on the area. It may be of interest to mention that invariably the last badger that is left in the hole comes out without any outside persuasion. Good dogs and plenty of them are needed for this business of badger digging.

Locally it is considered that the reason why there are so many badgers on the area is that the previous owner travelled for some distance for the purpose of badger digging, caught them alive and brought them back to be let loose again. Badger digging could then be prosecuted conveniently on his own estate.

With reference to the snaring of badgers, there is now an invention on the market, which is a snare attached to a mechanical device similar to that of a clay-pigeon trap, but it is very expensive to purchase and set up and is a source of danger to man and beast.

To the above Mr. W. L. Taylor has added the following note : Badgers are usually plentiful on Greensand in the south-west of England. In this formation they dig far and wide and I once saw a terrier emerge over half a mile from the point of entry in the main earth. The badger is an interesting, plucky and generally harmless beast and, except where serious damage to wire results from his individual and very conservative routine, he should never be persecuted.

R.E.F.S. SUMMER MEETING, SWEDEN.

By G. W. Hollis.

By my combined good fortune, first in obtaining a grant from the R.E.F.S. and secondly in being allowed special leave, I was able to take part in a tour to Sweden visiting forests and seeing something of the timber industry there. The party, numbering just over seventy members, assembled in London on 22nd July last and travelled from Tilbury to Gothenburg, which was reached on Monday the 24th. We then took train to Yjolby, passing through some very charming scenery consisting of large lakes surrounded by forests, a touch of colour being added by picturesque villas, all of which were built of wood. From Yjolby the party was taken by motor-coach to the Omberg Crown forests, which cover some 3,700 acres of productive forest land situated round Lake Vättern at altitudes varying from 250 to 800 ft. The first stop was at an excellent stand of Scotch larch 82 years of age, with an approximate height of 95 ft. and from 18 to 24 in. diameter at breast-height. There was a second storey of beech 59 years old, about 50 ft. high and a scrubby undergrowth of maple and beech in parts. A piece of plywood cut from one of the larches was on view, but the coarse grain and frequency of knots told rather against this species for plywood purposes. Self-sown ash 15 years old was then seen ; these had been nursed under a screen of spruce, the latter having all been removed. The ash stems were clean and about 30 ft. high. Very promising beech composed the next stand, these were 30 years old and the stems had been pruned : there was said to be little demand for beech and it is grown chiefly as a soil improver. We then walked through a plantation of *Pinus Murrayana* 6 to 8 years old and about 8 ft. high, with a mixture of self-grown mountain ash, to an area consisting of a number of small plots of many species about 13 years old, *Larix sibirica*, *Abies pectinata*, Fraser River Douglas and Lawson Cypress being included. Spruce stands of ages varying from 50 to 150 years were then seen with gaps planted with Sitka spruce, *L. sibirica*, *Abies pectinata*, *A. Nordmanniana*, *A. nobilis*, *A. grandis*, Douglas fir and others. Of the larches *L. kurilensis* was pointed out as an ideal species, having good shape and being finely branched. Notice was then drawn to a spruce plantation 34 years old which was considered too branchy, but no doubt we should be proud of such in England. An exceptionally fine stand of *A. sibirica* 35 to 40 years was then visited ; this species was said to have the best form of trunk of any yet tried. Douglas fir of poor type, strongly branched, were also seen. Continuing we passed through a stand of *A. pectinata* 65 to 70 years old, about 90 ft. high and averaging 12 in. diameter ; this area had an exceptionally good regeneration of the same species and of common spruce. Further on natural regeneration by strip felling methods was noted as being successful, and some fine pine 35 to 40 years which had been pruned to a height of 20 ft. were seen with an under storey of spruce. An oak stand 72 years old 70 ft. high and about 10 in. diameter was then commented on; the stems were clean and promising, the under storey was again of spruce.

An experimental area of *A. pectinata*, 72 years old and about 80 ft. high, was then visited; it had been very heavily thinned, but had an excellent regeneration, the oldest being about 10 ft. high. The last area seen that day consisted of some exceptionally good regeneration of spruce with some larch, pine, beech and birch. These were under a spruce stand that had been partially destroyed by storm in 1915. The regeneration was so thick that the party had difficulty in wading through it.

The train journey from Yjolby to Stockholm was taken over-night and three days were spent in the capital. The following day's tour was to Skutskar to visit the sulphite and sulphate pulping mills, the sawmills and the forests of the Stora Kopparbergs Birslag Co., Ltd., which is probably the oldest joint stock company in the world. The total forest area owned by this company is about 975,000 acres, of which 738,800 acres are productive forest land. The party was first escorted through the pulping mills and were able to follow the process from the log to the chemical cookers and thence to the drying rolls and finally to the strong dried sulphite or sulphate pulp ready for exporting to paper mills at home or abroad. 2,700 tons of dry bleachable sulphite pulp, 26,000 tons of dry bleachable sulphate pulp, and 900 tons of wrapping paper are produced yearly, besides 220,000 gallons of ethyl alcohol, 300 tons turpentine and 800 tons liquid rosin. Sulphate pulp is of lower grade than sulphite and is made from pine logs and waste from the sawmills; sulphite is made only from spruce logs, free of all bark. From sulphite are manufactured the higher grades of paper, while from sulphate brown paper and inferior grades are made. The huge stock of pulping logs stacked near the mills was astounding, and it was explained that practically a year's requirements had to be kept in hand to ensure a continuous supply of dried logs.

We then proceeded to the sawmill, where keen interest was shown in the modern equipment and the efficient way in which the mill was run. Two barking drums, taking some 4,000 logs in an eight hours shift, represented a type of machinery not seen in English sawmills and therefore of exceptional interest. The equipment of the mill included 18 frame saws, 3 edging machines, 3 planing machines, 3 systems of mechanical sorting of sawn materials, 14 adjusting benches, and 6 piling cranes. The annual output was stated to be about 25,000 standards. Excellent forests and plantations belonging to the company were seen. Pole pruning was in progress, and the results of this work evoked great enthusiasm; the plantation treated was pine and only stems selected for the final crop were pruned to a height of 20 ft.

A process of pulping different to the method adopted at Skutskar was inspected at Tollare. The logs were pulped by the action of revolving millstones subjected to 700 tons pressure, and the term mechanical pulp is applied. To mechanical pulp it is necessary to add 20 to 25 per cent. of dried sulphite pulp. This is added in the tanks to be dissolved and mixed. The mixture is then run through a screen and the water drained off by passing over numerous rolls revolving at great speed.

At Hallsberg, fine stands of timber belonging to the Skillbergs Bruk Co. were inspected. One of exceptional significance on an area of about 2½ acres consisted of 303 pines and 477 spruce, with a total volume of 29,890 cub. ft. Twenty-two pines and 17 spruces were measured and found to be 106 ft. high, and in 1927 one spruce was felled measuring over 120 ft. high. A shooting lodge made entirely of timber was much admired. The outer walls were of pine logs in the round, the under surface being moulded to fit snugly to the log beneath. The interior of the building was lined with oak panelling and furnished in true sporting fashion.

A spruce stand growing on deep peat which had been drained 50 years ago was of interest, the crop was about 55 ft. high and growing well. Plantations of pine were seen that had originated from self-sowing after treatment of the land with the Finnish plough. A modernized sawmill was inspected, the principal equipment consisting of one 325-h.p. steam engine, 3 frame saws, 1 edging mill, 1 cleaving saw, 1 butt saw, 1 edge saw, and 1 lath mill. The frames were taking from 50 to 70 logs, 6 to 9 in. diameter, per hour. One planing mill was working at the rate of 3,000 run-ft. per hour.

From Gothenburg the party visited Grafnas on forest common, which is a comparatively new forest area, having been grazed as common land so recently as 1916. The plantations, which have a most promising appearance, are mostly of spruce and pine with self-sown birch in mixture. Although the birch is outgrowing the conifers, it was considered too valuable as a soil improver to cut; it was very interesting to note the spruce growing under its shade and so very close to the birch stems without apparent damage from rubbing. Thinnings had been carried out in most of the areas visited. Pine and spruce planted on an undrained bog were very stunted, but a similar area drained in 1922 before planting showed the wonderful effect of the draining.

At Bondegarde a fine collection of exotic shrubs was seen, together with a flower and rock garden that would be hard to beat. So ended a splendid week crammed with tours and banquets. The voyage home, in delightful weather, was very enjoyable.

Reviewing the tour from a forestry point of view, we saw very few trees of really large dimensions, but the forests and plantations were as near to any forester's ideal as possible—trees tall, straight and cylindrical, closely grown, with sufficient crowns yet finely branched and forest floors mouldering to the proper degree. The natural regeneration of conifers especially of the common spruce was marvellous. The uneven-aged forests formed by natural regeneration and continued selection fellings were very impressive, especially where pine provided the upper storey with spruce beneath. Although there are several species of deer to keep in check, the Swedish forester has no rabbits to contend with nor apparently many of the injurious insects which are prevalent in Great Britain. One point in favour of our own forests is that we have a greater variety of species, and this of course tends to relieve the monotony that belongs to large forests of only two main species.

TREATMENT OF SCRUB.

By J. Fraser.

During the past thirteen years of the work it has been necessary to prepare for planting large areas of land which carried a scrub crop of an unprofitable type. The methods used in the preparation were not new methods, but they were used on a large scale and over a range of conditions which provide information for guidance in the future when dealing with similar areas. Changes in the application of old methods naturally suggest themselves, and it is to be hoped that foresters will continue to exercise their own judgment in the development of the work.

It is useful to distinguish classes of scrub crop that have been dealt with and those are briefly listed so that repetition may be avoided. In practically all the scrub areas the conditions were far from natural conditions: exploitation, grazing by farm stock, grazing by unnaturally large stocks of deer and rabbits, and fires had all combined to give to the scrub its present appearance. The following divisions are simply convenient descriptive classes distinguished for purposes of treatment.

(*a*) Scrub consisting of tall well-grown trees; crowns standing well above the ground; species mainly birch.

(*b*) Scrub of tall well-grown trees crowns as in (*a*); species birch, oak, alder, hazel, in varying proportions.

(*c*) Scrub of short old gnarled trees with wide spread low crowns; species birch, oak, alder, hazel, rowan; the height growth of the trees is probably as much as it is reasonable to hope for, in those species in the conditions where the scrub is found; in the west the birch and oak may be very unimportant and alder, hazel and rowan are the principal trees.

(*d*) Scrub consisting of a natural mixture of birch and Scots pine. The height growths of the two species and the relative height growths of the species in one wood are very varied. There is a remarkable similarity, however, in the vegetation cover of the soil; the similarity is remarkable in view of the wide range of soil and climate conditions over which this type of wood may be found. The cover is usually ling heather vacciniums (two species) mosses; there is little grass and the herb species are very few and unimportant; the surface is broken up in irregular hummocks and hollows of moss, and the other plants named above.

(*e*) Scrub of young birch, hazel, alder and rowan.

The soil conditions which are commonly found in the scrub areas may also be described very briefly as those conditions are important in considering what the scrub treatment is to be.

1. The scrub may occur on soil lying on the rock from which the soil was formed. The areas of scrub on this soil are not extensive in this division, but there are small areas and those are of great interest.

2. The scrub may be on covered scree; the soil which covers the scree may be largely the product of the weathering of the scree, but it may also contain large quantities of wash material. The patches of such scrub are usually small.

3. The scrub may occur on deep (viz., over 30 in.) wash soil lying in concave slopes. The area of such scrub may be small or it may be very large.

4. The scrub may be distributed along the margins of and in the rich flush areas of undulating country that has been heavily glaciated. The persistence of the birch in those hollows is due probably to the protection which the wet soil conditions have given against sheep farmers' fires and against grazing by sheep. The height growth of the scrub in those conditions is generally smaller than in conditions 1, 2, 3. The ridges in such areas may commonly carry Scots pine.

5. The scrub may be found growing on wash soils which rest on densely packed drift. The depth of the wash is difficult to correlate with the slope of the valleys. It is common to find the greatest depths on the steep more or less even slope of the valley and to find the wash on the more gentle slopes and on the flat low terraces very shallow. Where the lower terraces have been scoured and carved there are long ridges, and on those ridges the wash varies from practically nothing on the tops to very considerable depths on the lower parts of the ridges. On the deep wash scrub may be of type (*a*) or (*b*). On shallow wash the scrub type is commonly (*d*).

6. Scrub crops are found often on mounds and ridges that owe their origin to the direct deposition from ice or water and ice. Those mounds and ridges are usually gravel or gravel and sand, and the soils are more open than in the ridges and mounds resulting from cutting up of the drift terraces.

The term wash has been used in describing the soils distinguished. It is a useful descriptive term and need not necessarily imply any theory of origin of the soil. The wash is usually a comparatively stoneless layer and it does not appear to be the direct weathering product of the underlying drift. It may have originated from drift material similar to the underlying drift, and it appears to have been transported to its present position. The passage from the wash to the drift is sharp and clear, and there is not necessarily any obvious pan formation defining the passage from the wash to the drift. The suggestion that the wash has been deposited during heavy rain periods, and that in those periods the finer material of the drift has been washed down, appears at first to be a simple explanation, but if that explanation is accepted it is difficult to understand the shallow depths of wash found on the lower terraces. On long broad valleys the wash soils are deep in the concave slopes, shallow in convex slopes and shallow on the lower terraces.

In valleys with steep long even slopes (viz., not corrugated horizontally or vertically) the depth of the wash is often much greater than might reasonably be expected in view of the land slipping that takes place on those slopes in the rainfall conditions of the present day when horizontal contour drains may occasionally cause considerable trouble to a forester. The amount of leaching in the surface layer of the wash soils varies greatly, but the depth of the leached layer is apparently of much smaller importance in judging the value of the soil than is the depth of the whole wash layer.

The early treatment of the scrub was directed chiefly by the desire to keep down the formation costs of the new crop. It was decided very quickly that straight forward felling and burning of the scrub raised formation costs to a prohibitive figure. The easy solution appeared to be ringing out of the scrub and straightforward planting. The system cut out felling and burning charges, draining could go on without the preliminary burning of the slash material and the clear condition of the ground made rabbit destruction much easier. The system worked well in scrub of type (*a*) and in soils described as (1), (2), (3), and there are many examples of fine young crops resulting from the treatment. Disadvantages of the system appeared even in those favourable conditions, but the disadvantages were more evident in soil classes (4) and (5). Ringed trees became more liable to uprooting by wind (years '27, '33) and considerable expenses were incurred in repairing the wind damage. The surface layers of the soils in the ringed areas became very much wetter. The increase of moisture is probably due to the collapse of the drainage and aeration channels that run along the lines of the scrub roots. Similar water logging may be noted on hill faces that have been clear felled and replanted. On such clear felled areas it has been found that an increased number of surface drains became necessary after planting, although at the time of planting the areas appeared to be adequately drained. In areas where oak was plentiful very considerable damage was caused to the tops of the young planted trees by the dead branches of the oaks. Cases have been seen where dead branches of the oaks remain strong and sound on " laid in " trees after ten years. It should be admitted, however, that in some cases oak branches die off much more quickly. It is probable that in later years the ringed or " laid in " oaks will cause damage by windfalls. The early planted scrub areas were planted chiefly with Douglas fir, and it may be suggested by some that spruces will suffer less injury than the Douglas fir. Visitors to the Dunach areas support that view.

In young scrub a modified form of group system was used. Drifts of about 9-10 ft. were cut and similar widths of scrub were left uncut. The plants used for the new crop were Douglas fir. The treatment was on a small area only. Growth of the Douglas fir has been very satisfactory but the expense of weeding has been heavy and in 1933 it was decided that it was necessary to cut back the scrub in the drifts that had been left uncut at the time of planting. The experience does not in my opinion condemn the method of treatment but suggests that the planted drifts should be much wider.

In F.Y. 1930 group planting, on the lines suggested by Dr. Mark Anderson, was started and modifications of this system have developed in the course of the work. Groups have become larger and the attempt to distribute the groups regularly has been abandoned; the spacing of the plants within the groups has been increased and in the larger groups normal spacing is used. The position of the groups at the present time is determined largely by the position of the existing clear spaces in the scrub and those clear spaces are enlarged by ringing or felling. Some foresters have attempted to keep the unplanted scrub more or less across the line of the dangerous winds but the form of the ground surface and the crop itself must necessarily restrict such a plan. The number of species used in the scrub areas has increased. Norway spruce and Sitka spruce are the most commonly used trees, but tsuga, silver firs and larches have been used in small quantities. There has been an interesting attempt made recently to reduce as far as possible the preliminary ringing and cutting in the groups and to plant the young trees in a fairly heavy shade. The scrub will be ringed or cut later as the young crop requires.

The treatment of clumps of hazel coppice have given a good deal of trouble; this is true in young scrub and in the other classes of scrub. Our usual treatment was to clean out the hazel clumps in the groups or, where general ringing was the method used, the hazel was cut over the whole planting area. Where the work was done in advance the new hazel shoots became troublesome very early in the life of the planted crop and the lesson of the necessity for delaying the cutting of hazel was learned quickly. Even in cases where the hazel was cut immediately before planting it caused heavy weeding charges. The suggestion has now been made that the preparatory treatment of the hazel clumps should consist of ringing the greater number of the shoots in each clump and leaving one or two shoots untouched. The suggestion is that the living shoots will weaken the stools and that it will be possible to clean out all the surviving hazel and young seedling scrub and new coppice shoots arising from other species at the one weeding operation before those suppress the young planted trees.

Oak in a scrub crop presents another problem. The difficulty arises from the length of time during which the branches persist on ringed or "laid in" trees. This difficulty might possibly be met in future treatments by a modified group system. Oak could be treated by ringing or laying-in at the time of the planting of the first groups of ringed birches and alders and later planting might be made under the oaks.

There is no general code of rules that will guide a forester in all the details that he must consider in deciding the treatment of a scrub area, but a certain necessary guidance should be given by deciding what type of young crop is wanted to replace the scrub. The choices that appear possible are:—

(i) A pure coniferous crop with a slightly uneven age resulting from the successive treatments of scrub groups.

(ii) A mixed coniferous crop with a slightly uneven age resulting from the successive treatments of scrub groups.

(iii) A mixed coniferous wood even aged and with groups of varying size of different species and with small groups of the old broad-leaved scrub species.

Fortunately, the very varied soil types that usually appear within a scrub area of any extent will ensure that it will not be possible to form pure coniferous woods. The mixed coniferous wood of slightly uneven aged groups of trees might very easily be developed in a group system treatment of the scrub, and if this wood is to be formed it is suggested that in the later formed groups timber production might be subordinated to considerations of soil improvement and to the general appearance of the wood in the landscape. It is clear also that in this type of wood (ii) the areas left for the second period groups must be fairly extensive. The type (iii) will be the result of some of the later modifications of the grouping that have been tried out. The area of any scrub wood that should be dealt with at the first planting will be more or less the area of the final coniferous crop. It is not necessary to prescribe a general preliminary ringing or cutting within the area that is to be planted. The treatment of the scrub might be spread over several years and sudden changes in the external appearance of a scrub wood might be quite unnecessary.

A BALTIC SAND-DUNE AREA.

By J. W. Mackay.

During my annual leave in the summer of 1923, I paid a visit to the Kurische Nehrung, East Prussia, with the object of seeing the methods employed by the German Government Forestry Department in the reclamation and afforestation of a typical coastal sand-dune area, and considering how far the methods employed could be adapted for similar work on the Culbin Sands on the coast of Morayshire, the greater part of which was acquired by the Forestry Commission about the year 1921.

The area is approached via Koenigsberg, at which place I had an interview with Geheimer Regierungsrat Forstmeister Boehm, who gave me a letter of introduction to Oberfoerster Amoneit, the forest officer in charge at Rossitten, Kurische Nehrung.

The Kurische Nehrung is a narrow tongue of land running 61 miles north-northeast from Cranz to opposite Memel. It varies in width from about 500 yards to 2½ miles, and separates the Kurische Haff, a large triangular piece of tidal water, from the Baltic. It was at one time nearly covered with natural forest, but the Russians at the northern end and the Germans at the southern end demolished the timber in consequence of which the sand from the coastal dunes drifted with the wind and buried a number of villages and much fertile land on the inner side of the Nehrung. The maps show the sites of seven former villages which were obliterated by moving sand dunes between the years 1700 and 1846.

It was to avoid such depredations that the authorities commenced their protection works early in the nineteenth century on four grounds, the protection of villages from moving sand dunes, protection of the Nehrung itself against the danger of the sea breaking through, protection of the port of Memel, and protection of the post road which ran the whole length of the Nehrung.

The work consisted in the establishment and upkeep of a more or less artificial coastal sand-dune and the fixing and afforestation of the moving sand hills, which in places rise to a height of 200 feet. The Bauverwaltung (Engineering Department) are responsible for the coastal dunes, and employ their own staff. Beyond their limit the land comes under the care of the Forestry Department, but owing to financial stringency since the War planting had been suspended, the only works carried on being those necessary for the protection of villages, houses and land, and the post road. At Culbin at present, so far as I am aware, the Commission only has the problem of the fixation and afforestation of interior sand dunes.

Previous to the War the whole of the Kurische Hehrung and the mainland round the Kurische Haff to beyond Memel belonged to the German Empire. With the formation of the new Baltic States the northern half of the Nehrung together with Memel and part of the mainland east of the Haff were ceded by Germany to the new state of Lithuania. In pre-War times the Germans ran a daily steamer between Cranzbeek at the south-west corner of the Haff and Memel, calling at Rossitten. Since the division of territory, however, the steamship service on the Haff is very irregular and uncertain, and the traveller to Rossitten must either hire or walk from Cranz or Cranzbeek. As I wished to see the Nehrung as closely as possible, I decided to go by train from Koenigsberg to Cranz and walk from there to Rossitten, a distance of about 20 miles by road.

About three miles beyond the hamlet of Sarkau I reached the more or less unfixed sand areas, and the sandhills to my right became more and more prominent. At one place the post-road was completely buried in loose drift sand for a distance of several hundred yards, which made the going very heavy. The moving sandhills between Sarkau and Rossitten to the east of the postroad stretch for more than 7½ miles, and rise to a height of over 160 feet. The ground between the postroad and the Baltic was more or less fixed by grass planting.

I put up at the Hotel Kurisches Haff, and the following day Oberfoerster Amoneit took me to the Weisse Berg, where I saw stick hedges for the protection of the grass land against sand being blown in from the beach of the Haff. We then went on to the Schwarze Berg, a hill of pure drift sand rising to a height of 108 feet, many acres of which had been planted with mountain pine and Scots pine about 15 years previously. In the hollows where there is more moisture (and probably more organic matter than on the exposed surfaces and a larger proportion of the finer particles of disintegrated rock), the trees had grown fairly well. The ground was first laid out and divided with low fences into a network of squares 9 ft. 9 in. by 9 ft. 9in. A light covering of small branchwood, etc., had been spread inside the squares, and the ground planted without further fixing with 2-yr. seedling pines at 1 metre spacing, which gave three rows of three plants in each square. A little loam was added with each plant. The loam holds the moisture better than the pure sand and keeps the plants going for a few years. The Scots pine had started very well, but many of them were going back except in the moister places, where they were putting on good growths. The mountain pine gives a much heavier leaf fall, but the trees are bushy and spreading.

We then went to the coastal dunes (Vordünen) on the shore of the Baltic. The initial work is usually the formation of two low hedges of pine or other brushwood, parallel to the shore, and about 6½ ft. apart, to check the flow of sand and form a protective ridge or dune. If this does not give the desired height, one or more further hedges may be added as the earlier ones become covered with sand until the desired form and height are reached. Thereafter the form of the dune is preserved by planting sand grasses in lines forming a network of squares, usually 6½ by 6½ ft. A few plants are put inside each square. Two sides of the squares are at right angles to the prevailing wind. On the inner side of the dune the cross lines are dispensed with so that the movement of sand down the inner slope is not restricted. Either lyme grass (*Elymus arenarius*) or marram (*Ammophila arenaria* and *Ammophila baltica*) is used, whichever happens to be most handy.

Several miles of narrow belts of mountain pine had been planted to shelter the post road. Many trees had produced cones freely, but I was unable to find any natural pine seedlings.

For fixing the inner dunes a similar network of squares up to 13 by 13 ft. (4 m.) made of pine branches, birch, willow, or (on the Haff side of the Nehrung) *Arundo phragmites* is made use of. Willow has the advantage that the shoots often take root. The pieces are about 18 in. long, and are put in a slit made with a spade. The distance apart of the sticks varies according to circumstances; on gentle slopes they may be about 4 in. apart. The ground inside the squares is strewn with branchwood. In flat places short pieces of branchwood or split billets and small twigs laid flat on the surface are sufficient. For small basin-like hollows two stick hedges crossing in the centre are used.

The cost of these works even in pre-war times was extremely high. Herr Paul Gerhardt in his "Handbuch des Deutschen Duenenbaues," 1900, gives the following figures for the Kurische Nehrung :—

	Per Hectare. *Marks*	Equivalent per Acre. £	*s.*	*d.*
For pine hedges and ground covering	890	17	16	0
For soil and planting	520	10	8	0
	1410	28	4	0

By the older method of grass planting instead of hedges the cost, including soil and planting, was about £14 8*s.* 0*d.*

A small experiment with stick hedges in squares was tried at Culbin. but the cost was prohibitive.

The flora of the Kurische Nehrung on account of the wide differences in soils and conditions is a fairly rich one. During my stay of three days on the Nehrung, apart from grasses and commonest species, I made a collection of fifty species for Mr. J. Fraser Robinson, author of "The Flora of the East Riding," who is responsible for the following list :—

Achillea Millefolium, milfoil or yarrow.
Agrimonia Eupatoria, agrimony.
Andromeda polifolia, marsh andromeda.
Anthyllis Vulneraria, kidney vetch.
Astragalus arenarius, milk vetch.
Cakile maritima, sea rocket.
Circaea alpina, alpine enchanter's nightshade.
Epilobium sp., small willowherb.
Epipactis atropurpurea, helleborine.
Eryngium maritimum, sea-holly.
Fragaria vesca, strawberry.
Galium erectum (?), upright bedstraw.
Galium saxatile, heath bedstraw.
Galium verum, lady's bedstraw.
Geranium Robertianum, Herb Robert.
Habenaria bifolia, butterfly orchis.
Hypericum perforatum, St. John's wort.
Kochia canescens.
Lactuca muralis, ivy leaved lettuce.
Lathyrus maritimus, sea pea.
Lathyrus pratensis, meadow pea.
Ledum palustre, Sumpfporst (in German).
Linaria vulgaris, toad-flax.

Lotus corniculatus, bird's foot trefoil.
Lychnis Flos-cuculi, ragged robin.
Lysimachia nemorum, yellow pimpernel.
Melampyrum arvense, purple cow-wheat.
Mentha arvensis, corn mint.
Myosotis palustris, forget-me-not.
Oenothera biennis, evening primrose.
Petasites spurius (= *tomentosus*), hairy butterbur.
Potentilla anserina, silver weed.
Potentilla tormentilla, tormentel.
Pyrola rotundifolia, round-leaved wintergreen.
Rhinanthus Crista-galli, yellow rattle.
Rubus Chamaemorus, cloudberry.
Rubus fruticosus, bramble.
Rumex acetosella, sheep's sorrel.
Sambucus nigra, elder.
Solanum dulcamara, woody nightshade.
Stellaria graminea, lesser stichwort.
Thymus sp., thyme.
Trientalis europaea, chickweed wintergreen.
Trifolium arvense, hare's foot trefoil.
Trifolium procumbens, hop trefoil.
Trifolium repens, Dutch clover.
Veronica officinalis, speedwell.
Viola ericetorum (?), dog violet (?)
Viola tricolor, pansy.

The only distinct variations from our flora identified by Mr. Robinson were *Astragalus*, *Kochia* and *Petasites spurius*. *Ledum palustre* is shown as doubtfully British in the London catalogue of plants, 1908, and is not shown in Bentham & Hooker's "British Flora."

The plants which struck me as being most useful for sand fixation apart from the planted grasses were *Trifolium arvense* (hare's foot trefoil), found growing in considerable patches and which is important as a nitrogen fixer; *Oenothera* (evening primrose), which grows luxuriantly; *Eryngium* (sea holly), which is a schedule-protected plant on the area; and *Petasites spurius*, a tomentose species of butter-bur, which grows freely in the loose sand and spreads also by means of the pappus attached to the seed. Another plant which is attractive and should also be a good nitrogen fixer with its long, much-branched roots is *Latmyrus maritimus*, the sea pea.

I do not know whether it has been tried yet, but a plant I should much like to see tried out at the Culbin Sands is *Claytonia perfoliata*. It grows luxuriantly on the sands at Spurn Point, Yorkshire, and used to be very prevalent as a nursery weed at Forres, spreading by its seeds and also vegetatively.

EFFECT OF SLAG IN FIRST YEAR.

By D. Spraggan.

Effect on Freshly-planted Trees.—The improvement caused by slag is quite noticeable in the first year, more especially if the manure is applied in early spring. With spruces there may be additional height growth of two or three inches or the difference may only be seen in the length of the needle, the healthy colour of the plant and the strong bud formed at the end of the growing season.

At Slattadale in 1929, narrow strips of E.L., N.S. and *Abies nobilis* were slagged in the planting of that year, 2 oz. being given to each plant. The area had been drained and turfed. The soil was peat of 8 to 10 in. in depth, overlying grey drift and the vegetation mainly molinia and scirpus with erica-calluna and occasional myrica clumps. The slagging was done in early summer, and although very little growth was made, the N.S. and *A. nobilis* had a much better colour than those which had received no manure. No difference could be seen in the growth of the slagged and unslagged E.L.

In 1930, an area of P. 22 was drained, turfed and beaten up with S.S. and *Pinus contorta* and 2 oz. of slag applied per plant. This was on an area of fairly deep peat with molinia, scirpus, calluna, myrica vegetation where the original E.L. and S.S. had either died or remained in check. The slagging was done early in spring and the average growths for 1930 were S.S. 2 in., *P. contorta* 2·5 in. In the same year in P. 30 plots of N.S. were slagged and the average growth was 2 in. as compared with 1 in. in the unslagged area of N.S.

In 1932, a further checked area of P. 22 was drained, turfed and beaten up with S.S. and 2 oz. of slag applied per plant. The average growth for the year was 2 in. In the two examples of beating up of P. 22 no area was left unslagged to act as a control, the manure being applied as an essential part of the programme.

At South Strome, in 1929, plots of S.S. were slagged in P. 29 on a poor peat area. The average growth in the first year was 2 in., while in the controls the average growth was $\frac{1}{2}$ in. At North Strome in the same year, a similar plot of S.S. was slagged, 3 oz. per plant being applied under the turf, and although no measurement was taken that year, the growth appears to have been about 2 in. At Achnashellach plots of S.S. were slagged in P. 28 and P. 29, with a similar result, and in the beating up of 1932 and 1933, good growths were made on the slagged plants, S.S., J.L., and *P. contorta* on poor scirpus areas. It should be noted that all plants mentioned had been planted on turfs.

Effect on checked Plants.—On checked plants the effect of slag in the first year is slight, and generally takes the form of an improved colour and slightly longer needle. Occasionally, short growths of from $\frac{1}{4}$—$\frac{1}{2}$ in. are made. This has been noted on the checked plants slagged in the areas beaten up at Achnashellach in 1932 and 1933. Some of these plants had been the "originals" of 1922 and 1923, and others had been used in the beating up done in 1928.

Period during which Slag is effective.—From the results of the various slagging experiments at my disposal, there appears to be no definite time when the slag loses its effect. It seems to depend on the species and the soil conditions, but the best growths in most cases are produced in the second and third years after manuring.

In the 1929 slagging at Slattadale on a poor peat the strips of E.L. mentioned previously, are still improving and the growths are worth recording, viz. :—

——	1929.	1930.	1931.	1932.	1933.
	In.	In.	In.	In.	In.
Slagged plants	—	5½	7	8	9
Unslagged control	—	2	2½	2	2

The slagged plants have strong shoots with long needles and a good colour. The unslagged plants are of poor colour with short needles and many are in check. The N.S. slagged at the same time have made average growths in the years 1930–33 of 1·5 in., 4 in., 2 in., and 1 in., while the unslagged plants have been in check for two years. The slagged plants are now losing their colour and appear to be going into check. A few plants are still making fair growths.

The *A. nobilis* also slagged in 1929 are likewise losing their colour and growth, except individual plants on drain sides which are still growing well. The average growths in the years 1930–33 are 1·9 in., 2·2 in., 1 in. and 0·75 in. The unslagged plants are in check.

The S.S. slagged in 1928 and 1929 at Achnashellach, North and South Strome are still growing well. An example of the average growths for the South Strome 1929 plot is as follows :—1929, 2 in. ; 1930, 7½ in. ; 1931, 7·35 in. ; 1932, 5·28 in. ; 1933, 5·94 in. The appearance of this plot is not so good as in previous years, theco lour is poorer and some of the plants appear to be going into check. A small part of the plot was doing so well that the measurement was taken separately. The soil conditions were better, as shown by the clumps of *Juncus communis,* and the stronger myrica and the plants were still making large shoots. The average growths of the S.S. were as follows :—1929, 2 in. ; 1930, 8·1 in. ; 1931, 13·3 in. ; 1932, 14·4 in. ; 1933, 20·9 in.

The S.S. plot in P. 28 Achnashellach is somewhat similar, the plants appear to be losing colour this year, and the growth is poorer. There is a similar good section in this plot where the plants are all keeping their colour and growths up to 22·5 in. were measured in the current year.

The North Strome S.S. plot in P. 29 is still growing well, and the average growth for this year is 9 in. The conditions here are better than in the preceding plots and the unslagged plants in many cases appear to be coming out of check and some have made growths of 2 in.—4 in.

To sum up, on poor soil conditions N.S., S.S. and *A. nobilis* appear to be losing the effect of the slag after 4 or 5 years, while E.L. in almost similar conditions is still making good growth. Where the soil conditions are better the spruces continue to increase in growth year after year.

A case showing delayed action of slag at Slattadale in the P. 27 area may be given in conclusion. The ground was drained and turfed in 1927 and planted with S.S. The soil was deep peat of 3 ft.—4 ft. with old pine stumps embedded in it; the vegetation, short molinia, scirpus, both ericas, calluna and occasional small myrica clumps. In 1930, every third drain was deepened and 2 oz. of slag applied per plant in June. In 1930, there was no growth, but the colour of the plants was better. In 1931, the colour was still good and the needles longer. In 1932, the needles were still longer, but no growth had been made. In 1933, the plants were still in good colour, the needles were fairly long, and there was a growth of $\frac{1}{2}$ in. on the average. The unslagged plants, which had every third drain deepened in 1930, were still in check.

MISCELLANEOUS NOTES.

Plants from Latvian Scots Pine Seed.

The results obtained from this seed (I. No. 26/54) are undoubtedly peculiar. In the nurseries the seed germinated well, but there were disastrous losses in the 2-yr. seedlings stage. After lining-out matters went from bad to worse, the roots appeared to be affected, and most of the plants lost their needles quite early in the summer. The net effect was that 260 lb. of seed sown produced only about 400,000 plants fit for use in the field, a yield of under 2,000 plants per lb. The following descriptions of the nursery stages at Edensmuir and Tentsmuir Nurseries give a good idea of what happened.

Tentsmuir.—Five pounds of seed were sown producing 120,000 seedlings, a yield of 24,000 per lb. The count of 2-yr. seedlings was 68,700, and these were lined-out. The plants looked very well for the first few months, but after putting on from ½ in. to ¾ in. of new growth they appeared to receive a sudden check which continued until June, when practically all the plants were dead. The roots were affected, simply rotting away, they showed no signs of having been gnawed by grubs.

Seaton.—Twenty pounds of seed were sown yielding 370,000 1-yr. seedlings. In the second year the count was 300,000. Of these 200,000 were destroyed and 90,000 lined-out. The lined-out seedlings yielded 50,000 transplants which were also destroyed. The seedlings turned purple during the first and second winter, and were attacked by Lophodermium (probably secondary). The 90,000 plants lined-out made no progress whatever, the needles gradually dropping off and only bare stems remaining. The root system was very poor.

Reports on the subsequent growth of the plants have now been received (end of P. 32). They relate to Ringwood, Allerston, Ardgartan, Edensmuir, Drummond Hill, Devilla and Borgie Forests. With the partial exception of Allerston all the reports are of quite a favourable character. Mr. Murray reports that the plants at Edensmuir are thriving extremely well, at Devilla the rate of growth has been rapid and the trees are up to 3 ft. 6 in. in height. At Borgie they are said to have done quite well after leaving the nursery and to be hardier in appearance than the Scots pine of other origin alongside. Thus the position is that the seed was widely distributed in nurseries throughout England and Scotland, and in every case from 50 to 90 per cent. of the plants died or were moribund by the end of the third year. Other pine seed lots behaved quite normally, so it was not a question of climatic conditions. The surviving plants were put out in a number of forests in P. 29 and P. 30, and have since then grown satisfactorily.

One can only speculate as to the causes of the trouble, but it seems possible that root failure in the seedling stage was a primary cause. Dr. Rayner has shown that the different geographical races of pine have different mycorrhiza associations, some of which appear to be very specialised. What may have happened in this case is that the seedlings not finding their normal fungal associates in the soil dwindled for the most part and died. A proportion, however, were able to form normal mycorrhiza with the fungi present in our nurseries, and so survived. It would be quite in accordance with present views on mycorrhiza for these plants to develop normally in the forest.

W. H. Guillebaud.

Pruning of over-sized Douglas Fir in 1930.

Reports have been received regarding the P. 30 plots in eighteen forests. The experiments were carried out in accordance with the instructions of Silvicultural Circular No. 5 of 24/10/29, and were intended to follow up some preliminary work on shoot pruning of Douglas fir, carried out in 1915 in one of the American National Forests. It was desired to ascertain whether losses could be reduced by removing part of the leaf-bearing shoots and also to compare the effect of leader pruning as against branch pruning in relation to the establishment and subsequent growth of the plants.

The reports now received indicate the position after three growing seasons. Considering the fairly large number of areas in which the experiment was carried out, there are remarkably few exceptions to the general trend of the results. Only in one single case (Cynwyd) have the losses been appreciably higher in the controls than the pruned plants. On the whole losses have been low (from 0 to 10 per cent. in most areas), but even where the failures were heavy the unpruned plants have usually shown the fewest losses. There is no substantial difference between the losses in the leader-pruned as compared with the branch-pruned plants.

The following sample data show that pruning has not substantially affected height growth :—

Forest.	Control.		Leader Pruned.		Branch Pruned.	
	Total Height.	Leading Shoot.	Total Height.	Leading Shoot.	Total Height.	Leading Shoot.
	Ft.	In.	Ft.	In.	Ft.	In.
New Forest ...	8¼	27	7¾	27	8	28
Chepstow Park ...	4	11	4½	13	4	10
Bourne	—	8	—	10	—	7
Lyminge	8	28	7	28	—	—
Hemsted	4	10	4½	11	4	9

The reports, however, emphasise that the unpruned controls are in almost every case the most healthy and vigorous in appearance. Leader pruning has usually resulted in the formation of longer leading shoots. Die-back of the shoots, which so often takes place when over-sized Douglas fir are planted out, has been conspicuously absent in these trials. One can only conclude that the P. 30 planting season must have been exceptionally favourable.

There is not much in the reports about windthrow, and there has evidently been little damage due to this in most of the areas; some of the reports suggest that the pruned trees are slightly more wind-firm than the controls, but the evidence is not very conclusive.

A a rule the leader pruning has led to the development of very few double or multiple leaders, the latter has chiefly taken place where the plant was pruned below the top of the previous year's shoot. When cut back to a bud on the current year's shoot a single shoot almost always took the lead.

Japanese larch were similarly pruned in 6 forests in Division 2 and European larch in 2 forests in the same Division. The results are generally similar to those obtained with Douglas fir, *i.e.*, the controls have done best all round and branch pruning is slightly inferior to leader pruning. The only outstanding exception was at Cynwyd, where the controls had 50 per cent. losses, leader prunded 18 per cent. losses, and branch pruned 4 per cent. losses.

Summary.

For the particular season in question the experiment has failed in its object of reducing losses resulting from the planting of over-sized Douglas fir, Japanese larch and European larch, but the take over all was good and it is possible that in a less favourable season more definite results might have been obtained. The leader-pruned plants have made a satisfactory recovery from the operation, and this appears to be the better of the two methods tried.

W. H. G.

Sessile and Pedunculate Oaks.

The average forester or even the average botanist when asked how to distinguish between the sessile and the pedunculate oak will generally refer to differences in the length of the stalks of the acorns and leaves, the shape of the leaf base and the presence or absence of hairs on the under surface. It may come as a surprise to some to find how many distinguishing characters Dr. Gross of Allenstein has been able to tabulate in an article on sessile oak in East Prussia which appeared in the March, 1933, number of the *Zeitschrift für Forst und Jagdwesen.* Unfortunately we in this country have to deal very largely with intermediate forms, the result of cross pollination, and the most we can usually do is to classify our oaks as of "the sessile type" or "the pedunculate type" as the case may be. Even this distinction is often none too easy to make in practice so some may be interested in the complete list of characters which follows :—

——	Pedunculate Oak.	Sessile Oak.
Female flowers ...	Few	Many.
	Separated out and attached to a long stalk	Thickly clustered. Sessile on the end of the twig.
	Stalk about half as long as the leaf or longer	If stalked, the flower stalk shorter than the leaf stalk.
Fruits ...	Singly borne	Many, clustered together.
	Long stalked	Sessile or very short-stalked.
	Elongate and usually large ...	Usually small.
	Shining, with dark longitudinal streaks	Dull and plain coloured (without streaks).
Leaves ...	Irregular in form	Symmetrical.
	Very short stalked (stalks usually 1/10th inch long) or almost sessile	Long stalked (⅓ to 1-in. long).
	Auricled at the base	Usually wedge shaped at the base, seldom slightly auricled.
	4 to 5 lobes on each side ...	5 to 7 lobes on each side.
	Thin	Tough.
	Upper side more or less dull...	Upper side shining.
	Under side eventually quite bare (at the most only scattered hairs on the nerves)	Under side covered with quite inconspicuous *star-shaped* hairs (only clearly visible with a lens).
	Lateral nerves running into the angles between the lobes	Lateral nerves only at the base of the leaf running into the angles between the lobes.
	Borne irregularly in clusters at the ends of the twigs	Singly and horizontally borne.
	Reddish when first unfolded	Green from the start of flushing.
	Usually rounded at the tip ...	Usually pointed at the tip.
	Leaf stalk and midrib green ...	Leafstalk and midrib yellow-green to straw-yellow.
Buds ...	Roundish	Elongate and pointed.
	Clustered at the ends of the twigs.	Not clustered.
Branching ...	Bushy, spread inclined to be horizontal	Twigs more less ascending.
	Stem soon passing into a widely branched crown	In young oaks in a stand the stem persists in the leading shoot.
	Epicormic shoots common ...	Epicormic shoots rare or lacking.
Bark	Coarse and shortly cleft ...	Fine and long cleft (like the common elm).
	Hard. Difficult to scratch with the finger nail	Soft. Easily scratched with the finger nail.

—	Pedunculate Oak.	Sessile Oak.
Heart Wood ...	Reddish brown within ...	Lighter brown to yellowish within.
	Brownish with a greyish-green sheen	Yellowish.
	Large pores in broad spring zones	Small pores in narrow spring zones.
	Hard	Mild.

W. H. G.

NOTE ON FOREST FIRES.

A review by M. Pierre Buffault of the International enquiry into the matter of forest fires conducted by the International Institute of Agriculture, Rome in 1933 is given in the *Revue des Eaux et Forêts* for November, 1933.

Dealing with the causes of forest fires M. Buffault records the following percentages for France :—carelessness, 60 ; malice, 9 ; railways, 21 ; various and unknown, 10. These figures correspond approximately to those indicated for the United States, Canada and Sweden. Lightning is recognized, in France, as a causative agent, but rarely so, although cases are more frequent in British Columbia and Sweden. It is possible to state that spontaneous outbreaks attributable to pieces of broken glass acting as lenses, the fermentation of organic matter, friction of branches by wind, etc., are entirely hypothetical and, in practice, have never been verified.

The facts of the case have been stated by M. Lavawden ; there is one natural cause and that is lightning and all other causes are due to human agency. The conclusions of the enquiry are that by far the greater number of forest fires owe their origin to the negligence of individuals, a conclusion to which British foresters can heartily subscribe. M. Buffault also points out that with forest fires there are generally one or more secondary and aggravating circumstances involved, besides the initial cause of the outbreak. These are contributory to the eventual loss and are not usually sufficiently considered when the problem is reviewed.

The enquiry covers all the other important aspects of the fire question and reaches the following conclusions. Danger of fire is present in a more or less serious degree in every forest. In the application of protective measures sufficient account has not been taken hitherto of the natural defensive resources of the forest. Attention has mainly been directed to speedy notification of, and intervention in, outbreaks of fire. It is still hazardous to speak with assurance of tactics and technique in fire-fighting. The development of insurance is retarded in most countries by lack of preparatory work. Forest fire statistics are too often neglected. A preliminary conference of experts to draw up a plan of research into the whole question is desirable.

W. L. T.

Bath and West Show.

The Bath and West Show was held from 24th to 27th May at Wimbledon. The Forestry Commission in co-operation with the Forest Products Research Laboratory concentrated on showing the various uses and working qualities of home-grown timber. The Seasoning Section of the Laboratory exhibited a model pile of air-dried planks, round fence posts and re-conditioned timber. In wood preservation, posts that had been butt-treated with creosote and also those untreated were shown in order to demonstrate the increased life resulting from the use of preservatives. There was also an exhibit of telegraph poles which had been treated under pressure and had been in service over forty years with no sign of decay.

Utilization was represented by a varied collection which included 16 specimen planks of hardwoods and softwoods and wrought specimens of the same species moulded, recessed, morticed and drilled. The turning qualities of wood were seen in a number of articles, some being shown in the various stages of manufacture from the pole to the finished product. Two panels of oak-flooring made of Forest of Dean oak were exhibited, one made with blocks and the other with strips ⅜-in. thick laid on a sub-floor. Flooring blocks of beech, hornbeam, elm, oak, yew and Scots pine were shown.

Small containers made of various softwoods showed the possibilities of English timber for the packing trade. Other exhibits included an elm tin plate box, a crate with elm ends and spruce sides for milk transport and a cheese box made of poplar. In the furniture section there was a Windsor chair made of elm and beech and another chair of beech with sides and back of bent-wood, also a small chest of drawers in Scots pine with ten drawers each of different kinds of coniferous wood. A set of elm furniture consisting of a dining-room table, chairs, writing desk and lamp-stand was much admired.

The exhibit on the whole gave a very good example of the uses of home-grown timber. Owing to the small attendance at the Show not so big a crowd as usual visited the Forestry Pavilion but it received its fair share of attention.

F. G. Pearson.

Royal Show.

The Royal Show was held from 4th to 8th July at Derby. The Forestry Commission in co-operation with the North Midland Home Grown Timber Merchants' Association presented an interesting exhibit illustrative of the commercial uses of home-grown timber.

Inside the Pavilion was shown among other things a large variety of woods for furniture and for the motor and sports trades. An unusual exhibit consisted of bent oak stirrups such as are used in Mexico and which are made in Nottinghamshire. There was a large display of turnery including various types of handles made of ash, brushbacks of birch, and dairy utensils of sycamore, and there was a fine set of hardwood and softwood planks.

Space was provided adjoining the Pavilion for the larger exhibits, these included gates and fencing, agricultural implements, rustic tables and benches and logs of ash, oak and elm as well as boards of many species.

The Show was well attended and during the five days a large number of visitors inspected the forestry exhibits. F. G. P.

Employment of Foresters' Families.

A subject which I should think is occupying the minds of some of the older foresters of the Commission is what they are going to do with their children when they have finished school, as, in so many cases, they live so far away from a town. A good many of the younger foresters may not be interested in this question at present but most of them will be later on.

I have been trying for the past two and a half years to get my son placed but have failed so far. The managers at both the Horsham and Newcastle Labour Exchanges have also been keeping a look out for a job for the lad and at Horsham it is just possible that he could have got employment but even if he had it would have cost me 9*s.* per week for fares, and he would probably have received a wage of 7*s.* 6*d.* per week or even less while learning a trade. At Newcastle if he had got a post I would have had to pay for his lodging as he could not have travelled each day. It is now possible that my son may get a post in London but this would have been out of the question if he had not had relatives there. If he gets this post in London he will only get home for one week each year. I have no helpful suggestions to make as to what can be done in the matter, but somebody else may be able to solve the problem and this is written as a sort of feeler. W. J. Bewick.

Ploughing.

In the early part of this year ploughing operations were commenced in Slaley Forest and at first is appeared as if it was going to be a very expensive job, both as to the cost per acre and for spare parts for the ploughs. The implements brought on to the area were a single plough, a double plough and a sub-soiler. At first the single plough was tried but it was soon found that with breakages and stops this was not going to answer. The double-furrow plough was next tried and for a time seemed as if it was going to do the work in first-class style, but as it turned out it was only because it had been working in less rocky ground than the single furrow plough and we were soon back into the old trouble.

The subsoiler and the single plough were next tried together and after that all our difficulties were at an end and the two were worked together until the ploughing was finished, the subsoiler clearing a track for the plough. Many of the rocks moved by the subsoiler weighed at least 5 cwt. Altogether 124 acres were ploughed, 76 of which are being planted this year. The best method of planting this ground is the circular spade as it is possible with this tool to bore clean through the turf into the ground, thus enabling one to get the plant well firmed. The Schlich spade was tried, but was no use except where there was any amount of loose soil. At the end of last planting season I planted 50 S.P., 50 C.P. and 50 S.S. on the overturned turf, and the same number and species in the furrow and up to the present there is 18 per cent. of deaths in those on the overturned turf, and 4 per cent. in the furrow, but by the end of the winter I expect it will be among those planted in the furrow that the biggest percentage of deaths will take place because on my last inspection the trees so planted were standing in water. I may add that it looks as if trees would go ahead without any trouble now as with the subsoiler working at a depth of about 20 in. an abundant quantity of loose soil is available for the plants.

W. J. B.

Shelter Belts on exposed Areas.

It has occurred to me that on newly acquired areas something might be done about the provision of shelter during the first planting season on exposed land. Most places have their share of exposed land, and usually the most favourable sites are planted first, leaving the exposed land until the last. My suggestion is that during the first and second years shelter belts should be planted where exposure is severe. After taking due note of the strength and direction of the wind the distance between the belts would have to be marked on the ground. Species for the belts would probably be beech or sycamore, beech preferably as it is a fairly hardy tree, gives most shelter and the belts need not be so wide as for sycamore. Good sturdy plants should be used and if they do not get away quickly, enough slag should be applied.

The main planting of the exposed places should be left until the last year of planting and assuming that planting is being done at the rate of 100 acres per year, the belts on a thousand acre area would have been growing for 8 or 9 years before the time came to plant the exposed land. By this time, the belts would have grown enough already to be of some value as shelter, perhaps not a great deal, but if your exposed area is covered, as a good many are, with heather and gorse, these will afford the small plants shelter for two or three years and by this time your belts will have grown enough to be of great service.

Care would have to be taken of the belts, weeding and beating-up being very important.

I think belts formed on these lines could be made with good results. I have in mind an area at Exmoor where Scots pine was planted in P. 21 and P. 22, some of which have suffered badly from blast and interplanting has had to be done to help to form a crop. We have learned since that Corsican pine would have been a better species to have planted, but the fact remains that no species will give of its best on exposed land without some shelter. Interplanting means additional cost and shelter belts might not only eliminate this but would also result in the production of better timber than we could otherwise expect on exposed land.

R. E. PALLETT.

PLANTING MATTOCKS.

I wonder whether any forester has thought of a successful way of shallow notch planting for spruce. I find with the existing mattocks that the work is laborious and necessitates the handle being kept practically vertical otherwise too deep a notch is made. By bending the blade of the mattock 10 deg. upwards towards the handle the work is made much easier. It is then practically impossible even for a careless man to plant too deeply. I suggest that this type be used generally for spruce planting.

T. H. LEWIS.

REMOVING BROKEN AXE HANDLE.

It is generally found difficult to remove the broken portion of the handle from the eye of the axe as it cannot be burned out in the open fire or the temper of the steel will be spoiled. The following hint may therefore be found useful. Drive the sharp edge into soft earth (preferably wet) up to the eye and make a fire round it, leave it for 5-10 minutes when the broken handle can easily be tapped out while the temper of the blade remains undamaged.

T. H. L.

SLAGGING AT SLATTADALE.

Slagging was first carried out at Slattadale in 1929, and has been done every year since, except 1931. The operation was carried out on both newly planted plants on turfs and plants in check on turfs. The amount of slag applied to each plant in every case was 2 oz. and the method applying was also the same in each case. A piece if turf was removed from round the stem of the plant treated and after applying slag the piece of turf was replaced.

Slagging of newly planted Plants.—The slagging in 1929 was done some time after planting with the result that little effect was shown at the end of the growing season. Norway spruce, *Abies nobilis* and European larch were treated. The N.S. and *A. nobilis* in a slagged plot showed better colour than the unslagged plants of these species at the end of 1929, but there was no improvement in height growth. There was also little difference between slagged and unslagged E.L. at the end of 1929. From 1930 onwards there was a marked difference between slagged and unslagged plants.

The maximum annual height growth of N.S. and *A. nobilis* was made during 1931 but there has been a gradual decrease in the annual growth and length of new needles of both these species since then. They have also become much paler in colour during the last two years. A few plants of both species have still retained their colour, however, and show good growth. The maximum annual height growth in 1933 was N.S. 8 in. and *A. nobilis* 4 in. The unslagged plants of these two species have remained in check since planting and show no sign of improvement.

There has been a gradual increase in the annual height growth of slagged E.L. from 1930 onwards and in 1933 the average height growth was 9 in. On the unslagged area many of the plants are dying away while the remainder show very poor growth, the average height growth for 1933 being 2 in.

In 1930 Sitka spruce and *Pinus contorta* were slagged and as slag was applied shortly after planting the plants showed an improvement at the end of that year. The height growth of S.S. was 2 in. and of *P. contorta*, 2½ in. The average maximum height growth of S.S. during 1931 and 1932 was 9 in. There was a falling off in length of annual shoot in 1933 on the hard knolls but plants still show fair growth although they are not so dark in colour as during the two previous years. In the hollows where the peat is not so tough they have retained their colour and show a good growth in height. There has been a gradual increase in the annual height growth of P.C. which was 7 in. in 1933, and plants have still a fine healthy colour. Unfortunately there is no unslagged portion in this area so that comparison between slagged and unslagged plants is not possible.

An outstanding feature in the 1932 slagging was the difference at the end of the season between the height growth of 2 + 2 and 2 + 1 S.S. When measured at end of 1932 the former showed an increase in height of only 2 in. while the average growth of the 2 + 1 plants was 6 in. The 2 + 1's are still showing a better annual height growth than the 2 + 2's, the measurement for 1933 being 2 + 1, 7 in. and 2 + 2, 5 in.

Slagging of checked Plants.—In 1930 S.S. which were planted on turfs in 1927 and were in check were treated with slag. At end of 1930 the plants had improved in colour and there was an increase in length of the 1930 needles. There was further improvement shown in colour and length of needles during the next two years, but except for a few plants there was little increase in height growth. Odd plants showed a fair height growth for 1932, the maximum being 5 in. The average height growth for 1933 was ½ in., the maximum being 6 in. The plants have still a healthy colour. The unslagged plants on the same area are still in check and show no signs of recovery.

In the spring of 1933 N.S. and *P. contorta* which were planted in 1930 were treated with both basic slag and potassic slag, and although there is an improvement in the colour of manured plants as compared with untreated plants there is no marked difference between the basic slag plot and the potassic slag plot.

D. J. Urquhart.

Manuring with Slag and Semsol.

In P. 33 areas of mounded 2 + 1 S.S. and *Pinus contorta* were treated some with slag and some with semsol at the rate of 2 oz. per plant. The manures were applied in January and February before planting on top of turfs except in the case of one area of semsol where the manure was applied under turfs. Planting was carried out in March and April. The ground treated is on a moderately steep southerly slope about 800 ft.; and is mainly of the heather, scirpus type with some molinia flushes. Rainfall is over 100 in.

Both semsol and slag have definitely affected plants in the first year. The colour of S.S. is in general a dark green and some plants have made a growth of 4 in. No difference can be seen in plants manured under or on top of turfs. On the whole plants treated with slag appear slightly better than those treated with semsol. *P. contorta* shows a remarkably good growth and colour with both manures and is very much healthier looking than untreated directly notched plants nearby. Deaths are equally distributed and no more than normal.

C. Macdonald.

Manuring of checked Spruce.

In February, 1933, two acres of checked spruce (1 acre N.S. and 1 acre S.S.) at Achnashellach were drained in the 1925 plantation and the plants were given 2 oz. of manure each. No beating up was done. Half an acre of each species was given slag and the other half acre was manured with semsol. The manure was sprinkled round the collar of each plant.

The plots are situated on a gradual slope facing N.W. and include several morainic knolls. In both plots the soil is peat overlying hard grey drift. On the knolls the peat is from 6 in. to 12 in. deep and in the hollows 12 in. to 30 in. The vegetation is similar on both plots, with scirpus predominating on the knolls, along with short molinia-erica-calluna, while in the hollows the molinia is stronger, the scirpus less noticeable and the erica-calluna longer. In 1925 when the area was planted very little draining was done and the trees were planted on the flat, 2 + 2 N.S. and 2 + 3 and 3 + 3 S.S. being used. The plots were examined at the end of September, 1933.

Norway Spruce Plots.—Only about 30 per cent. of the plants were alive when the experiment commenced and these were in a state of complete check. In most cases only a few side branches bore needles which were small and yellow in colour. The slagged plot showed no change except in a few individual cases where there was a slight improvement in colour. A fair proportion of the plants in the semsol plot when examined had improved in colour, a few showed an increase in length of needle while some had shown no change.

Sitka Spruce Plots.—About 60 per cent. of the plants were alive when the experiment commenced. These were large plants and were all in check with the typically yellow needles. When examined few of the plants in the slagged plot had shown any improvement. In one or two cases the colour had improved and the current year's needles were slightly longer. While most of the plants in the semsol plot show no improvement the effect in a few individual cases has been striking. In some the current year's needles have a better colour and are much stronger, growths of half to three-quarters of an inch were measured. While no definite conclusions can be drawn at this early stage of the experiment it appears that after 8 years in check the Sitka spruce have greater recuperative powers than the Norway spruce. It seems also that the semsol has had slightly more effect than the slag. It should be noted that in many cases the improved plants were situated on the drain sides.

Slag and Semsol.—In the ordinary work of beating-up in 1933 on poor ground in P. 26 part of the area was manured with semsol and part slagged, 2 oz. were applied to each plant. The soil was peat of variable depth overlying grey drift and the vegetation, mainly long calluna, molinia, scirpus, erica and sphagnum. The ground had been drained, turfed and beaten up with S.S., with a few S.P. on the knolls and some *Alnus oregona* at 10 ft. apart amongst the spruces. The average growth of the S.S. was 2 in. in the slagged plot and $1\frac{3}{4}$ in. in the semsol area. The pines had made an average growth of 2 in. in both areas and the alders 10 in. in the slagged area and 12 in. in the semsol plot.

D. Spraggan.

Experimental Planting at Glenhurich.

The experiment was laid down in March, 1926, to find out the most suitable species for planting on the northern slopes of Loch Doilet.

A typical piece of ground about half an acre in extent was fenced in against rabbits, sheep and deer. It is on a slope of between 30 and

45 deg. and required no drains or other preparation. The highest elevation is about 140 ft. and the area is somewhat exposed. The main soil conditions are a surface layer of hard dark peat 3 in. in depth over a reddish brown soil with few stones. A band approximately 2 in. deep of greyish leached soil immediately below the peat crosses the middle of the area from west to east. The average annual rainfall is about 100 in. Severe frost at the elevation of this plot is uncommon. The herbage is mainly composed of heather with a sprinkling of molinia, bell heather, scirpus with occasional bracken and hard fern with lichen in isolated patches.

The trees were planted in bands of three rows each running up and down the slope, and consisted of 100 plants each. They were planted in the following order from west to east—

Species.	Ident No.	Age.
Sitka spruce	22/20	2 + 2
Norway spruce	B.1	2 + 3
Tsuga	22/25	2 + 2
Thuya	—	2 + 2
Scots pine	Altyre 1	2 + 1
Corsican pine	23/7	2 + 1
Pinus contorta	—	2 + 1
Jap. larch	Howden 1	2 + 1

The trees were planted with mattocks, after surface screefing. The planting distance for all species was 4 ft; no beating up has been done. All plants were counted and measured in the autumn of 1933 with the following results :—

Species.	Percentage of deaths.	Total average height.	Current Year's Growth. Extremes.	Current Year's Growth. Average.	General appearance.
		ft. in.	in.	in.	
Sitka spruce ...	16		Stationary		Yellow, still in check
Norway spruce	13		,,		,, ,,
Tsuga... ...	33		,,		,, ,, some dead leaders.
Thuya ...	1			4	Healthy, some of the original leaders died back but new strong shoots have been produced.
Scots pine ...	4	5 10	6–18	12	Healthy, dark colour.
Corsican pine	18	3 7	4–10	6	Healthy, good colour.
Pinus contorta	17	4 6	6–23	10	Healthy, good colour.
Jap. larch ...	62	6 4	4–22	10	Healthy, but slightly blasted on western side.

WM. MCCLYMONT.

Planting of Seedlings.

During the past three years experiments have been carried out in Glenhurich Forest on the planting of seedlings in the forest. Approximately 26 acres were planted as follows: 20 acres 2-year, and 2 acres 3-year S.S. seedlings turf-planted, and 4 acres J.L. 2-year notched in on surface. The 2-year S.S. were planted on the poorer types of soil with a surface vegetation of scirpus, lichen, heather and occasional bracken over from 3 in. to 15 in. of peat over a red sandy soil at an elevation of from 80 to 960 ft. with a southerly exposure.

The poorer types of soil were treated with 2 oz. of basic slag per plant. These show a marked improvement on those not treated, in some cases having a greater total height than 2 + 2 transplants planted at the same time. The plants not treated compare quite favourably with transplants on similar types of soil.

The method of planting was notching right through turfs and spreading the roots on the natural surface. Where 3 in. to 4 in. turfs are used this costs no more than for transplants, but if thicker turfs are used slips have to be cut out to allow the stems to clear, which increases the cost. If care is taken to cut the slips on the lee side from the dry frosty winds in February and March they provide shelter for the plants. Seedlings, however, appear to suffer less in this respect than transplants, as being small they are less exposed.

The 3-year S.S. were planted on an average type of soil with molinia grass, rushes and bracken over moist black soil of an elevation of 200 ft. with a southerly exposure. They received no treatment and compare favourably with the transplants used on similar soil. The 2-year J.L. were notched in on the surface in screefs and have a good healthy appearance.

Seedlings are not so suitable for planting on the surface as for turf planting. If no screefing is done they are easily smothered, unless weeding is done very carefully and at least twice a year. Weeding is more costly than for transplants and there is more risk of plants being cut. Screefing is not to be recommended where, as at Glenhurich, the average rainfall is 100 in. per annum, unless on a very steep slope.

Turf planting of 2-year seedlings is quite successful, and has the advantage of reducing costs of transport, especially where the forest is at some distance from the supplying nursery and the plants have to be handled several times before reaching their destination. I have no actual figures available but from observation of local transport, I should think transport costs should be reduced by half. If they are treated with 2 oz. of basic slag per plant little or no weeding is required, as the plants get above the vegetation in the second year. The saving in transport and weeding should cover the cost of slag. There should also be a considerable saving in nursery work as at least one year's lining-out and weeding are saved.

G. Munro.

DAMAGE BY LIGHTNING.

During the night of 6th-7th August, 1933, a severe thunderstorm passed over Strone Farm, Glenloy Forest, on the north side of the Caledonian Canal, about 6 miles east of Fort William. At the height of the storm a loud explosion was heard, and it was feared that some serious damage had been done. The following morning it was found that the only damage done was to a big ash tree growing 12 yards from the end of the house. A triangular slice of wood 9 ft. 2 in. long by $7\frac{1}{2}$ in. wide and $3\frac{1}{2}$ thick at the middle and extending 14 in. into the ground, had been wrenched out of the side of the tree and thrown up against a fence about 6 yards away. On examination it appeared that the tree had been struck, via a nail driven into the tree, 12 in. below the top of the slice. The wood round the nail was charred and the stroke had followed the line of three other nails down the trunk. The tree is still looking quite healthy at the end of October, 1933.

J. MACKENZIE.

PRUNING TOOLS.

The following is a note on a few types of pruning tools with remarks regarding their respective merits as observed in their use at Culloden in the pruning of Douglas fir.

Pruning Hook.—Somewhat similar to Glasgow Bill Hook. Suitable only for brashing, speedy in use, but not suitable for final crop trees, as it does not cut clean, usually breaks the branch and tears the bark, or leaves spurs.

Swedish Pruning Knife.—Six-in. blade fitted at right angles to extension pole. Suitable only for branches up to $\frac{1}{2}$-in. diameter, does not cut clean and apt to injure the bark. Difficult to operate on branchy stems, as the necessary movement to give it sufficient cutting force cannot be obtained. With this tool the operator has to stand directly below the branch to be cut, and requires to be supplied with a steel helmet.

Pole Saws.—These are light curved saws which fit on to extension rods of wood or metal. Two sizes were used, one 22 in. long (5 teeth to 1 in.) and one 18 in. long (7 teeth to 1 in.). The shorter saw was satisfactory in use up to 15 ft. Higher, it was slow in cutting and difficult to keep in the saw cut, due to the rod having to be kept more perpendicular. The longer saw was found to be speedier and more easily worked, due to the greater length of curve. The larger teeth also seemed to be an advantage as saw dust from the smaller toothed saw was troublesome to the operator.

Hand Saw and Ladder.—This method was quite satisfactory but pruning by pole saws was less expensive up to 18 ft. Pole saws are fitted with short handles and are quite suitable for pruning from ladder or brashing.

A. MACKINTOSH.

Use of Sulsol against Meria Laricis.

In Inchnacardoch Nursery during the summer of 1933 most E.L. beds were sprayed fortnightly with amberene as recommended. Two beds, however, of 2-year seedlings were treated throughout the summer with Sulsol in similar sprayings. The spray was made in the strength 5 lb. (3 pints) Sulsol to 100 gallons of soft soap solution (5 lb. soft soap per 100 gallons of water).

No larch beds were badly attacked by *Meria* but there was undoubtedly less browning of needles apparent in the two beds sprayed with Sulsol. The greener appearance of these beds as compared with the others became more noticeable in late summer and autumn. It cannot, however, be said that the size or shape of the Sulsol sprayed seedlings is any better than that of those treated with amberene.

H. C. Beresford-Peirse.

Methods of Drill Sowing.

In F.Y. 1933 attempts were made in Inchnacardoch Nursery to improve on the accustomed method of drill sowing, either in the direction of better germination or greater economy. The general method employed, after a bed has been made up is as follows :—A drill roller is run over the bed. Seed is put in the drills from a sowing lath, the drill is then filled with finely riddled soil from a lath and finally the bed is rolled with a plain roller.

Alterations on a small experimental scale applied to all species sown were made on this old method in two directions :—(*a*) to do away with the rolling of beds and therefore avoid the possibility of caking, and (*b*) to do away with riddling soil and filling in drills with it, which is the most expensive part of the sowing operation.

Four series of experiments were laid down :—

(*a*) Drills were made with a rake fitted with blunt V-shaped teeth spaced 6 in. apart : the rake was drawn across the bed (this in place of drill roller). After seed was sown drills were filled by drawing a cuffer lightly over the bed, and the bed was then left.

(*b*) Same as (*a*) except that finally the bed was rolled with plain roller.

(*c*) Drills were made as formerly with a drill roller. After sowing drills were filled by drawing cuffer over bed, and the bed was then left.

(*d*) Same as (*c*) except that bed was finally rolled with plain roller.

Several points have emerged from the experiments :—

(i) As the ground was in excellent condition for sowing no caking occurred on rolled beds and so any advantage of the rake method (*a*) did not appear. It is slightly slower than drill roller.

(ii) Birds were definitely more inclined to dig up drills on beds that did not have a final rolling than on rolled beds.

(iii) Covering drills with a cuffer rather than with riddled soil from a lath did not appear to affect germination adversely in any way. At the same time it is a much cheaper method.

This last fact seems to justify extended use of method (*c*) or (*d*). If caking is anticipated method (*a*) may well prove effective and a further trial will be given to this method.

The cost of sowing at Inchnacardoch has already been reduced by about half by the use of a Rototiller and it is hoped further to reduce the cost by eliminating the filling of drills with riddled soil without any deterioration of germination.

H. C. BERESFORD-PEIRSE.

LIST OF TECHNICAL STAFF.

Headquarters.

At 9, *Savile Row, London, W.*1.
Story, Fraser, Education and Publications Officer.
Guillebaud, W. H., Chief Research Officer.
Sangar, O. J., Assistant to Technical Commissioner.

At Imperial Forestry Institute, Oxford.
Macdonald, James, Research Officer, England and Wales.

At 25, *Drumsheugh Gardens, Edinburgh.*
Macdonald, J. A. B., Research Officer, Scotland.

England and Wales.

Assistant Commissioner's Office (55, *Whitehall, London*).
Taylor, W. L., Assistant Commissioner.
Ross, A. H. H., District Officer (Acquisitions).
Pearson, F. G. O., District Officer.

Division 1 (*Chopwellwood House, Rowlands Gill, Co. Durham*).
Hopkinson, A. D., Divisional Officer.
Batters, G. J. L., District Officer.
Fossey, R. E., District Officer.
Dicker, A. C., Estate Officer.

Division 2 (15, *Belmont, Shrewsbury*).
Long, A. P., Divisional Officer.
Fairchild, C. E. L., District Officer.
De Uphaugh, F. E. B., District Officer.
Best, F. C., District Officer.
Smith, R. H., District Officer.

Division 3 (*Beacon House, Queen's Road, Bristol*).
Scott, Frank, Divisional Officer.
Ryle, G. B., District Officer, Higher Grade.
Russell, W. D., District Officer.

Division 4 (55, *Whitehall, London*).
Felton, A. L., Divisional Officer.
Lowe, George, District Officer.
Stileman, D. F., District Officer.
Sanzen-Baker, R. G., Probationer District Officer.

Division 5 (*Llandaff Chambers, Regent Street, Cambridge*).
Jones, E. Wynne, Divisional Officer.
Muir, W. A., District Officer.
Connell, C. A., District Officer.
Cownie, F., Estate Officer.

Division 6 (*The King's House, Lyndhurst, Hants*).
Young, D. W., Deputy Surveyor.
Forbes, R. G., District Officer, Higher Grade.
MacIver, L. E., District Officer, Higher Grade.
Thom, J. R., Probationer District Officer.
Yarr, W. J., Assistant to Deputy Surveyor.

Division 7 (*Whitemead Park, Parkend, Lydney, Glos*).
Popert, A. H., Acting Deputy Surveyor.
Forster Brown, W., Deputy Gaveller (Mines).
Wylie, N. A., Probationer District Officer.
Roper, John, Survey Clerk.

School for Forest Apprentices.
Broadwood, R. G., District Officer, Higher Grade (Instructor).—Parkend, Lydney, Glos.

Scotland.

Assistant Commissioner's Office (25, *Drumsheugh Gardens, Edinburgh*).
Sutherland, John D., Assistant Commissioner.
Cameron, John, Land Agent.
Mackie Whyte, J.P., District Officer.
Webster, John, District Officer.

Northern Division (51, *Church Street, Inverness*).
Fraser, James, Divisional Officer.
Mackay, J. W., District Officer.
Beresford-Peirse, H. C., District Officer.
Oliver, F. W. A., District Officer.
Spraggan, D. S., District Officer.

North-Eastern Division (12, *North Silver Street, Aberdeen*).
Steven, H. M., Divisional Officer.
Bird, D. H., District Officer, Higher Grade.
Cowell-Smith, Robert, District Officer.

South-Eastern and Western Division (25, *Drumsheugh Gardens, Edinburgh*).
Murray, J. M., Divisional Officer.
Newton, L. A., District Officer, Higher Grade.
Whellens, W. H., District Officer.
Gosling, A. H., District Officer.
Macdonald, J. M., District Officer.

School for Forest Apprentices.
Watson, Harry, District Officer (Instructor).—Benmore, Argyll.

Foresters.

England and Wales.

Division 1.

Name.	*Grade.*	*Name.*	*Grade.*
Anderson, T. E.	Head	Gough, W. R.	II
Weir, A. B.	I	Hodgson, William	II
Bewick, W. J.	II	Gilson, R. B.	II
Anderson, J. T.	II	Simpson, G. A.	II
McNab, Colin	II	Liddell, Joseph	II
		Kirkup, J. T.	II

Division 2.

Name.	*Grade.*	*Name.*	*Grade.*
Butter, Robert	Head	Brown, G. H.	II
Jones, H. W.	I	Cowe, J. F.	II
Shaw, J. L.	I	Lomas, John	II
Anderson, J. W.	I	Edwards, D. T.	II
Fraser, Robert	I	Jones, David	II
Roberts, W. G.	I	Jones, Alfred	II
Harris, W. A.	II	Evans, J. E.	II
Harrison, Percy	II	Reese, W. H.	II

Division 3.

Name.	*Grade.*	*Name.*	*Grade.*
Hale, W. J.	I	Wild, P. W. S.	II
Williams, John	I	Harrison, Phillip	II
Squires, C. V.	I	Caddy, Thomas	II
Laney, Horace	II	Edwards, L. T.	II
Hollis, G. W.	II	Reid, Duncan	II
Pritchard, Roderick	II	Wellington, C. R.	II
Jones, A. H.	II	Carnell, R.	II
Pallett, R. E.	II		

Division 4.

Name.	*Grade.*	*Name.*	*Grade.*
Aston, A. S.	I	Cottenham, W. C.	II
Dyer, H. C.	I	Gulliver, G. H.	II
Nelmes, F. J.	I	Aston, T. H.	II
Wallington, A. W.	I	Phelps, S. E.	II
Richards, G. H.	II	Saunders, H. J.	II
Butler, Robert	II	Kent, William	II
Johnson, A. E.	II	McKenzie, Colin	II

Division 5.

Name.	*Grade.*	*Name.*	*Grade.*
McGlashan, John	I	Price, Alfred	II
Tribe, William	II	Parry, A. A.	II
Hendrie, T. F.	II	Smith, J. J.	II
Clark, J. S.	II	Wyatt, Lionel	II
Bewick, Robert	II	Jackson, W. V.	II
Johnson, Harry	II	Halsey, H. R.	II
Everitt, F. W.	II		

England and Wales.—continued.

Name.	*Grade.*	*Name.*	*Grade.*
Division 6.			
Forgan, William ..	Head	Gale, Bertie ..	II
Aston, O. R. T. ..	I	Colwill, S. W. ..	II
Parker, F. H.	II	Wallington, H. J.	II
Adams, J. H.	II		
Division 7.			
Smith, Frank	Head	Watson, Frank ..	II
Humphries, W. J. ..	I	Lees, George	II
Lewis, Tom	I	Morgan, T. R.	II
Walker, A. E.	II	Williams, D. N. (School)	II
Christie, W. L.	II	Roberts, James.. ..	II
Taylor, G. J.	II	Light, George	II
Adams, Isaac	II	Hyett, S.	II

Scotland.

Name.	*Grade.*	*Name.*	*Grade.*
N. Division.			
Anderson, William ..	I	Gunn, John ..	II
McEwan, James ..	I	Kennedy, John	II
Murray, William ..	I	Cameron, Roderick	II
Mason, William ..	I	Stewart, P. C. ..	II
McClymont, William ..	II	Mackenzie, John	II
Mackay, Kenneth ..	II	Mackintosh, A.	II
Macdonald, Donald ..	II	Ferguson, J. M.	II
Drysdale, A.	II	Gordon, J. ..	II
Macintosh, William ..	II		
N.E. Division.			
Cameron, John ..	Head	Clark, F. J. ..	II
Warren, Alexander ..	Head	Allan, James ..	II
Shaw, Robert	Head	Mackenzie, George	II
Sinclair, William ..	I	Ross, Allan ..	II
Lamb, J. A.	I	Allan, Thomas ..	II
Edwards, Johnston ..	I	Kennedy, J. M.	II
Mitchell, F. M.	II	Murray, G. J. A. M.	II
Robbie, John D. ..	II	Mackay, William	II
McConnell, James ..	II	Kennedy, J. A. M.	II
Corbett, John	II	Robbie, James D.	II
S.E. and W. Division.			
Paterson, S. H. A.	I	Macmillan, Hugh	II
Simpson, A. N.	I	Ross, W. L. ..	II
Macintyre, J. F.	I	Macrae, Murdo ..	II
Cameron, Hugh	II	Grant, Alastair	II

Scotland.—continued.

Name.	*Grade.*	*Name.*	*Grade.*
S.E. and W. Division—continued.			
Reid, J. M.	I	Donald, R. R. (School)	II
Calder, J. M.	II	McDonald, J. D. ..	II
Fraser, A. M.	II	Watson, James ..	II
Graham, Alexander ..	II	Sinclair, Laurence ..	II
Cameron, Alistair ..	II	Ritchie, M. A.	II
Thomson, G. J. ..	II	Graham, J. McK. ..	II

Research and Experiment.

Gray, W. G. (Oxford) ..	II	Mackenzie, A. M. (Headquarters)	II
Grant, Alexander (Edinburgh)	II	Maund, J. E. (Oxford)..	II
		Farquhar, J. (Edinburgh)	II

REGISTER OF IDENTIFICATION NUMBERS

FOREST YEAR, 1933.

The order of arrangement is as follows :—

Serial number (preceded by the last two numbers of the forest year in which supplies were received); quantity; species; crop year; origin; vendor; purity per cent.; germination and fresh seed per cent.

33/1 1 lb.; *Picea sitchensis;* 1932; U.S.A. (Elk Creek, Clatsop, Oregon, altitude sea level); Long-Bell Lumber Co.

33/2 2 lb; *Alnus cordifolia;* 1932; France (Corsica); gift from French Forestry Service.

33/3 7 lb.; *Quercus Mirbeckii;* 1932; Algeria; gift from French Forestry Service.

33/4 14,496 lb.; *Quercus sessiliflora;* 1932; Bavaria (Spessart); H. Keller Sohn.

33/5 4,692 lb.; *Quercus sessiliflora;* 1932; Germany (Harz Mountains and Thüringer); Schultze & Co.

33/6 100 lb.; *Fagus sylvatica;* 1932; Northern Italy (Appennines, altitude 2,600-4,000 ft.); A. Ansaloni.

33/7 336 lb.; *Quercus pedunculata;* 1932; Denmark (Seeland); J. Rafn & Son.

33/8 500 lb.; *Quercus rubra;* 1932; Holland (Arnhem-Dieren); Nederlandsche Heidemaatschappij.

33/9 20,440 lb.; *Quercus pedunculata;* 1932; Holland (Arnhem-Dieren); Nederlandsche Heidemaatschappij.

33/10 10 lb.; *Quercus conferta;* 1932; Hungary; gift from Hungarian Forestry Service.

33/11 628 lb.; *Picea excelsa;* 1932; Austria (altitude 650-1,650 ft.); J. Stainer; 98·9; 86 + 3.

33/12 126 lb.; *Picea sitchensis;* 1932; Canada (Skidegate, Graham Island, Queen Charlotte Islands); Canadian Government; 97·9; 85.

33/13 521 lb.; *Picea sitchensis;* 1932; Canada (Masset, Graham Island, Queen Charlotte Islands); Canadian Government; 97·9; 85.

33/14 107 lb.; *Pinus contorta;* 1932; Canada (Shuswap Lake, altitude 1,400-1,600 ft.); Canadian Government; 97·5; 85 + 3.

33/15 5 lb.; *Thuya plicata;* 1932; Canada (Fraser Valley, near Agassiz); Canadian Government; 93·3; 72 + 4.

33/16 16½ lb.; *Thuya plicata;* 1932; Canada (Fraser Valley, near New Westminster, altitude 50-150 ft.); Canadian Government; 93·3; 72 + 4.

33/17 12 lb.; *Tsuga heterophylla;* 1932; Canada (Fraser Valley, near New Westminster, altitude 50-150 ft.); Canadian Government; 97·9; 41 + 11.

33/18 19½ lb.; *Abies grandis;* 1932; Canada (Crescent, Boundary Bay); Canadian Government; 97·9; 56 + 5.

33/19 25 lb.; *Alnus oregona;* 1932; Canada (Fraser Valley, near New Westminster, altitude 50-150 ft.); Canadian Government.

33/20 10 oz.; *Alnus sitchensis;* 1932; Canada (Frozen Lake, near Yale, Fraser Valley, altitude 3,500 ft.); Canadian Government.

33/21 2 oz.; *Cupressus nootkatensis;* 1932; Canada (Capilano River, near Vancouver, altitude 2,000-3,000 ft.); Canadian Government.

33/22 2 lb.; *Alnus viridis;* 1932; France; J. Rafn & Son.

33/23 224 lb.; *Quercus sessiliflora;* 1932; Czechoslavakia (Carpathian Mountains); J. Rafn & Son.

33/24 1,018 lb.; *Fagus sylvatica;* 1932; Central France (Auvergne); Versepuy.

33/25 3,221 lb.; *Pinus Laricio;* 1932; Corsica (Valdoniello, altitude 2,900-3,300 ft.); J. Grimaldi; 99·0; 47 + 4.

33/26 113 lb.; *Larix europaea;* 1932; Northern Tyrol (Uplands of the Inn Valley, altitude 2,000-2,600 ft.); J. Jenewein; 86·9; 59.

33/27 525 lb.; *Larix europaea;* 1932; Switzerland (Münster, altitude, 3,900 ft.); J. J. Roner; 87·6; 25 + 1.

33/28 112 lb.; *Carpinus Betulus;* 1932; France; Vilmorin-Andrieux.

33/29 2¾ lb.; *Ulmus campestris;* 1932; Spain; gift from Spanish Government.

33/30 1 lb.; *Sequoia gigantea;* 1932; U.S.A.; Vilmorin-Andrieux.

33/31 2 lb.; *Chamaecyparis Lawsoniana;* 1932; France; Vilmorin-Andrieux.

33/32 10 lb.; *Acer platanoides;* 1932; France; Vilmorin-Andrieux.

33/33 5 lb.; *Robinia Pseudacacia;* 1932; France; Vilmorin-Andrieux.

33/34 3 lb.; *Pinus radiata;* 1932; California; J. Rafn & Son.

33/35 3 lb.; *Pinus maritima;* 1932; Corsica (altitude 1,500 ft.); J. Rafn & Son.

33/36 52½ lb.; *Alnus incana;* 1932; Swiss Alps; J. Rafn & Son.

33/37 5 lb.; *Alnus glutinosa;* 1932; Prussia (Spree Woods); J. Rafn & Son.

33/38 4 lb.; *Tilia grandifolia;* 1932; Southern Europe; J. Rafn & Son.

33/39 1 lb.; *Betula papyracea;* 1932; U.S.A. (New Hampshire); J. Rafn & Son.

33/40 10 lb.; *Pinus montana* var. *uncinata;* 1932; Denmark; J. Rafn & Son.

33/41 2 lb.; *Pyrus Malus;* 1932; Balkans; J. Rafn & Son.

33/42 1 lb.; *Pyrus communis;* 1932; Balkans; J. Rafn & Son.

33/43 501 lb.; *Larix leptolepis;* reputed 1932; Japan; Shinano Shubyo Co.; 96·6; 42 + 3.

33/44 9 lb.; *Castanea mollissima;* 1932; Japan; K. Yashiroda.

33/45 9 lb.; *Castanea japonica* var. *shibakuri;* 1932; Japan; K. Yashiroda.

33/46 2 lb.; *Larix europaea;* 1932; Silesia (Sudeten); J. Rafn & Son.

33/47 11 lb; *Quercus palustris;* 1932; U.S.A. (Missouri); J. Rafn & Son.

33/48 ¼ lb.; *Pinus monticola;* 1932; British Columbia; J. Rafn & Son.

33/49 6 lb.; *Alnus cordifolia;* 1932; Italy (Calabria); gift from Italian Forestry Service.

33/50 260 lb.; *Pinus pinaster;* 1932; Portugal (Leira); gift from Portuguese Government.

33/51 75 lb.; *Pinus sylvestris;* 1932; Scotland (N.E.); own, collection, extracted at Seaton.

33/52 2½ lb.; *Pinus sylvestris;* 1932; Scotland (N.E.); own collection extracted at Tulliallan.

33/53 13 bushels; *Pinus sylvestris;* 1932; Scotland (N.E.); own collection.

33/54 64 lb.; *Pinus sylvestris;* 1932; Scotland (S.E.); own collection.

33/55 116 bushels; *Pinus sylvestris*; 1932; Scotland (S.E.); own collection.

33/56 ¾ lb.; *Pinus sylvestris;* 1932; Scotland (West); own collection.

33/57 16 lb.; *Larix europaea;* 1932; Scotland (N.E.); own collection, extracted at Tulliallan.

33/58 430 lb.: *Larix europaea;* 1932; Scotland (N.E.); own collection, extracted at Seaton.

33/59 99 lb.; *Larix europaea;* 1932; Scotland (S.E.); own collection.

33/60 ¾ lb.; *Larix europaea;* 1932; Scotland (West); own collection.

33/61 ½ lb.; *Pinus montana;* 1932; Scotland (N.E.); own collection.

33/62 ¾ lb.; *Abies Nordmanniana;* 1932; Scotland (West); own collection.

33/63 1 bushel; *Cupressus nootkatensis;* 1932; Scotland (N.E.); own collection.

33/64 30 lb.; *Fraxinus excelsior;* 1931; Scotland (S.E.); own collection.

33/65 20 lb.; *Fraxinus excelsior;* 1932; Scotland (S.E.); own collection.

33/66 112 lb.; *Quercus pedunculata;* 1932; Scotland (S.E.); own collection.

33/67 1 lb.; *Pinus pinaster;* ? 1932; Norway; gift from Captain J. B. Dunbar.

33/68 3,900 transplants (2 + 2); *Larix leptolepis;* crop year unknown; origin unknown; Col. Bryce Allan.

33/69 1,350 transplants (2 + 3) ; *Picea excelsa ;* crop year unknown ; origin unknown ; Ardchattan Estate.
33/70 1,350 transplants (2 + 2) ; *Picea sitchensis ;* crop year unknown ; origin unknown ; Ardchattan Estate.
33/71 18,000 transplants (2 + 2) ; *Fagus sylvatica ;* crop year unknown ; origin unknown ; Howden & Co.
33/72 309 lb. ; *Quercus pedunculata ;* 1932 ; England (S.W.) ; own collection.
33/73 29,258 lb. ; *Quercus pedunculata ;* 1932 ; England (South) ; own collection.
33/74 84 lb. ; *Quercus pedunculata ;* 1932 ; Penllergaer ; own collection.
33/75 376 lb. ; *Quercus pedunculata ;* 1932 ; England (West) ; own collection.
33/76 4,671 lb. ; *Quercus pedunculata ;* 1932 ; England (Midlands) ; own collection.
33/77 65,607 lb. ; *Quercus pedunculata ;* 1932 ; England (East) ; own collection.
33/78 1,618 lb. ; *Quercus pedunculata ;* 1932 ; England (East) ; Lord Bristol.
33/79 20 lb. ; *Quercus sessiliflora ;* 1932 ; Caio ; own collection.
33/80 70 lb. ; *Quercus sessiliflora ;* 1932 ; England (East) ; own collection.
33/81 12,232 lb. ; *Quercus sessiliflora ;* 1932 ; England (South) ; own collection.
33/82 6 lb. ; *Quercus Ilex ;* 1932 ; England (South) ; own collection.
33/83 4 lb. ; *Fagus sylvatica ;* 1932 ; Brechfa ; own collection.
33/84 70 lb. ; *Fagus sylvatica ;* 1932 ; England (East) ; own collection.
33/85 1,394 lb. ; *Fagus sylvatica ;* 1932 ; England (South) ; own collection.
33/86 1 bushel ; *Aesculus Hippocastanum ;* 1932 ; England (East) ; own collection.
33/87 100 lb. ; *Fraxinus excelsior ;* 1932 ; England (North) ; own collection.
33/88 819 lb. ; *Fraxinus excelsior ;* 1932 ; England (Midlands) ; own collection.
33/89 70 lb. ; *Fraxinus excelsior ;* 1932 ; England (S.W.) ; own collection.
33/90 112 lb. ; *Fraxinus excelsior ;* 1932 ; England (South) ; own collection.
33/91 2 lb. ; *Fraxinus excelsior ;* 1932 ; Rheola ; own collection.
33/92 90 lb. ; *Fraxinus excelsior ;* 1932 ; England (West) ; own collection.
33/93 342 lb. ; *Fraxinus excelsior ;* 1932 ; England (East) ; own collection.

33/94 16 lb.; *Juglans regia;* 1932; England (Midlands); own collection.

33/95 ½ lb.; *Betula alba;* 1932; Bruton; own collection.

33/96 33 lb.; *Betula alba;* 1932; England (East); own collection.

33/97 3 lb.; *Acer macrophyllum;* 1932; Canada (British Columbia); gift from Canadian Government.

33/98 40 lb.; *Acer Pseudoplatanus;* 1932; Bodmin; own collection.

33/99 85 lb.; *Acer Pseudoplatanus;* 1932; England (South); own collection.

33/100 125 lb.; *Acer Pseudoplatanus;* 1932; England (Midlands); own collection.

33/101 61 lb.; *Acer Pseudoplatanus;* 1932; Wales (South); own collection.

33/102 66 lb.; *Ulmus montana;* 1932; England (West); own collection.

33/103 2 lb.; *Alnus glutinosa;* 1932; Bodmin; own collection.

33/104 6 lb.; *Alnus glutinosa;* 1932; Rheola; own collection.

33/105 5 lb.; *Alnus glutinosa;* 1932; England (East); own collection.

33/106 4 bushels; *Alnus incana;* 1932; England (West); own collection.

33/107 75 lb.; *Castanea sativa;* 1932; Bodmin; own collection.

33/108 2,535 lb.; *Castanea sativa;* 1932; England (South); own collection.

33/109 55 lb.; *Castanea sativa;* 1932; England (Midlands); own collection.

33/110 300 lb.; *Castanea sativa*; 1932; England (East); own collection.

33/111 2,299 lb.; *Castanea sativa;* 1932; England (West); own collection.

33/112 2 bushels; *Pinus Laricio;* 1932; England (South); own collection.

33/113 45,000 seedlings (1-year); *Fagus sylvatica;* crop year unknown; origin unknown; Dicksons Nurseries.

33/114 20,000 transplants (1 + 1); *Fagus sylvatica;* crop year unknown; origin unknown; Dicksons Nurseries.

33/115 50,000 seedlings (1-year); *Fagus sylvatica;* crop year unknown; origin unknown; Ben Reid & Co.

33/116 249,000 seedlings (1-year); *Fagus sylvatica;* crop year unknown; origin unknown; English Forestry Association.

33/117 159,000 transplants (1 + 1, 2 + 1); *Fagus sylvatica;* crop year unknown; origin unknown; English Forestry Association.

33/118 40,000 seedlings (2-year); *Fagus sylvatica;* crop year unknown; origin unknown; Markyate Forestry Co.

33/119 75,000 transplants (2 + 1); *Fagus sylvatica;* crop year unknown; origin unknown; Chambers Green Nurseries.

33/120 5,000 transplants (1 + 1) ; *Fagus sylvatica ;* crop year unknown ; origin unknown ; E.S.S.E.

33/121 10,000 transplants ; *Quercus pedunculata ;* crop year unknown ; origin unknown ; G. W. Pledge.

33/122 4,000 transplants ; *Castanea sativa ;* crop year unknown ; origin unknown ; G. W. Pledge.

33/123 500 plants ; *Juglans regia ;* crop year unknown ; origin unknown ; gift from N. Spence.

(B 12/4479)Q Wt. P 3214-746-375 250 25 3/34 H & S, Ltd. Gp. 12