JOURNAL

OF THE

FORESTRY COMMISSION.

No. 16 : MARCH, 1937.

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EDITORIAL.

Personnel of the Commission.

We regret to have to record the death of Colonel Walter Steuart-Fothringham, one of the original members of the Forestry Commission. He has been succeeded by Colonel L. Ropner, M.C., T.D., D.L., M.P., who was appointed a Commissioner in July last.

Commission Staff Changes.

There have been many new appointments and transfers of technical officers during the past year, mainly in connection with the additional work in England and Wales under the Special Areas Scheme.

Mr. Wynne Jones was transferred to London as Chief Acquisitions Officer (England and Wales) and Mr. James Macdonald left Oxford to act as Divisional Officer, No. 5 Division in his place; Messrs. G. B. Ryle and A. H. H. Ross were appointed acting Divisional Officers in two new Divisions with Offices at Cardiff and Carlisle respectively. Mr. S. W. Edwards was appointed to the Whitehall Office as Chief Estates Officer, England and Wales. Seven new District Officers were appointed on probation, *viz.*, Mr. C. A. J. Barrington (Division 4), Mr. J. H. Currie (Division 6), Mr. W. Forsyth (Division 1). Mr. T. A. Robbie (Division 2—but lent temporarily to N. Division, Scotland), Mr. J. Q. Williamson (Division 7), Mr. D. H. Chapman (Acquisitions—Whitehall) and Mr. C. G. Morrish (Estate—Division 5). Other movements among the District Officers were as follows :—Messrs. R. H. Smith and F. Cownie transferred to Acquisitions work (Whitehall); Mr. Beresford-Peirse to Acquisitions work (Edinburgh); Mr. W. A. Cadman to Division 2; Mr. G. D. Rouse to Division 5, and Mr. J. S. R. Chard to the S. W. Division.

Just as the Journal is going to press the transfers of Mr. A. P. Long to the post of Deputy Surveyor, Dean Forest and of Mr. A. H. Popert to Divisional Officer, No. 2 Division are announced.

Thinning Course.

A course in thinning which included instruction in the drawing up of thinning plans, the marking of trees, questions of costs and revenue, and demonstrations in pruning, was held in the Forest of Dean from 31st August to 5th September last. The course was conducted by Mr. Sangar and Mr. Popert, and was attended by ten District Officers and five Foresters. From all reports it was successful in every way.

Green Manuring.

Attention is called to the article by Mr. W. H. Guillebaud on green manuring which appears in this issue. This is a difficult and debatable question and it is all to the good that the subject should be ventilated. The conclusions reached are necessarily tentative, and further investigation is clearly desirable.

Social Service Associations.

The members of the Department who are resident in England and Wales have decided to adopt the town of Chester-le-Street in Durham, and details of the scheme will be found elsewhere in the Journal. In Scotland a Civil Service (Scotland) Community Service Association has been formed and members of the Forestry Commission are supporting this body.

It is hoped that every member of the staff of the Commission will associate himself with one or other of these schemes.

Contributors to the Journal.

The following Divisions have been selected as special contributors to next year's Journal: Divisions 1, 3 and Scotland, North-Eastern.

The special contributors to the present number of the Journal are Divisions 2, 5 and Scotland, Northern.

The Rabbit Problem.

A Select Committee of the House of Lords has been investigating the rabbit problem, and has just issued its report. A brief summary of the evidence given by our Chairman will be of interest. The Commission's expenditure on protection against rabbits, he stated, is approximately £33,400 per annum whereas receipts from sales are only £3,500. The total loss to the nation is much greater than this, however, because forestry operations on private estates are hindered and in many cases abandoned owing to the damage done. To enclose small plantations with a wire-netting fence frequently adds one-third or more to the cost of establishment and subsequently it is only by constant vigilance that the young trees are saved. Forestry in general suffers because where rabbits are numerous it is seldom possible to practise natural regeneration, and underplanting often becomes far too expensive.

As regards the efficacy of the different methods of getting rid of the pest it will be remembered that a questionnaire was issued last year to all those in the Commission's service who are directly concerned in protection against rabbits. In reply to the question as to which method of catching rabbits is most effective, 42 per cent. said they favoured a combination of snares, steel traps and ferreting; 23 per cent. stated that they avoided the use of steel traps and in special cases, for example when plantations in the thicket stage have been invaded, rabbits have to be driven out and caught in long string nets. Much depends naturally on the character of each locality as to which method should be used. It makes all the difference if the soil is suitable for warrens or hard to burrow in (when many rabbits lie-out) whether there is scree, which is awkward for "gassing", or whether there is much rough herbage for shelter.

The conclusion generally arrived at was that every means in one's power had to be used and even then eradication was extremely difficult.

As regards the comparative humaneness of the various methods of destruction 55 per cent. of those replying to the questionnaire considered snares to be the least cruel, but ferreting with nets also had many supporters. Cyanide fumigation has been used only on a small scale on the Commission's property, consequently the advantages and drawbacks of this method have still to be put to the test.

Recent Acquisitions.

It will no doubt be of interest to the Commission's staff to learn how much land was acquired during the calendar year 1936. In the following table the areas are classified according to counties and the amount of plantable land :—

LAND ACQUIRED DURING 1936.

County.	Plantable.	Other.	Total.
	Acres.	Acres.	Acres.
England and Wales.			
Cardigan	494	89	583
Carmarthen	315	67	382
Carnarvon	296	330	626
Cumberland	1,756	215	1,971
Devon	113	—	113
Glamorgan	46	203	249
Lancs	835	—	835
Montgomery	2,761	1,119	3,880
Norfolk	838	80	918
Shropshire	26	—	26
Suffolk	829	10	839
Sussex	396	511	907
Yorks	49	2	51
Total—England and Wales ..	8,754	2,626	11,380
Scotland.			
Aberdeen	257	6	263
Argyll	3,487	3,094	6,581
Dumfries	1,269	329	1,598
Fife	37	2	39
Kirkcudbright	962	98	1,060
Moray	227	—	227
Perth	155	4	159
Ross	95	—	95
Total—Scotland	6,489	3,533	10,022
Total—Great Britain ..	15,243	6,159	21,402

PROGRESS REPORT ON RESEARCH: JANUARY, 1937.

By W. H. Guillebaud.

1.—Staff.

Mr. James Macdonald was transferred from the Research staff to Division 5, and is succeeded by Mr. R. G. Sanzen Baker. Arrangements have been made with the Imperial Forestry Institute whereby Mr. W. R. Day takes over some of the former duties of Mr. Macdonald and is also available for special investigations on silvicultural problems.

2.—Nursery Experimental Work.

Further trials were carried out at Kennington on the stratification of seed. The most spectacular results were obtained with two-year-old stored seed of *Pinus contorta*, I. No. 34/40. Seed stored in the normal way and sown in spring 1936 gave a yield of 13,000 seedlings per pound, while the seed stratified at the beginning of February and sown on the same date as the dry stored seed gave a yield of 40,000 seedlings per pound, an increase of over 300 per cent. Very old stored seed of Scots pine (I. No. 31/91) also responded to stratification, the yield being increased from 25,000 to 38,000 per pound. In this case the best results were given by short-period stratification, *i.e.*, from the beginning of March. Curiously enough the reverse result was obtained with more recently stored seed of Scots pine, with which even short-period stratification proved harmful.

Early sowing gave the following striking results at Kennington:—

Production in 1,000s of usable 2-year Seedlings per Pound of Seed.

—	Japanese larch.			Sitka spruce.			*Pinus contorta.*		
	Grade I.	Grade II.	Total.	Grade I.	Grade II.	Total.	Grade I.	Grade II.	Total.
Sown 12/3/35	17	20	37	32	33	65	28	21	49
Sown 4/5/35	6	27	33	10	33	43	9	15	24

Early sowing has given an increase in total production in all three species as well as greatly increasing the proportion of Grade I plants. A more elaborate experiment on date of sowing carried out in 1936, also at Kennington gave the following production of 1-year seedlings per pound of seed sown.

Date of Sowing.	Yield in 1,000s per Pound.	
	Sitka spruce.	*Pinus contorta.*
March 2	84	67
,, 16	55	54
,, 30	71	68
April 13	64	55
,, 27	47	43
May 11	51	32
Difference required for significance ..	20	16

Apart from the inexplicable but apparently significant drop in the mid-March sowings there is little to choose between the first four dates of sowing. The end of April and the May sowings on the other hand have given definitely lower germination with both species. The conclusion is that seed of the above species should not be sown later than the middle of April in Kennington Nursery.

In Scotland experiments were carried out in 1936 in eight nurseries and autumn sowing (1935) included. With Sitka spruce a high yield—over 70,000 1-year seedlings per pound—was obtained at Newton nursery by sowing in October and the plants averaged 1½ inches in height. Spring sowing gave a lower yield and appreciably smaller plants, the size falling off markedly in the plots sown after the middle of April. Mr. J. A. B. Macdonald points out that the date of sowing experiments demonstrate clearly that the weather conditions before, during, and just after sowing play a large part in the success of any one sowing and point to the need for further work on the control of soil moisture in the seedbed.

An experiment on the use of soiling crops, started in 1933 in three nurseries in Scotland, has now been assessed. Two of the experiments gave no conclusive result, but in the third, at Altonside there was evidence of the beneficial effect of manuring combined with a green crop. Good results were obtained by digging-in a crop of oats and tares which had been manured with farmyard manure. Artificials (applied to the green crop) were also effective in improving the size of the subsequent seedlings and transplants. The unmanured green crop had no effect. Direct applications of artificials without any green crop appear to have been harmful.

During the last year or two the nursery treatment of walnut has received a good deal of attention at Kennington nursery. The principal methods employed have been stumping (cutting back the shoot to just above ground level and pruning off all the long roots) and manuring with farmyard manure. Stumping appears a promising method with plants not less than two years old, it is useless with one-year seedlings. After stumping the plants require at least two years in the lines at a spacing of not less than 12 inches apart, and preferably more. Manuring deepens the colour of the foliage, but has not had much effect on shoot growth at Kennington.

Experiments on the raising of poplars at Kennington brought out the following points :—

(1) Cutting should be taken from the lower, stouter part of a strong one-year-old shoot, and on no account should the terminal bud be included.

(2) The best results are obtained from cuttings not less than 7 inches in length and lined-out with the top only just visible above ground.

(3) The cuttings should be lined-out not less than 6 inches apart in the lines and 12 inches between the lines.

(4) The practice of stumping the plants at the end of the first year and re-lining at a wide spacing has proved very successful at Kennington. Cuttings of various lots of poplars raised in 1934 were cut back and re-lined in unmanured nursery soil at a spacing of 2 feet by 3 feet. At the end of the first year all side branches were removed and during the second year the stems were kept pruned to half the height of the plants. The plants are now three years old (1+2) and the heights range from 5 to 12½ feet with many plants over 9 feet.

3.—Plantation Experiments.

Peat Soils.—Pinus contorta continues to grow well on the deep peat on Lon Mor at Inchnacardoch, while both this species and Sitka spruce are very promising on the dug-over peat at Borgie Forest.

Upland Calluna Soils.—Possibly owing to the wetter summer of 1936 Sitka spruce is looking more hopeful on the ploughed ground at Teindland and may yet become established. The plants look best where in mixture with mountain pine or *Pinus contorta*. A 10-acre block of the latter species is growing very well. Other outstanding species are grey alder, Japanese larch and Hybrid larch.

Dorset Heaths.—The direct sowings of various species of pines on ploughed ground continue to make good progress. An excellent germination of Corsican pine was obtained on patches which had been treated with compost prepared from hop-waste.

Thetford Area.—The beech have recovered to some extent from the effects of the 1935 frost, but there are many failures to replace.

Chalk Soils.—Ash transplants are making remarkably good growths when planted among widely spaced alder of P.32. Further ash will be introduced in P.37.

Loam and Clay Soils.—The hoeing experiments with ash and sycamore at Tintern continue to give interesting results. The ash groups which were hoed in 1935, the year of planting, were divided into two series, half

of which were hoed in 1936 and half left unhoed. The response to hoeing is apparent from the following data :—

	Mean Height.		*Mean Shoot Growth in*
	ft.	in.	1936 (in.)
A. Control. Not hoed..	2	2	1
B. Hoed in 1935 but not in 1936 ..	3	9	16·3
C. Hoed both in 1935 and 1936 ..	4	2	23·4

The plants in B and C are very sturdy with large terminal buds, but in the autumn the plants in C had markedly darker and larger foliage than those in B. The B plots are beginning to grass over, and it is possible that the plants may check in the coming year. It is interesting that the control plants, which put on shoots of over 4 inches in the first year, should have gone into check in the second year.

Sycamore also have responded quite definitely to hoeing. During the two years 1935 and 1936 the hoed plants put on 22 inches in height as compared with 10½ inches in the case of the unhoed plants.

A larger scale experiment is to be carried out this year on the hoeing of ash, reducing the area to be hoed in each group with the object of bringing down the cost.

4.—Sample Plot Work.

In addition to the routine work of re-measurement, two new plots were established in a 31-year-old mixed crop of Douglas fir and Corsican pine growing on blown sand adjoining Culbin Forest. The Douglas fir are 34 feet in height, some 2 feet higher on the average than the Corsican pine. This represents the slowest growth of Douglas fir that we have met in the sample plot work. One of the plots has been thinned to favour the retention of the Douglas fir while in the other the Corsican pine will probably form the final crop.

Some pruning experiments have also been carried out in young plantations in Divisions 5 and 7.

5.—Research Work at Aberdeen University.

Dr. Laing has continued his investigations on the root and shoot development of European larch. In this connection he has been giving some attention to the different strains of European larch in Scotland, in particular to the question of the colour of the young female flowers. Trees with green flowers are distinctive in other ways from those with red flowers ; this is a point which seems to deserve closer examination. Dr. Fraser has made an ecological study of an interesting plantation of Sitka spruce and other species on Durris Forest, and has published an account in Vol. X, No. 2 of *Forestry*. He has also done some vegetational survey work on the Forest of Bin in connection with Dr. Muir's soil survey of the area.

6.—Mycorrhiza Research.

Samples of humus collected from two stands of Sitka spruce in British Columbia were used for inoculating soil in which seed of Sitka spruce was sown. Seed of the same species was also sown in pots containing a mixture of soil and compost prepared from hop-waste. The mycorrhiza structures have not yet been examined, but very fine one-year seedlings, averaging about 2½ inches in height were raised in the pots containing one of the Canadian lots of humus (without compost). The second lot did not give nearly such good seedlings. The compost treatment gave quite as good plants as those in the better lot of Canadian humus. Good germination of Corsican pine and excellent plants were obtained on an area of ploughed ground at Wareham Forest, which was direct sown in patches after digging 2 pounds of hop-waste compost into each patch. The same compost also gave good results with Scots pine and *Pinus contorta* sown on ploughed ground at Allerston, and the seedlings produced were sturdier and of a better colour than those from the same seed lots sown in the nursery. Dr. Rayner found on examining the roots that the plants raised on the moor had more healthy-looking root systems than those raised in the nursery. Some of the seedlings are being planted out in P.37 as ball plants manufactured by the French plant-roll machine.

7.—Soil Research (Macaulay Institute).

Dr. Muir has extended his soil survey to include the Forest of Clashindarroch where the rocks are intermediate in type between the basic igneous of the Bin and the quartzite of the Balloch. It is hoped to complete the whole investigation during 1937, linking up the soil survey with an independent survey of the vegetation by Dr. Fraser, and with the Divisional Officer's allocation of tree species.

Dr. Stewart has made further analyses of nursery soils in Scotland. It is hoped in course of time to be able to correlate actual productivity with the analytical data obtained in the laboratory, and so to place manurial treatment on a sounder basis.

8.—Research on Vole Disease.

It has been decided to proceed with this project. In 1936 the Bureau of Animal Population at Oxford started a comprehensive investigation of the voles, to be carried over three years. A pathologist has been appointed with the aid of a grant from the Medical Research Council, while the Agriculture Research Council have put up the money for an Isolation Laboratory, at Oxford, where the pathological work can be carried out. The Forestry Commission are giving financial assistance towards the field side of the work.

9.—Advisory Committee on Forest Research.

The Committee met at Fort Augustus in July 1936 and inspected the peat experimental work on Glen Righ, Inchnacardoch and other forests along the Caledonian Canal.

A special meeting was also held in London in December 1936 to discuss the question of fundamental research relating to forestry. A report stating the views of the Committee has been prepared.

10.—Mycology.

Elm Disease.—The spread of the elm disease to America, traced to the importation from Europe of elm logs for veneers, has led to the U.S. Department of Agriculture sending two of their specialists over to Europe. These men have spent a considerable amount of time in this country and have assisted Mr. Peace in his survey. The disease is now known to occur in Northumberland, so it extends throughout the whole of the country south of the Tweed ; it has not yet been recorded from Scotland. Cases of recovery of lightly diseased trees continue to occur.

Butt Rot of Conifers.—Mr. Peace has completed his survey of this disease and a report is in course of preparation.

Frost Investigation.—In an article (the first of a series) published in the Journal *Forestry*, Messrs. Day and Peace discuss the mechanism of frost injury. It appears that there is a good deal of uncertainty as to the precise factors involved; according to various theories it may be either chemical, nutritional disturbance taking place or toxic substances accumulating during prolonged exposure to cold; it may be physico-chemical, the colloidal structure of the cell being damaged by too sudden alterations in the conditions under which it exists; or it may be physical and depend on the rupturing of the cell membranes and possibly of the cell walls by the mechanical action of ice. Messrs. Day and Peace consider it probable that more than one of these methods of injury are concerned in the frost injury of trees.

11.—Entomology.

Chafer Grubs.—Mr. Brown's progress report on the chafer work will be found elsewhere in the Journal.

Arrangements have been made for Mr. Brown to devote practically the whole of his time to the study of this problem. The first step is to carry out a survey of the more heavily infested nurseries to ascertain the species present and obtain as much data as possible on the effect of locality factors upon the distribution of the chafer and the incidence of damage. It should also be possible during the survey to clear up some of the doubtful points regarding the life-histories of these pests.

It will be of great assistance to this investigation if Foresters and Foremen in charge of nurseries will keep a specially close watch for chafers and other soil grubs, and will report through the usual channels any points of interest, and especially any evidence of heavy infestation. Samples of grubs (packed in a little moist soil) might be sent direct to Mr. J. M. B. Brown, Imperial Forestry Institute, Oxford.

Pine Beetle.—An interim report has been prepared by Mr. H. S. Hanson of the Farnham House Laboratory; this will be published shortly in the Bulletin of Entomological Research.

It has been decided to continue the investigation during the next two years and Mr. Hanson is now engaged on a survey covering the whole of Great Britain. The survey will be combined with a series of experiments on control by means of trap stems, billets, etc., and it is hoped to secure sufficient information to enable an authoritative Bulletin to be produced as an outcome of the work.

Pine Shoot Moth.—A large supply of parasitised material was obtained from Austria in the spring of 1936. From this over 10,000 adults of the egg parasite, *Copidosoma geniculatum*, were bred out at the Farnham House Laboratory and these were liberated partly on Wareham Forest and partly at Rendlesham. It is unfortunate that the parasites emerged rather too early, *i.e.*, before the shoot moth had started its main period of egg-laying; how far this will affect the results remains to be seen.

Insect Carriers of the Watermark Disease of Willows—A grant was given to the East Anglian Institute of Agriculture to enable the appointment of Mr. E. M. Callan, as a field entomologist, to investigate the part played by insects in the spread of the Watermark Disease. Mr. Callan is working under the direction of Dr. W. J. Dowson of Cambridge University, who has been studying the disease for some years past. There are several insects, the most important being the shot-hole gall midge, *Rhabdophaga saliciperda*, which is believed by Dr. Dowson to be the means whereby the disease is spread from tree to tree. Mr. Callan is studying their life-histories and hopes to be able to establish definitely the mode of transmission.

Chermes cooleyi.—A small grant was given to Dr. A. E. Cameron of Edinburgh University to enable him to continue his observations on the Sitka spruce generation of this insect. Sitka spruce galls produced by *Chermes cooleyi* have been found in 28 localities distributed over 14 counties in Scotland, and ranging from the Solway Firth to Ross-shire. So far the damage done is unimportant and it seems that the late frosts in April and May, more than any other factor, keep the insect in check.

12.—Utilisation.

A number of home-grown telegraph poles of Corsican pine, Sitka spruce, and Norway spruce, which were impregnated at Princes Risborough, were offered to the Post Office for service trials but were turned down for various reasons. It is now proposed to utilise these on one of the Commission's forests where a local telephone line is required.

Mr. G. H. Donald of the Laboratory has carried out a number of pruning studies on specially selected logs which are sawn up and graded on the assumption that the trees had been pruned according to given schedules. The pruning schedules are based on the rate of growth of the trees, as determined in each case by stem analysis. These studies are yielding interesting indications as to the economic value of pruning.

A CHEAP METHOD OF BALL PLANTING.

By W. L. Taylor.

(*Revue des Eaux et Forêts*, August 1936.)

M. Ph. Bauby contributes an article on a method of planting which is, in certain of its aspects, new in practical forestry. It is an elaboration of the well-known and safe, if expensive, principle of planting with balls of earth. The writer summarises the common risks encountered in ordinary planting of conifers and the advisability of utilising " well-furnished " plants and, in general, the more costly transplants in preference to seedlings. His remarks relate mainly to the dry Mediterranean region of France and the frequency of drought conditions and are, in some measure, relevant to the conditions of low rainfall met with in East Anglia and elsewhere in Great Britain. By the *motte* method the less costly seedlings are utilised instead of transplants.

The risks of planting (notching) conifers by the usual method in dry regions are well appreciated especially with seedlings or transplants lacking in a proper proportion of root to shoot. Even well-grown transplants, carefully planted, may succumb to drought and show a disconcerting percentage of losses in some seasons. Another factor contributing to losses, unless proper supervision is exercised, is the careless treatment of plants during the period elapsing between the raising in the nursery and planting out in the field. Exposure, and drying out of roots, and negligent bundling and packing with consequent heating in transit are always fatal.

Planting *en motte* is said to overcome most of the normal planting risks, but the question is one of cost, actually of the cost of the various methods at command for establishing plantations in relation to results.

The method explained in this paper is the provision of an artificial *motte* (clod), or ball of earth by means of rolling the root system in paper with enough good, moist earth to answer its purpose, planting the paper-rolled tree plant by the dibble or planting iron and relying on the early disintegration of the paper wrapping not to hinder normal root development. In a small-scale experiment (*Côte-Salyenne*), made in 1930 with 100 cypress, 99 plants grew, the hundredth having been killed by an insect pest. The method was tried out on what is described as a larger scale the following year, in the forests of *Aubagne* and *Cassis*, with a like measure of success. The species utilised were Cypress (*C. sempervirens*) and the Aleppo pine.

The operation was successful but expensive. For various reasons, speed, cost and uniformity, rolling by hand left much to be desired and mechanical aids were investigated to reduce the cost of parcelling the roots in their paper cylinders thus to diminish also the cost of transport and with a view to planting with a dibble without pre-cultivation of the soil. The method is recommended also for planting on rocky hill-sides where soil between the rocks is scarce. In this respect it closely resembles the Divisional experiment being carried out in Ennerdale Forest where

Sitka spruce has been planted in the interstices between rocks in small cardboard pots.

The machine (see page 17) which has been adapted to the rolling of the roots and soil is on the principle of a large cigarette roller. Several types are available but that known as an "*Enroule-mottes*" of which an illustration is given is recommended. This machine will roll seedlings having a total root and shoot length of $15\frac{3}{4}$ in. (cm. 40). The resulting cylindrical *mottes* are of a diameter of just under 1 in. (cm. 2·5). This model, made in cast aluminium, can be obtained from the Société Provençale Agricole, 15, rue Edmond-Rostand, Marseilles, price 120 francs, carriage extra.

It is claimed that the success with the *motte* is assured because the root is placed, upon lifting, in normal contact with good moist earth and cannot suffer from transplanting. It is also claimed that the limits of the planting season can be extended. The operation is described as economic but unfortunately no costings are given; in its favour it can be said that the use of seedlings is facilitated, that planting with the dibble or planting iron is rendered possible, that transport is simple and that the ground needs no special preparation. The paper used must be of a common type, and not stout or tough. No mention is made of the spruces and the *motte* method may not be entirely suited to these surface rooting species. The main advantage with other conifers and broadleaved trees appears to be in the more extended use of seedlings and the saving in cost in comparison with the utilisation of transplants.

THE FRENCH PLANT-ROLL MACHINE.

By J. WEATHERELL.

The machine referred to in the previous article was used in the establishment of Experiment 47, P.37, at Allerston II, 21.1.37. The following notes refer to observations made on that date and on previous preliminary trials. The machine has proved itself to be practical in use. As regards the economical point of view, this will be best decided when the results in the field become known.

It is essential that a shelter be erected when the machine is used outside because the slightest wind affects the paper and makes rolling impossible. The shelter should be easily movable to counter directional changes in the wind. Overhead shelter as well as side shelter is advisable so that prepared rolls, paper and machine can be protected in case of showers, otherwise the work cannot be carried out in wet weather. It is also advisable to have the rolls planted on the same day as they are made. The moisture within the roll tends to make the paper covering soft and the rolls are then less easy to handle. When planted within an hour or so of being rolled, the rolls are good to handle, they are easier to insert than a naked plant, especially a small seedling, and if properly made there is no tendency for the paper to unroll. It was found that small one-year seedling Corsican pine ($\frac{3}{4}$ in. to $1\frac{1}{2}$ in.) were easier to roll than the larger two-year seedlings ($2\frac{1}{4}$ in. to 6 in.) of the same species. With the two-year seedlings the roots were rather bulky for speedy work and needed more time in arranging to prevent twisting.

The method of rolling was as follows. A sheet of foolscap was laid on the canvas as far back as it would go but without the back edge being turned up. Sufficient "rolling medium" (*i.e.*, seedbed soil 60% plus B.L. humus 40%) was then laid on the paper near the back of the machine. The seedling was placed on the medium and, if necessary, the roots were cut so that the root ends did not come nearer than $1\frac{1}{2}$ in. from the end of the paper. The roots and medium were carefully pushed well into the canvas fold. If properly done, the handles could be quickly and easily drawn forward, the roll extracted and the corners of the paper tucked in at the top and bottom. The roll was then ready for planting. The above method did not exactly agree with the instructions received but it was found to make a neater roll at a greater speed than was the case when it was attempted to push the paper underneath the medium.

In rolling the following points are important :—

(1) The paper should be placed as far back on the canvas as is possible without the back edge being turned up, *i.e.*, the paper should lie flat.

(2) The machine must not be overloaded with rolling medium. Any excess makes for slow work, necessitates a very strong pull on the handles and a consequent liability to strain the canvas. The correct amount is found by a little practice and when found, makes rolling quick and easy.

(3) The addition of well-decomposed humus to the seedbed soil for the rolling medium greatly facilitates rolling. The humus can be compressed, the soil cannot, and slight overloading with such a mixture is of less consequence than would be the case with pure soil.

(4) A piece of sacking, folded to about eight thicknesses, should be placed underneath the front of the machine. This was found more satisfactory than twigs.

(5) It is important that the seedling root tips are not less than 1½ in. from the end of the paper. This allows the paper to be twisted to close the roll without the roots being doubled up. The one-year seedlings had roots 4–7 in. in length and for these a full sheet of foolscap was used, the extra spare paper at the end of the roll being an advantage. With the two-year seedlings it was frequently necessary to cut off the tips of the longer roots.

(6) The seedbed soil and humus must be riddled. Small stones do not allow the machine to work properly.

A test was made to get some idea of the possible speed of rolling. Using one-year Corsican pine seedlings, 50 rolls were made in 25 minutes. This is equivalent to 120 rolls per hour. The work was not unduly hurried and particular care was taken to ensure satisfactory rolls being made. During the test a plentiful supply of materials was at hand. Further practice would undoubtedly improve on this figure. Whilst making rolls it was occasionally found that the paper did not roll properly. The paper edge from the back of the machine did not always follow the intended circular movement. This was possibly due to the paper not being in quite the best position at the start. The paper did eventually double itself to allow a roll to be made. Such rolls, when finished, appeared to be perfectly satisfactory from the practical point of view and were made use of. An examination of such a roll showed that the roots were in the correct position and the point did not appear to be of much importance. When the handles had been pulled forward to their limit, they were pushed back and the roll extracted. No trouble was experienced in getting the roll out of the machine. The weight of the rolling medium was sufficient to prevent it unrolling. A small amount of soil tends to collect in the bottom of the machine. This must be removed at intervals otherwise the machine does not roll properly.

The machine was secured to the bench by two ring bolts. These were so fixed that the machine was raised from the bench in order to tilt it up for occasional cleaning. Two holes were bored in the bench about 19 in. apart, the bolts placed on the axle rod and then passed through the bench. Apart from fixing the position of the paper previous to rolling, and, to a lesser extent, the amount of soil and humus to be placed in the machine, no difficulties were encountered.

The machine appears to be about right for one-year seedlings. For two-year seedlings it might be an advantage to have a little more canvas and slightly deeper sides (the latter point being to raise the height of the movable rod) so that a thicker roll could be produced. Where a

two-year seedling has an extensive rooting system such as had some of the two-year Corsican pine used for Experiment 47, P.37, only a small amount of soil and humus in proportion to the rooting system, can be enclosed. A thicker roll for bigger seedlings would probably be easier to work also.

The rapid enclosure of the plant roots in ordinary soil and humus will, theoretically, reduce the death rate of one-year seedlings in direct planting. If this is found to be correct in practice the use of one-year seedlings might well become safer than has been the case in the past. The use of good soil and humus alone, or possibly with the addition of slag, for the rolling medium should reduce initial check and promote growth. The slag could be mixed with the medium previous to rolling and the cost of " applying " the slag would be negligible. The planting season might be lengthened considerably. With care, that is, keeping the roots under water between lifting and rolling, it may even be possible to transplant during the growing season. A further advantage of the method is that with a notch of adequate depth a good root formation can be obtained. It is also easier and quicker to get a roll into the planting position than it is with naked roots.

GREEN MANURING IN FOREST NURSERIES.

By W. H. Guillebaud.

Introduction.

The practice of green cropping is almost universal in our forest nurseries. It is a typical text-book practice, and as such has been accepted as the proper thing by each generation of foresters leaving the schools or universities. In the infancy of forestry this method of cultivation was no doubt borrowed from agricultural practice, possibly without any very careful examination of its scientific basis. Nowadays the agriculturists are beginning on their part to question the value of green manures and a good deal of experimental research has been carried out on the subject. The results at the moment are somewhat baffling and it is evident that the question is much more complicated than was at first realised. In particular the stage at which the crop is turned in and the nature and time of sowing of the following crop have important effects on the result.

This would seem then an appropriate moment for foresters to examine their practice of green cropping and to see what can be said for and against it.

The present enquiry was initiated by the Assistant Commissioner for England and Wales, Mr. W. L. Taylor, who had been impressed on his inspections by the unsatisfactory nature of many of the green crops in his nurseries. He pointed out that whatever the value of a good, dense, green crop may be it was obviously waste of money to raise sparse crops which became overrun with weeds and which, when dug-in, contributed only a negligible amount of organic matter to the soil.

Accordingly the appended questionnaire was drawn up and issued to all nurseries in England and Wales, and to a certain number of nurseries in Scotland, with the object of ascertaining what was the current practice as regards type of green crop used, method of manuring, etc. In addition the Divisional Officers in England and Wales were requested to consult the County Agricultural Advisers and obtain their views as to the best methods of raising green crops.

Out of a total of about 74 nurseries in England and Wales 58 replies were received relating to 56 nurseries. (Two of the forms were completed by District Officers and relate to their own general experience.) It is assumed that the remaining 18 nurseries do not employ any form of green crop. Forms were also received in respect of 11 nurseries in the N. and N.E. Divisions of Scotland.

Thanks are due to Mr. G. V. Jacks for providing the writer with recent publications and other information on the subject of green manuring.

1. *Nature of Green Crop employed.*

The table below sets out the type of green crop used in the nurseries in England and Wales, and separated according to texture of soil.

	Mustard.	*Lupins.*	*Lupins and Tares.*	*Other Crops (Mixtures).*
Light soils (sands and sandy loams)	3	14	2	1
Strong soils (loams and clay loams)	13	14	5	5
Total (Nurseries)	16	28	7	6

The most popular green crop is evidently the lupin which is extensively used in the loamy nurseries as well as on the lighter soils. Most of the replies do not state whether blue lupins or yellow lupins are grown but the yellow lupin is advocated in a number of cases.

The mixture of lupins and tares is used in 7 out of 12 nurseries in Division 2. Other mixtures are oats, tares and peas (1); lupins, tares and mustard (1); lupins and mustard (3); mustard and rape (1).

In the Northern and North-Eastern Divisions of Scotland the practice is different from that in England. In Scotland the standard crop is a mixture of oats and tares (Swedish tares are specified in some cases). In the Northern Division oats are the principal crop, the ratio of oats to tares being about 3 to 1 by weight while in the North-Eastern Division tares form the main crop, the ratio being 1 of oats to 3 of tares.

Recommendations of County Agricultural Advisers.—The majority of the Advisers recommend mustard or blue lupin as the best crop. In some cases the advice is qualified in the sense that lupins are recommended for sandy or sour soils and mustard for more loamy soils and where lime is not markedly deficient. In Divisions 2 and 4 vetches (tares) are considered preferable to either lupins or mustard for clayey soils. In Divisions 5 and 7 reference is made to the autumn sowing of a mixture of rye and trifolium if the seed can be got in in September. Later in the autumn it is stated that rye alone should be sown. In the same Divisions oats and tares are recommended for sowing in February but from April onwards only mustard or lupin is considered suitable.

Rye or oats is suggested as a green crop for Cannock nursery in Division 2 in preference to lupins or mustard, and rape or a mixture of rape and mustard for some of the north Wales nurseries in the same Division.

Observations.—Unless the difference in the climatic conditions is the determining factor it is not apparent why the type of green crop employed should differ so markedly in the two countries. The oats and tares mixture favoured in Scotland appears to have been very little tried in the South and it might be worth while experimenting with this mixture.

As regards the question of date of sowing it is understood that in the North-Eastern Division of Scotland the mixture is sown generally in May, and sometimes even later, with usually satisfactory results.

The lack of mention of any root crop is a little surprising; there might be some advantages in this type of crop in a chafer-infested nursery and where the ground is foul with weeds.

Nothing very novel in the way of suggestions has come from the Agricultural Advisers. Mustard or lupins are the crops favoured by the majority, especially for sowing during the late spring and summer. The oats-tares mixture is apparently considered suitable only for early sowing (February) but as a rule nursery ground is not available for green cropping until later in the year. The same difficulty would apply to the autumn sowing of such a mixture as rye and trifolium.

From the point of view of cost of seed mustard is a much cheaper crop than lupin though there may be nurseries where the soil is too light or acid for mustard.

More advantage might perhaps be taken of the practice of sowing two crops of mustard, sowing the first crop a little earlier than usual. In this way autumn weed growth is prevented and it is more probable that the soil will be enriched in humus.

The preference for lupins is probably based upon the fact that the plants accumulate additional nitrogen, but as against this conifer plants at any rate do not appear to require much in the way of nitrogen, and it seems likely that any nitrates would be washed out of the soil before the trees could utilise them.

2.—*Method of Sowing and Amount of Seed Sown.*

(i) *Method of Sowing.*—This varies in the different Divisions. Divisions 1, 2, 4 and 5 used broadcast sowing in most of the nurseries while in Divisions 3, 6 and 7 the seed was sown in drills. In Scotland the usual method is broadcast sowing.

Observations.—Most nurseries do not possess a seed driller and must borrow from a neighbouring farmer if they desire to employ drill sowing. This may account in part for the general preference for broadcast sowing.

On ground that is badly infested with weeds drill sowing has, no doubt, considerable advantages and in dry seasons cultivation between the rows should also help the development of the crop.

(ii) *Amount of Seed used.*—The average quantities used in England and Wales were :

Mustard 34 lb. per acre (maximum 97 lb., minimum 8 lb.)
Lupins 134 lb. per acre (maximum 225 lb., minimum 50 lb.)

As the maximum and minimum figures indicate, the range is very considerable.

There is some indication that success may be partly related to density of sowing, *i.e.*, the majority of those nurseries which reported poor green crops sowed less than the average weight of seed per acre.

In the Scottish nurseries the quantities were either 2 cwt. of oats and 1 cwt. of tares, or 2 cwt. of tares and ½ to 1 cwt. of oats per acre.

Recommendations of County Agricultural Advisers.—The quantities prescribed are as follows :—

Mustard from 14 to 30 lb. per acre, average 20 lb.
Lupin from 120 to 150 lb. per acre, average 135 lb.
Rape from 8 to 10 lb. per acre.
Tares 130 lb. per acre.
Oats and Tares from 1 bushel each to 2½ bushels oats plus 1½ bushels tares per acre.
Trifolium 14 to 20 lb. per acre.
Rye 4 bushels per acre.

Observations.—The average density of sowing in the Commission nurseries appears to be rather heavier than the Agricultural Advisers recommend in the case of mustard, but about the same for lupins. It is possible that some nurseries are sowing mustard unnecessarily heavily. Apart from the question of cost a thinner sowing might give a stronger plant but much may depend upon the state of the nursery as regards weeds.

3.—*Manurial Treatment.*

The majority of nurseries employ manure of some sort in connection with their green crops. The table below shows the number of nurseries not using any manure, whether organic or inorganic, for raising the green crops.

Division 1	.. .. ..	None (5 nurseries)
2	.. .. ..	None (11 nurseries)
3	.. .. ..	9 nurseries out of 13
4	.. .. ..	4 „ „ 10
5	.. .. ..	4 „ „ 9
6	.. .. ..	2 „ „ 5
7	.. .. ..	1 „ „ 4
	Total ..	20 nurseries out of 57

Rather over one third of the nurseries thus grow their green crops without any manure.

Where manures are used it appears that more than 50 per cent. of the nurseries use some form of organic manure, either alone, or more rarely with the addition of artificials.

The following is a more or less random selection of the manurial treatments given :

Nursery.	*Manure.*	*Quantity.*	*Crop.*
Dalby (Sandy loam)	Chicken manure	8 tons per acre	Blue lupins.
	Kainit	4 cwt. ,,	
	Basic slag	4 cwt. ,,	
Wykeham (Sandy loam)	Farmyard manure	10 tons per acre	Blue lupins.
	Kainit	4 cwt. ,,	
	Basic slag	4 cwt. ,,	
Cannock (Sand)	Shoddy	10 cwt. per acre	Lupins and vetches.
	Sulphate of potash	4 cwt. ,,	
	Basic slag	4 cwt. ,,	
	Ground limestone	5 cwt. ,,	
	Sulphate of ammonia (as top dressing)	2 cwt. ,,	
Gwydyr (Heavy loam)	Basic slag	4 cwt. per acre	Lupins and vetches.
	Sulphate of potash	4 cwt. ,,	
	Ground limestone	5 cwt. ,,	
	Sulphate of ammonia	2 cwt. ,,	
Brecon (Heavy loam)	Farmyard manure	7 tons per acre	Lupins.
Dartmoor (Sandy loam)	Basic slag	3¼ cwt. ,,	Lupins.
	Sulphate of potash	2¼ cwt. ,,	
	Sulphate of ammonia	2¼ cwt. ,,	
	Lime	5½ cwt. ,,	
Ampthill (Sandy loam)	Stable manure	16 tons per acre	Mustard.
Salcey (Clay)	Heavy application of leaf mould		Mustard.
Rendlesham (Sand)	Farmyard manure	12 tons per acre	Lupins.
Clipstone (Sandy loam)	Sulphate of potash	2 cwt. per acre	Mustard.
	Basic slag	2 cwt. ,,	
Laughton (Sand)	Basic slag	2 cwt. per acre	Oats, tares, peas.
	Sulphate of potash	2 cwt. ,,	
	Sulphate of ammonia	2 cwt. ,,	
Ringwood (Sandy loam)	Basic slag	3¼ cwt. per acre	Lupins.
	Sulphate of potash	2¼ cwt. ,,	
	Sulphate of ammonia	2¼ cwt. ,,	
	Ground limestone	5½ cwt. ,,	
Herbert (Loam)	Basic slag	6 cwt. per acre	Lupins.

In Scotland the tendency has been to use a complete dressing of artificials, an average application being 4 cwt. basic slag, 3–4 cwt. Kainit and 1–2 ammonium sulphate per acre. One nursery (Newton) expressed a preference for farmyard manure (10 tons per acre) if obtainable.

Manuring in some form appears to be the universal practice in Scotland for the raising of nursery green crops.

Recommendations of County Agricultural Advisers.—There is general agreement among the Advisers that manuring is necessary in order to

secure a successful green crop, but the prescriptions vary considerably in detail. In one or two cases a dressing of farmyard manure is recommended but the majority prescribe only artificials, the average quantity being about 5 cwt. per acre. For lupins only potash and phosphate are required, but in the case of mustard a complete dressing is usually recommended. Typical dressings prescribed are as follows :—

Mustard	.. 5 cwt. Superphosphate, 1 cwt. Ammonium sulphate, and 1 cwt. Kainit.	Friston.
Mustard	.. 2 cwt. Superphosphate, 2 cwt. Ammonium sulphate, and 1 cwt. Potash salts.	Swaffham.
Lupin	.. 2 cwt. Superphosphate, 2 cwt. Potash salts.	Swaffham.
Mustard (Clay soil)	2–3 cwt. I.C.I. concentrated fertiliser plus 1 ton ground limestone.	Northants.

Observations.—Two distinct though related factors are involved in the question of manuring for a green crop in forest nurseries. (1) Manures are applied in order to secure a quick-growing, bulky crop of the plant to be raised. A good green crop results in the effective smothering of weeds and a large bulk of vegetable matter for working in to the soil. (2) The manures applied, in so far as they are not leached out, are a definite contribution to the fertility of the nursery soil. This latter aspect is dealt with in more detail in a later section of the report.

As far as the actual effect of manuring upon the growth of the green crop itself is concerned, there is not much direct evidence because it has not been the general practice in our nurseries to leave unmanured controls, or to experiment with different quantities of fertilisers. The indirect evidence, however, coupled with the recommendations of the Agricultural Advisers, leaves little doubt that manuring is usually necessary if a satisfactory bulk of green crop is to be obtained.

The form which manuring should take and the quantities to be applied will depend to some extent upon local conditions but there are one or two general principles which may be mentioned.

In the first place there does not seem very much point in manuring with farmyard manure or other form of organic matter. Such manure often brings in weeds and in any case is usually limited in amount and perhaps better employed on manuring the nursery lines or seedbeds. Satisfactory green crops can be grown on most soils with the aid of artificials alone.

Secondly a complete dressing consisting (except in the case of non-leguminous crops) of a mixture of nitrogenous, phosphatic and potassic fertilisers is likely to be generally more effective than unbalanced manuring consisting of only one or two of these nutrients. The leguminous crops, however, do not as a rule require nitrogenous dressings.

As to quantity, theoretically this should be based upon analysis of the respective nursery soils, and such analyses have in fact been carried out for many of the nurseries in Scotland (and a few in England) by the

Macaulay Institute for Soil Research. Where no such data exist there is only general experience as a guide. It is probably better to err on the side of over- rather than under-manuring, and a formula which has proved effective in many cases is the following :—

Basic slag (high grade)	4 cwt. per acre
Kainit	4 cwt. ,, ,,
or	
Sulphate of potash	2 cwt. ,, ,,
Sulphate of ammonia	2 cwt. ,, ,,

When manuring for lupins on acid sandy soils 3–4 cwt. of superphosphate might be substituted for the slag and the sulphate of ammonia omitted.

It is often a good practice, when dealing with green crops other than lupin, to apply a light top dressing of nitrate of soda if the plant is backward in developing.

It should be observed that where two successive crops of mustard are taken, the second crop should not require any manuring if the first crop has succeeded.

In general, attention is called to the desirability of making simple manuring experiments and of leaving at least two small unmanured strips as a control.

4.—*Stage of Development of Crop when dug-in.*

(i) *Lupins.*—The practice is very variable, and there are evidently considerable differences of opinion. The replies may be summarised as follows :—

Time of digging-in.	*Number of Nurseries.*
Before flowering	8
Coming into flower	7
In flower	13
Just after flowering	6
Later (stems woody)	9

A number of the replies stresses the importance of digging-in the green crop while it is still soft, *i.e.*, in the early flowering stage. When a reason for this preference is given it is usually to the effect that if the lupins are left until the stems are hard they are not properly decayed when the time comes for lining-out and are then a nuisance. On the other hand the advocates of late digging-in state that the stems decay more slowly when they are hard and woody and produce more humus in the soil.

(ii) *Mustard.*—There is less difference in practice than in the case of lupins. In most nurseries the mustard is turned in either when just coming into flower, when actually in flower, or while still soft. Only in three nurseries out of 16 is the crop dug-in at a later stage when the plants are hardening off.

(iii) *Oats and Tares.*—The practice in Scotland is to dig the crop in when the tares are in flower or just coming into flower, and while the oats are still green.

Views of the County Agricultural Advisers—Relatively little specific information was forthcoming on this point, but the general view appeared to be in favour of early digging-in while the stems were still soft. In one case (Cannock Nursery) a direct warning was given against late digging-in on the grounds that the decomposition of the hard stems would have a very adverse drying effect on this light soil.

Observations.—The best time at which to dig-in a green crop is a question which has received a good deal of attention lately among the agriculturists. The most recent view appears to be that a great deal depends upon the nature and time of sowing of the crop following. Evidence is accumulating to show that a green crop dug-in early, when the stems are soft and green, and at a time when the soil is warm, is decomposed extremely quickly with a rapid production of carbon dioxide and of soluble nitrates. Unless the green crop is followed quickly by a crop which can utilise the nitrates these are washed out of the upper layers of the soil and largely lost. When a green crop is dug-in in a lush condition very little actual humus appears to be formed, the organic matter being almost completely broken down. On the other hand by delaying digging-in until later in the autumn when the stems are getting woody and when the soil has cooled down slightly the rate of decomposition is much slower and more humus is likely to accrue to the soil.

When we consider our forest nursery practice there seem to be some fairly strong arguments against early digging-in of green crops. In the first place we know that most of our trees, especially the conifers, do not respond to additional supplies of nitrates, and secondly, most of these nitrates are formed within three to four weeks from digging-in the green crop when the ground is either fallow or at the best is newly lined-out with trees in their resting stage. The trees following a green crop dug-in say in September will not be able to utilise much of the nutrients set free by the decomposition of the crop until the following May or June, with the whole of the winter rainfall intervening. The best way of holding the more soluble nutrients formed would be presumably in the humus, and the lighter the soil the more important will be the part played by the humus in retaining the plant foods.

The obvious objection to digging-in the crop late when the stems are getting woody is that decomposition may be so much delayed that the stems are still hard when the time comes for lining-out, and this may lead to considerable difficulty. There may be some way of getting over this, such as chopping the stems before digging them in.

As far as general principles are concerned it appears to the writer that the arguments are in favour of postponing the digging-in of the green crop as late as possible, not only with the object of increasing the yield of humus and so helping to retain the soluble mineral nutrients in the soil, but also as a means of checking the growth of grass and other weeds in the autumn. Incidentally, both of these reasons can be advanced in support of taking two successive crops of mustard rather than one, though in this case the first crop can be dug-in while still green and soft.

The length of time the green crop can be left standing in the autumn will depend also to some extent upon when the ground is required for lining-out. If it is wanted for early lining-out it may be impracticable to delay digging-in until the stems of the green crop are getting hard as there may not be enough time for these to decay. On the other hand if the ground is to be reserved for seedbeds this factor should be of less importance. In some crops the tendency of the plant to re-sow itself may also be a difficulty. The recommendation which is put forward here is merely to the effect that other things being equal the green crop is most likely to benefit the soil if digging-in is postponed as late as conditions permit.

5.—*Quality of Green Crop produced.*

The questionnaire asked for information as to whether a smothering crop had usually resulted. Out of 50 replies 36 were in the affirmative and only 14 in the negative. The proportion of unsatisfactory crops was much higher in the non-manuring nurseries. Out of 16 nurseries which did not apply manures 10 reported unsatisfactory crops.

Observations.—A great deal depends upon the standard adopted for a "smothering crop". It is perhaps questionable whether inspecting officers would have accepted all, or indeed many, of the 36 affirmative answers as correct. Taking the replies at their face value the position is not too unsatisfactory.

6.—*Whether Seedbeds or Transplant Lines follow the Green Crop.*

Fifty-six replies were received from England and Wales. The practice in 45 nurseries was to line-out on ground which had previously been green cropped. In five nurseries, almost all on heavy soil and growing hardwoods, the green crop ground is used for seedbeds. In the remaining nine nurseries there was no constant practice, and either seedbeds or lines might follow the green crop.

In Scotland transplant lines follow the green crop in 6 out of 11 nurseries, the remaining five being indifferent, following a green crop with either seedbeds or lines according to the circumstances of the case.

In a number of the replies from nurseries in England and Wales the practice of following green cropped land with conifer seedbeds is specifically condemned as bad, though no reasons are given.

Observations.—Apart from the possibility that undecomposed stems may interfere with the preparation of the seedbed it is not very obvious why coniferous seed should not be sown on ground which carried a green crop the previous summer. There is no reason to suppose that the soil will be overcharged with available nitrogen, the winter rains will dispose of that, nor does it seem likely that the effect of the green crop will be to affect the physical condition of the soil unfavourably for the growth of seedlings. On the whole it is doubtful whether the prejudice against making seedbeds on ground which has carried a green crop can be justified.

7.—*Recommendations for the Improvement of existing Practice.*

A number of nurseries, in which the practice has been to raise green crops without manure, recommend manuring.

In two nurseries in Division 3 and in four nurseries in Division 5 the recommendation is made to stop the practice of green cropping and to substitute bare fallow with frequent cultivation. In two cases the sowing of a late crop (August) of mustard, after the fallow, is recommended.

Drill sowing as opposed to broadcast sowing has a number of advocates. If the seed is sown in drills 2–3 hoeings can be carried out before the crop closes over and thus a large proportion of the annual weeds destroyed.

Several replies recommend yellow lupin in preference to blue lupin; and in a number of cases the substitution of mustard for lupins is recommended, partly on the ground that two crops of mustard can be taken and the autumn weeds kept down. Mustard is also considered by some to be better for chafer-infested land than lupin.

One or two replies stress the importance of intensive cultivation in improving the condition of the soil and the growth of the green crop.

Observations.—There are no very novel recommendations for the improvement of existing practice. With regard to the species of lupin, it was found at Kennington Nursery that yellow lupin though rather slow to start gave a much more smothering crop than the blue lupin.

8.—*Assuming that a good Bulk of Vegetable Matter is obtained, does Green Cropping improve the Soil for the Production of Trees?*

Including Scotland, 68 replies were received; these are classified as follows:—

Yes	51 replies	= 75 per cent.
No	11 ,,	= 16 ,,
Indefinite	6 ,,	= 9 ,,

An examination of the returns of those nurseries replying in the negative showed that out of 11 no fewer than seven were among the non-manuring nurseries, *i.e.*, those which grew their green crops without the aid of any manure. This may be suggestive of the part which manuring plays in the benefits conferred by the green crop. The question is further discussed in the concluding section of the Report.

Among the 75 per cent. of affirmative replies are a number of very positive statements as to the value of green cropping. Improvement of soil texture is one of the points stressed.

Observations.—In the absence of definite experiments the views expressed represent personal opinions and not proof. At the same time some weight may reasonably be attached to the experience of men many of whom have had their nurseries under observation for a considerable number of years.

The Place of the Green Crop in Forest Nursery Practice.

Most of the considerations which arise in connection with the practice of green cropping in forest nurseries have already been touched upon

in the observations to the individual sections of the Report. It remains to discuss the broad question as to what should be the place of green cropping in our nursery practice.

The matter can be looked at from three distinct points of view, namely in relation to :—(*a*) maintenance of the fertility of nursery soil, (*b*) practical convenience in running the nursery, and (*c*) control of chafer and other soil larvae.

(a) *Fertility of Nursery Soil.*—It will be generally admitted that nursery soils require manuring from time to time if their fertility is to be maintained.

In conversation, Dr. Ogg, Director of the Macaulay Institute for Soil Research, recently expressed the matter more or less in the following way. Fertility is something which, though very hard to define, is a characteristic of a productive soil. A fertile soil may keep a fairly high level of productivity for a number of years, but if nothing is put back the soil often quite suddenly ceases to be satisfactorily productive, it has lost its accumulated fertility. To restore it to its original condition may take years of care and work. If this is a correct statement of the case it may partly explain why manuring experiments in poor nurseries often fail to give positive results in a single year, and it also gives a reason for not letting a good nursery down even though the apparent effects of manuring may be relatively inconsiderable.

Assuming then that regular manuring is essential in what form shall the manures be applied? Most nurseries have difficulty in obtaining as much farmyard manure or leaf mould as is required and are then thrown back upon artificials. Experimental work so far upon the use of artificials for the manuring of conifers has been very disappointing. In part this may be due, as suggested above, to the fact that the soils in question had lost their fertility and the manuring was not applied over a sufficient period to produce results. On the other hand there is some evidence to suggest that growth-promoting substances may be present in organic manures, but lacking from the artificials, and that by applying the artificials to a green crop we may in fact help the trees to utilise the mineral nutrients more efficiently.

Another consideration is that of humus. Most of our nursery soils are very poor in humus and so tend to lose their available mineral food substances by leaching; they are difficult to work if there is much clay in the soil, aeration is defective, etc., etc. The digging-in of a green crop, provided it is not turned in too soon, should increase the proportion of humus. At least it should assist to retain in the soil the added phosphate, potash, and lime.

A further point which may be mentioned is that a field crop represents a change in the utilisation of the soil. Different, possibly deeper, layers of the soil are explored by the roots of the field crop and there are some grounds for believing that such a change is beneficial.

The three points discussed above all rest on a somewhat hypothetical basis and the manurial value of green cropping in nurseries can only be established by prolonged and careful investigation. The Research Branch

has carried out a number of carefully planned small-scale experiments on green cropping with, on the whole, inconclusive results. Only in one experiment in one nursery was there any definite evidence of benefit to the subsequent trees as a result of digging-in a manured green crop. In the view of the present writer the weak point in these experiments has been their small scale and strictly limited period. To get valid results it would be necessary to take the entire manurial treatment of the nursery into account and to extend the work over a period of not less than two green crop rotations. Experiments would also have to be carried out in more than one nursery.

Manuring, however is not the only foundation for the practice and there are two other aspects which remain to be discussed.

(b) *Practical Conveniences in running the Nursery.*—For the proper running of a nursery it is very desirable that a proportion, say a quarter, of the area should not be under trees during the summer. If this arrangement is adhered to ground is always available in the autumn for lining-out and in the spring for seedbeds, and there need be no delay in getting on with the work. Such land can either be bare fallowed during the summer or put under green crop. Bare fallowing is usually the best way of dealing with very weedy ground, but it presupposes constant cultivation during the growing season. In large nurseries where either horse labour or a rototiller or other means of mechanical cultivation may be available a bare fallow may be the cheapest as well as the best method of clearing the ground.

In small nurseries where all cultivation has to be done by hand a bare fallow is a rather expensive operation, and in such cases the simple alternative is the sowing down of a green crop. Provided that a dense smothering crop is obtained the annual weeds at least are effectively dealt with and the ground is available when it is wanted for lining-out or for forming seedbeds. In large nurseries, where mechanical cultivation is possible, manuring considerations may often turn the scale in favour of a green crop.

(c) *Control of Chafer and other Soil Larvae.*—One of the strongest arguments for a regular rotation in a nursery is the menace presented by the soil grubs. If the whole area of a nursery is kept continuously under either seedbeds or lines the risk of the soil becoming infested by chafer is almost certainly increased. By taking regularly part of the area out of tree production an opportunity is given for collecting the grubs and the attack is more likely to be kept under control. These remarks apply primarily to attacks of *Melolontha; Phyllopertha* with its one-year life cycle presents a somewhat different problem.

When using the word rotation the taking of a green crop is not necessarily implied, the non-productive part of the area may be bare fallowed. In the light of our present limited knowledge of chafer control, a bare fallow lasting at least until midsummer, with the soil frequently cultivated, and combined with hand picking, appears much the most hopeful method of dealing with the problem. Green cropping alone is certainly no solution, and unless the sowing of the crop is delayed until the fallowing has done its work the ground might as well be under trees. There is no evidence

to show that a mustard crop, for example, has any deterrent action upon the chafer, and when the green crop is in occupation of the soil it is impossible to do much in the way of cultivation or hand picking.

Conclusion.

Before attempting to arrive at a conclusion as to the utility of green cropping it may be well to consider the alternatives. There appear to be only two :—

(i) keep the nurseries continuously under trees manuring with organic products (farmyard manure, leaf mould, compost, etc.) every two or three years;

(ii) work the nurseries on a rotation, bare fallowing the non-productive area, and again applying organic manures.

The first alternative runs up against the snag of soil grubs, and perhaps of perennial weeds. In the writer's opinion it is a dangerous one and in any case it presupposes a sufficient supply of organic manures to keep the nursery in good heart.

The second alternative is quite feasible, but it presupposes adequate supplies of organic manure and equipment for mechanical cultivation.

It is concluded that in the average nursery, dependent on artificial manures for the maintenance of fertility, the digging-in, after manuring, of such crops as mustard or oats and tares has a number of points in its favour. It is perhaps doubtful, having regard to the cost of seed, whether the preference for lupins is justifiable, exceptional local conditions apart.

Appendix.

Questionnaire circulated by the Assistant Commissioner for England and Wales to Divisional Officers :—

Division .. .. Nursery .. .. Soil type

1. Nature of green crop usually employed.
2. Method of sowing, and amount of seed sown per acre.
3. Manurial treatment (if any) for green crop. Quantities applied.
4. Stage of development of crop when dug-in.
5. Has a heavy smothering crop usually resulted ?
6. Do seedbeds or transplant lines usually follow the green crop ?
7. Any recommendations for the improvement of existing practice with regard to green cropping.
8. Assuming that a good bulk of vegetable matter is obtained, is it your experience that green cropping does improve the soil for the production of trees ?

R.E.F.S. EXCURSION TO KENT AND SUSSEX, 1936.

By W. G. MILNE.

The Royal English Forestry Society chose Tunbridge Wells as the venue for its annual excursion last year. Some of the estates and plantations visited are described below.

An interesting day was spent inspecting the 10,000 acre estate of the Marquess Camden at Bayham Abbey.

Churchfield Wood Plantation is an area of approximately ten acres, clay-loam soil, southerly aspect, elevation 260 ft. Five acres of this area was planted with two-year oak seedlings at 3 ft. spacing and the balance with ash and European larch at 5 ft. alternately, planting being carried out during the spring of 1930. In an oak area selected seedlings were used with taproot intact. It is amazing how the oak seedlings have pushed their way through the thicket of brambles, bracken, hazel and other woodland weeds, as I understand no weeding at any time has been done; the crop has now attained an average height of $3\frac{1}{2}$ ft. with losses not exceeding 7 per cent. The ash and E.L. area is also good, although the larch have suffered from suppression by weed growth in patches.

Hilly Mead Plantation is another area of about ten acres with similar soil conditions, aspect and elevation. It was planted in the spring of 1931, with two-year oak seedlings at 3 ft. spacing. Here again we saw the oak pushing their way through a jungle of hazel, ash and oak coppice, with brambles and bracken.

At Little Shoesmiths Farm we saw a charcoal pit, with the charcoal burner busy lighting the fire, so he had before him a sixty-hour vigil before the pit was "drawn" or uncovered and the fuel bagged up in grades. The cost of burning is roughly fourpence per bushel, or 10s. to 11s. per cord of wood. Prices ranging from £5 to £8 per ton are obtainable for best charcoal. Charcoal is used in Kent and Sussex as fuel for the drying of hops—with which industry forestry in that district is closely connected.

Buckland Hill Chestnut Plantation is a large one consisting almost entirely of pure chestnut coppice grown on an eleven years' rotation. The material is mainly manufactured into fencing poles. One acre of this class of coppice will yield at least 25,000 cleft fencing poles and I understand that as much as £24 per acre has been obtained from this area within the last few years.

Rowland Wood is also chestnut coppice, only having a fairly heavy overwood of oak. Soil and other conditions are similar to the Buckland plantation and the average over the last three or four cuttings of underwood is £11 per acre, thus showing that with a heavy overwood the yield from the underwood is greatly reduced.

A small area of about eight acres called Skents Wood is on clay-loam soil with a northerly aspect, elevation 250 ft. It was planted in the spring of 1911 with E.L. and S.P. alternately at 3 ft. spacing with beech and ash interplanted at 9 ft. apart through the crop. What are left of the S.P. and ash are hopelessly suppressed, while the beech are still alive under

the larch. This is a very fine stand of E.L. carrying 872 stems to the acre and a cubic capacity of over 3,000 cubic feet per acre. To my mind this area requires a heavy thinning, as a few poles lying on the ground newly felled showed signs of heart rot, this state of affairs is being encouraged by the obvious overcrowding.

Hollow Wood Plantation is an area of ten acres, soil light sandy loam and white sand, northerly aspect, elevation 200 ft., and was planted with Douglas fir in the spring of 1913 at 4 ft. spacing. The cost of plants, fencing and planting was £11 8s. 6d. per acre. The plantation suffered from pine weevil during its early stages; it was cleaned and thinned in 1925 and a heavy thinning took place in 1935. The height of the stand now is from 45–50 ft. with an average quarter-girth (measurement at breast height) of 5 in. According to the Forestry Commission Yield Tables this plantation would come under the third quality class.

Bakers Down Wood consists of old S.P. not of good quality owing, I am afraid to bad management, but nevertheless here we had one of the most interesting sights of the tour. After several acres had been clean cut, the timber cleared away, lop and top burnt and a wire netting fence erected round the felled area it was left to nature. The scheme has proved most successful as the forester now has thousands of plants with which to form a crop, all nicely distributed over the area, having seeded from the old Scots pine surrounding the plot. Some magnificent old oaks were seen on this estate, one in particular having about 400 cubic ft. in a 16 ft. length of bole.

On the Chevening Estate comprising some 5,000 acres, 600 acres are woodland. In elevation it varies from 300 ft. to 700 ft. above sea-level. The woodland policy is based on the desire of the owner to preserve a typical example of Kentish coppice with standards there being two important considerations—amenity and game. The woodlands consist mainly of oak and ash standards, over chestnut and ash coppice on the clayey soils, while on the chalky brash, beech, oak and elm form the main crop, while during the past few years a few plots of E.L. with ash and chestnut have been introduced on the poorer soils with quite good results, when replacing old worn-out coppice with standards.

Bedgebury Forest was the only Forestry Commission area visited during the excusion. Here we saw the manufacture of S.P. thinnings into pitprops and high pruning of S.P. plantations after thinning, both operations being most instructive. Replanting of this area was started by the Commission in 1925–26 and to date 478 acres have been planted. The species used in the earlier years were mainly Douglas fir and Sitka spruce, with oak on the better soils. The prevalence of frost on this area is very marked, and the May frost of 1935 has done a great deal of damage to Douglas fir and Sitka spruce. In 1929 and subsequent years S.P. has been the chief species planted, but on small areas E.L., C.P., oak and ash have been used where the soil is suitable. The Forestry Commission have here an area laid out in a series of forest plots, to study some of the less common species grown under forest conditions. A start was made in the planting of these plots in 1929 and to date 102 plots have been planted,

each being about ¼ acre in size. Many species have suffered severe check by frequent spring frosts. Alongside the Sitka plot we saw a plot of *Picea omorica* which has never suffered from frost and is growing beautifully. Two other very nice plots are *Pinus sylvestris* (England) and *Pinus laricio* (Ursuline).

The Pinetum at Bedgebury was also visited; this is a joint undertaking between the Royal Botanic Gardens, Kew, and the Forestry Commission. Its institution was decided upon in 1924. Here again the management is fighting a battle against nature, as spring frosts are proving disastrous to many of the Chinese and European species of *Abies* and *Picea*. It was most interesting to see so much natural regeneration taking place all through this area in the vicinity of fine old conifers which have been retained as specimen trees. These included Scots pine, Lawson's cypress, Western red cedar, Sitka spruce, Douglas fir, *Abies grandis*, *Abies nobilis*, and European larch.

The Whiligh Estate belonging to Sir George Courthope consists of about 3,000 acres of which some 600 acres are woodland. It has always carried some of the finest oak in England. Oak timber from this estate was supplied for the roof of Westminster Hall, both in 1394 and at its restoration in 1914. The old plantations were mainly pure oak, oak standards with Spanish chestnut coppice, and European larch with Spanish chestnut coppice, while the younger crops are oak with occasional small groups of Douglas fir, Japanese larch, Sitka spruce and Scots pine; all these groups of conifers are growing splendidly, and to my mind have improved the amenities of the estate, and will give a quick return.

Young seedling oak can be seen springing up naturally all through these beautiful and well-cared-for woods—a very pleasing sight. A visit was paid to the timber yard which was equipped in 1911 and deals with some 30,000 cubic feet per annum, chiefly oak. The plant consists of a rack bench with a 28 ft. table, capable of taking saws up to 78 in. diameter. There is a large push bench, a small vertical band saw, and a steam windlass. The power is obtained from a 14 h.p. Marshall steam engine with a large fire box for burning wood.

Cottage Field Plantation which was visited proved most interesting. There was an old oak stand (naturally regenerated), still in close canopy and showing very fine clean stems, part of the area was underplanted with *Abies grandis* in 1928–29 and part with *Tsuga albertiana* (*heterophylla*) in 1931–32. This young undercrop is growing exceedingly well in spite of the dense canopy.

A very enjoyable excursion had as its final feature tree felling and log sawing competitions arranged on the Marquess of Abergavenny's Eridge Castle Estate. A topic frequently discussed during the tour was pruning, and it was interesting to have the views of the timber merchants present on this subject. I came to the conclusion that timber merchants were prepared to pay approximately twice as much per cubic foot for practically any species of hardwood or conifer that had been pruned when young and kept free from knots. They were even prepared to pay more than this for material suitable for ship-building, as the class of timber required for

this industry must be absolutely free from knots, and they stressed that to-day they could not get suitable material owing, as they put it, to bad management of growing crops. They maintain that when buying timber at the present day they have to safeguard themselves against the possibility of the greater number of stems acquired, producing a very small percentage of first-class material when manufactured owing to black, rotten and loose knots, not visible externally.

With so much fine soil for tree growth (hundreds of acres much better than the Scottish wheat and potato land), the quality and quantity of timber in Kent and Sussex are somewhat disappointing, but it is gratifying to see that the younger plantations are being properly established and cared for. I am very grateful to the Commissioners for the opportunity afforded to visit English woodlands for the first time.

CHAFER DAMAGE IN NURSERIES IN ENGLAND AND WALES.

1935 Growing Season.

In order to assess the economic damage caused by the chafers in England and Wales and to ascertain where the principal losses occurred, a circular was issued through the Assistant Commissioner to all officers in charge of nurseries who were asked to report on the losses which had occurred in seedlings and transplants, as disclosed on lifting the plants in the winter 1935–36 for lining-out or planting.

The results have been summarised in the accompanying table.

1. *Number of Nurseries infested.*—Out of a total of 74 nurseries 33 are reported as infested, *i.e.*, 45 per cent. This does not imply that chafer grubs are present over the whole area of the 33 infested nurseries but merely that damage of either local or general extent has been recorded in those nurseries.

2. *Area affected.*—Column 6 shows that the 33 infested nurseries comprise 65 per cent. of the total nursery area. This means that the smaller nurseries are more free from chafer than the larger ones. Also, probably, the damage is more evident in seedbed nurseries (these are usually larger) than in local nurseries used only for lining-out.

3. *Distribution of infested Nurseries.*—Divisions 1 and 3 have a much lower percentage of infested nurseries than the remaining Divisions. Divisions 2, 4, 5 and 6 show from 74 to 84 per cent. of their nursery areas as more or less infested with chafer. In Division 7 all the nurseries are subject to damage. Strictly speaking, Division 4 should come into the lower group with less than half the total nursery area affected by chafer, but in two nurseries considerable damage has been done by the grubs of the ghost swift moth bringing the area of ground affected by soil grubs up to 81 per cent.

The fluctuations of damage are very puzzling; some years ago the Thetford nurseries were full of chafer and much damage was reported, but in the last year or two the losses have been almost negligible. In Scotland the nurseries at Inchnacardoch were fairly free of chafer for the first five or six years, but this year a serious outbreak of *Serica* has occurred, causing much damage.

4. *Losses of Seedlings and Transplants.*—The data as to actual losses represent the Forester's estimate as to what proportion of his total losses can be fairly ascribed to the work of the chafer. The natural tendency will be to over- rather than under-estimate the loss due to the chafer and consequently the figures are likely to represent the maximum damage. In the case of seedlings the data relate mainly to beds lifted for lining-out or planting and except in the case of Delamere do not appear to cover the one-year seedbeds remaining over to two years.

Columns 8 and 11 indicate that 6½ million seedlings and 1½ million transplants were lost owing to chafer attack during the 1935 growing

Summary of CHAFER DAMAGE in Nurseries in England and Wales.

August 1935-May 1936.

Division.	Total No. of Nurseries.	No. of Nurseries infested with Chafer.	Total Area of Nurseries under Seedbeds and Lines. (*sq. yds.*)	Area of infested Nurseries only. (*sq. yds.*)	Per-centage of Area infested.	No. of Seedlings held at Stock-taking 1935 (infested Nurseries only). (*000's*)	No. of Seedlings lost owing to Chafer Damage. (*000's*)	Per-centage.	No. of Trans-plants held at Stock-taking 1935 (infested Nurseries only). (*000's*)	No. of Trans-plants lost owing to Chafer Damage. (*000's*)	Per-centage.
1	2	3	4	5	6	7	8	9	10	11	12
I	9	1	333,900	42,900	13	3,250	368	11	1,552	4	0·2
II	11	6	260,950	192,450	74	22,352	4,095	18	6,796	351	5
III	14	5	162,900	67,100	41	1,898	185	10	1,835	157	9
IV	16	5 Chafer 2 Swift Moth	177,600	83,200C. 60,900 S.M.	47 34 } 81	5,327	16 340	0·3 6	2,786	130 103	5 4
V	13	7	543,950	456,450	84	10,517	411	4	11,743	373	3
VI	7	3	153,050	116,550	76	8,178	334	4	3,917	73	2
VII	4	4	131,900	131,900	100	7,072	801	11	2,162	385	18
TOTAL ..	74	33	1,764,250	1,151,450	65	58,594	6,550	11	30,791	1,576	5

season and the autumn and winter of 1935–36. These losses represent respectively 11 per cent. of the seedlings raised in the infested nurseries and 5 per cent. of the transplants. The heaviest seedling losses occurred in Division 2, which accounted for 4 million (practically all in Delamere nurseries) out of the 6½ million reported to have been lost in the whole of England and Wales. The next largest loss was in Division 7 where 800,000 seedlings were destroyed. In the remaining Divisions the losses were relatively low.

The transplant losses were more evenly distributed over the Divisions except for Division 1 where the number destroyed was almost negligible. Losses ranged from 73,000 to 385,000 plants in the remaining Divisions and were relatively most serious in Division 7 where the losses represented 18 per cent. of the plants lined-out.

5. *Cost of the Damage.*—If the seedlings are priced at 8s. per 1,000 and the transplants at 30s. per 1,000 the chafer damage in England and Wales cost the Commission something over £4,500. Of course all the plants destroyed by chafer would not have lived if there had been no chafer, and there are other considerations which make any simple calculation somewhat fallacious. If even 50 per cent. of the above figure can be directly ascribed to the chafer, which seems a fairly safe assumption, the loss has been well over £2,000. Beside the direct financial loss the effect of the shortage of plants upon the planting programme is also a most serious matter.

6. *Conclusions.*—When the results are considered as a whole the cockchafer menace is seen to be serious, but not disastrous, except perhaps in years such as the present in which there is a shortage of plants to complete the programme. Locally the damage may easily reach catastrophic dimensions, for example, in the Delamere Nursery in Division 2, and Fairoak Nursery in Division 7, but when the losses are spread over the whole of England and Wales the damage, in the year under review, is probably not so great as a severe drought or a spell of very frosty weather would occasion.

The relatively greater freedom from chafer of the small lining-out nurseries is a point worthy of note. The freedom may be more apparent than real as minor damage to transplants may easily be overlooked.

The data throw little light upon the relative susceptibility of different species of chafer damage. Some very heavy losses occurred in beech, but it is not possible to say that the chafer singled out the beech beds for attack. There is no species which has not in some nursery suffered severely from chafer.

As regards measures of control four methods of approach are possible, namely :—

(i) Prevent the adult females from egg-laying in the nursery soil. Before this can be attempted with any prospect of success a very complete knowledge of the pairing and egg-laying habits of the different species is necessary. This is one of the most important lines of work for the future.

(ii) Collect the grubs in the soil by hand, or expose them to attack by birds, or destroy them by some form of rotary cultivation. All these methods deserve further attention.

(iii) *Use of Soil Insecticides.*—Hitherto this has not proved very successful, but possibly a closer study of the movements of the larvae in the soil and their susceptibility at different stages of development would increase the chances of success.

(iv) *Biological Control.*—The chafer larvae are frequently parasitised by species of Diptera, though the percentage of parasitism is not usually very high. In other countries parasites occur which might be established over here. Under this heading comes also the study of the conditions favouring the chafer and the parasite respectively.

Each of the above lines of approach deserves detailed study, but it is quite likely that a satisfactory degree of control can only be achieved by some combination of all the possible methods. The first essential is a comprehensive survey of our nurseries to determine the distribution of the chafer species and the incidence of damage.

W. H. G.

PROGRESS REPORT ON CHAFER WORK, 1936.

By J. M. B. Brown.

1.—Biological.

A Tachinid parasite has been bred from the garden chafer (*Phyllopertha*) and, together with an hymenopterous hyperparasite, has been sent away for identification. It was abundant at Delamere last year and, although there was no opportunity for studying the numerical relations of parasite and host, it may be recorded that its presence coincided with a sharp decline in the outbreak of *Phyllopertha* there.

2.—Insecticide Tests.

Further trials were made in the Old Pale at Delamere and in Rhinefield Nursery, New Forest.

Delamere.

These embraced insecticidal and repellent tests in a break of Christmas trees and tests to determine whether the chemicals used damaged the plants, using the same concentrations on beds of Scots pine seedlings.* For the toxicity tests stronger dosages were used than those which gave an encouraging measure of control in 1935, but these dosages caused some damage to the seedlings, while the Christmas tree experiment was a failure because very few chafer larvae were found even in the controls. The repellent test on the Christmas trees gave a result that at first seemed hopeful, but it was found later that no reliance can be placed on this (see tables). Nothing but the irregular distribution of the larvae can explain why the smaller dose of Seekay should give 73 per cent. control of *Phyllopertha* and the heavier dose only 26 per cent. Evidently in these conditions four replications were not enough. The tests were, of course, directed against *Phyllopertha*, but it was interesting to find so many *Melolontha* larvae, mostly of the 1934–38 generation. These appeared to have been little affected by the chemicals.

The beds of S.P. seedlings presented an interesting picture. Assessment of the damaged seedlings was not easy, and a later count in February or March, 1937, is desirable. The July application of Cyjack, in conjunction with the toxicity tests, caused scorching of the foliage, which was considerable in the stronger dosage, but comparatively few seedlings were dead at the date of the inspection. Application at the end of May of a weaker solution only (in conjunction with the repellent test) also caused

* The chemicals used were again I.C.I. Seekay and I.C.I. Cyjack. The object of a repellent substance is to prevent the chafers from laying their eggs on the area treated.

considerable damage, of which the reduction of the stock by 55 per cent. is an approximate measure. The damage was concentrated in the otherwise hardly noticeable hollows in the beds, where the fluid collected and evidently killed the seedlings as they pushed their way through the soil.

The Seekay was dibbled in and, in the beds treated in July, each injection point was the centre of a circle of scorched seedlings, many of which were certainly dead. In the beds treated in May, no such effect was, of course, perceptible. This lethal action could probably be much reduced if means could be found for distributing the chemicals more uniformly in the soil; but the figures for plants destroyed by chafers make one doubt whether Seekay is toxic enough in any case.

No final judgment can be given on the results of the experiments now: nor are further tests with these chemicals recommended until more detailed information about their action is available. It is necessary that their harmful action on the plants should be studied and, if possible, eliminated: that the influence of moisture and soil texture on their toxicity and spread should be considered, and that the effective range of injections of Seekay should be measured. Researches into some of these problems have already been undertaken at I.C.I. laboratories. At the same time, more information should be obtained about the oviposition of the chafers which we hope to deter.

TREATMENTS:

A_1: I.C.I. "Cyjack" (Monochlornaphthalene) 1·25% @ ½ Gall./sq. yd.
A_2: do. 1·5% do.
A_3: do. 2·5% do.
B_1: I.C.I. "Seekay" (O- & P-dichlorbenzenes) @ 150 lb./acre.
B_2: do. 300 do.
B_3: do. 500 do.
C: Control.

Repellent Tests, 28th–29th May, 1936.

Treatment.	Seedlings counted.					Chafer larvae.			
	Total.			Per cent.		Per 128 sq. ft.		As per cent. of control.	
	Good.	Chafered.	Total.	Good.	Chafered.	Phyllopertha.	Melolontha.	Phyllopertha.	Melolontha.
A_1	501	31	532	94	6	232	49	47·3	109
B_1	1,195	175	1,370	87·2	12·8	133	26	27·2	58
B_2	1,053	119	1,172	89·9	10·1	362	38	73·9	84·4
C	1,022	153	1,175	87	13	490	45	100	100

Effect of the Chemicals upon the Plants, July 15th, 1936.

Treatment.	A_2 Seedlings.		A_3 Seedlings.		B_2 Seedlings.		B_3 Seedlings.		C Seedlings.	
	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
Good ..	2,044	75	1,633	65·5	2,316	86·8	2,308	81·5	2,281	86·3
Chafered ..	219	8	148	6	88	3·3	126	4·4	228	8·6
Apparently affected ..	456	16·1	706	28·2	260	9·8	399	14·1	134	5
(Killed) * ..	(27)	(1)	(69)	(2·8)	(53)	(2)	(176)	(6·2)	(5)	
Total ..	2,719		2,497		2,664		2,833		2,643	

* Included in preceding figure.

Rhinefield Nursery, New Forest.

The object of this experiment was threefold :—

(i) To test the assertion of the forester that paraffin is an effective deterrent to chafer larvae.

(ii) To prove whether Seekay when evenly forked into the beds immediately prior to sowing can protect them from egg-laying beetles in the summer and/or from larvae already in the soil.

(iii) To test in the same way a proprietary insecticide.

For these purposes an area was chosen in Rhinefield Nursery, which was known to be infested with *Serica* larvae. The beds were prepared for sowing in the middle of March, and the chemicals were applied on the 23rd of that month. There were four replications of each treatment—the treatments were :—

0 : Control 8 replications. Size of unit plot = 20 ft. × 3 ft.
1 : Paraffin, 4 pints per plot, mixed with wood ash and forked in.
2 : ,, 3 ,, ,, sprayed on and forked in.
3 : ,, 5 ,, ,, ,, ,, ,, ,,
4 & 5 : Proprietary insecticide, 4 pints per plot, watered on, forked over.
6 : I.C.I. Seekay, 5 oz. per plot (= 215 lb. per acre) evenly forked in.
7 : ,, ,, 10 ,, ,, (= 430 lb. per acre) ,, ,,

The experiment was partly vitiated by the appearance in the beds of a considerable—but indeterminable—number of large *Melolontha* larvae. However, certain inferences can be drawn from the table, which summarises the results of two consecutive counts on the same 16 drills in each plot. The first column gives the number of firm seedlings and the second, the number of evidently chafered seedlings, found at the date of the assess-

ment. The third column gives the loss of firm seedlings, expressed as a percentage of the total stock, good and bad, at the date of the first examination, and the last column the aggregate of the evidently chafered seedlings, expressed as a percentage of the same total stock. This last is a minimum figure; no account could be taken of seedlings killed as they pushed through the soil, nor of those chafered seedlings which were accidentally removed by the men while weeding. A third examination will be made before the plants are lifted when perhaps some further damage will be revealed.

Conclusions.

(i) There was altogether considerable damage to the crop of seedlings, much more in the outside Blocks I and IV than in the intermediate ones. In all, it amounted to a reduction since midsummer of about 40 per cent. of the crop, of which chafer larvae were responsible for something over 30 per cent.

Treatments.	Date of Assessment.	Seedlings.		Reduction per cent. 5.8.36 Stock.	Chafered Seedlings per cent.
		Good.	Chafered.		
1. Paraffin 5 pints/plot watered on	5.8.36	1,058	220	18·2	17·1
	20.10.36	852	64	34	22
2. Paraffin 3 pints/plot watered on	5.8.36	909	268	24·25	22·3
	20.10.36	608	212	49·25	40
3. Paraffin 4 pints/plot forked in with ashes ..	5.8.36	907	192	18·3	17·3
	20.10.36	735	91	33·8	25·5
4. Evans' insecticide 4 pints/plot watered on.. ..	5.8.36	1,144	158	12·5	12
	20.10.36	918	132	30	22·3
5. Do. ..	5.8.36	1,082	141	11·7	11·5
	20.10.36	829	134	32·3	22·4
6. Seekay S.P. 5 oz. per plot	5.8.36	1,089	361	26·6	24·3
	20.10.36	843	149	43·5	34·3
7. Seekay S.P. 10 oz. per plot	5.8.36	1,211	323	22·1	20·8
	20.10.36	935	108	39·9	28
0. Control	5.8.36	766	361	32·8	31·7
	20.10.36	663	81	41·3	38·8
0. Control	5.8.36	1,017	332	24·5	24·6
	20.10.36	721	174	46·5	37·5
Control average of 2 replications	5.8.36	892	347	28·7	28·2
	20.10.36	692	127	43·9	38·1
Aggregate	5.8.36	9,183	2,356	22	20
	20.10.36	7,104	1,145	39·5	30

(ii) For the control plots, the corresponding loss was 44 per cent. of which chafer accounted for at least 38 per cent.: for the Seekay treatment the percentages were but little lower (41·7 and 31·1). For the weakest paraffin treatment, the figure was actually higher (49·25 per cent, 40 per cent.), but it seems probable that the stronger dosages exercised some deterrent or toxic effect (34 per cent, 23·8 per cent.).

(iii) The close agreement between the figures for treatments 4 and 5 (same dosage) suggests that the measure of the control achieved (reduction of chafered plants from 38 per cent. to 22·4 per cent.) is approximately accurate. There were, however, traces of injury to the seedlings, so that it is not likely that the chemical could safely be applied more liberally even prior to sowing. The results of an experiment carried out in the Delamere nurseries proved that it cannot be applied after germination without severe scorching of the seedlings while its repellent effect on the oviposition of *Phyllopertha* seemed to be very slight there. At any rate those constituents which cause damage to the plants must be eliminated or watered down before it can bear further trial.

(iv) No estimate has so far been possible of the population of *Serica* larvae (of either generation) in the several plots, but there may be facilities for this when the seedlings are lifted.

3.—Projected Work.

(i) *Chemical Control.*

While it is clear that the past season's researches have not brought to light any effective chemical either for the purpose of repelling the beetles or of killing the larvae, yet the search for such an agent must not be given up. There are other untried products possessing insecticidal constituents and those already tried prove that partial results may be achieved. There is foundation for the hope that some fresh, more toxic, substance may be discovered, or that the efficacy of those already tried may be increased, when more is known about their properties and about the habits of the insects. It is proposed, therefore, in co-operation with Imperial Chemical Industries, to try out a variety of products on a small scale to begin with and then, if any give encouraging results, to study their action thoroughly and give them a more exacting trial in the field. Details of experiments projected will be furnished in due course.

Notes.—An experimental application of naphthalene was made in Nagshead Nursery, Forest of Dean, by the local authorities on a vacant piece of ground sown with a catch crop. The object was to deter *Phyllopertha* from laying her eggs on the treated sections, but on examination in September only 27 *Phyllopertha* larvae were extracted from the whole area including controls, so that no result could be obtained. The naphthalene dressing (of respectively, 1 oz., 2 oz., and 3 oz. per square

yard) did not harm the plants but did not affect the considerable population of large *Melolontha* grubs in the beds.

(ii) *Biological Control.*

There are a good many points in the life-histories of the four chafers associated with forest nurseries which require elucidation, some of which, although small, are of practical importance.

General :

(i) Approximate periods of emergence and influence upon these of latitude and spring weather.

(ii) Average number of days taken, after emergence, for the ripening of the egg. In cold weather, when the beetles do not feed, may this be greatly prolonged ?

(iii) Is only one batch of eggs laid, or is a second, and possibly a third batch of eggs matured after the first series has been laid ?

(iv) Depth at which the eggs are laid in different soils and more particularly in nursery seedbeds.

(v) Soil and vegetation which attract the beetles for the purpose of egg-laying.

Naturally, all of these points must be separately investigated for the four species.

Melolontha :

(i) Is the 1930–34–38 series of swarm years general throughout the South and Midlands.

(ii) In the North and in Scotland, where *M. hippocastani* is presumably the species commonly encountered, what is the length of cycle and are swarm-years discernible ?

(iii) What is the behaviour of the newly hatched larvae, and what food do they prefer ?

Rhizotrocus :

(i) Is the life cycle always one of three years and are swarm-years discernible in England ?

(ii) What habitats do the beetles affect, and why have they been comparatively scarce in forest nurseries now for some years ?

Serica :

In what habitats is *Serica* found, and is it bound to any particular type of vegetation (*e.g.*, oakwoods, bracken) or to special soil conditions ?

Phyllopertha :

(i) Range of movement of the beetles and larvae.

(ii) Identity and biology of Tachinid parasite found at Delamere.

Schedule showing the State of our Knowledge of the Life-histories and Habits of the Chafers.

——	Melolontha.	Rhizotrogus.	Serica.	Phyllopertha.
1. Length of cycle.	4 yrs. (? Rarely 3 in south).	3 yrs. (? Rarely 2 in south).	2 years.	1 year.
2. Swarm-years.	1930, 34, 38, etc., in south.	—	Apparently even years in F. of Dean.	—
3. Approximate date of emergence.	May 6 (in south).	July 1 (in south).	July 3 (in south).	June 1 (in south).
4. Approximate period of flight.	—	—	—	—
5. Pairing.	Few days (2-5) after emergence probably after feeding.	—	—	—
6. Date of first oviposition.	2-3 weeks after emergence.	—	—	—
7. No. of series of eggs.	? Disputed whether second egg-laying rare or general.	Normally one.	Normally one.	? Probably one.
8. Approximate depth where eggs are laid.	Grass turf ½-2 in. Stony soil 2-10 in. Nursery bed 10-20 in.	Grass turf 2-3 in. (Light soil).	2-5 in. in light soil (under grass turf).	1-2 in. in turf, deeper in seedbeds.
9. Soil, vegetation, etc., attractive to beetles.	—	—	Sandy soil.	Grass or clover.
10. Number of eggs.	1st series 20-25. Average total ?	1st series 20-35. Average total 20-35 ?	1st series 15-25. Average total 15-25 ?	1st series 10-25 ? Average total ?
11. Time of flight.	? 9-10.30 p.m. B.S.T.	8-30 - 10 p.m. B.S.T.	9-30-10.30 p.m. B.S.T.	Sunlight.
12. Food plants.	Broadleaved trees, oak, alder, apple, chestnut, cherry, walnut, plum, maple.	—	Bracken.	Fruit trees, rose, etc.
13. Habitats.	? Chiefly wooded land.	Chiefly fields ?	Chiefly woodlands ?	Chiefly grassland.

ROYAL SCOTTISH FORESTRY SOCIETY.

1936 Meeting.

By L. E. MacIver.

The 54th annual excursion of the R.S.F.S. was held on 8th to 12th June, 1936, with headquarters at Edinburgh.

The first day of the excursion was occupied in a visit to the timber sheds and wagon-repairing shops of the Fife Coal Company at Cowdenbeath. It was interesting to see the manufacture of composite pitprops by the fitting of hardwood cores into slightly tapered steel tubes. Any species of hardwood is used for these centres, and the props are of various lengths and diameters in sizes very similar to the softwood props now being turned out by the Forestry Commission. The cores—all those seen being home-grown beech—are delivered to the colliery company sawn out in octagonal shape and after being turned to the round in a lathe are fitted by hand into the steel tubes. The timber used by the Company including these steel-cased props and sleepers is 82 per cent. foreign and 18 per cent. home-grown.

At the Aitken Colliery belonging to the same company stocks of peeled props, foreign and home-grown, were inspected. Here we were informed that 92 per cent. of foreign and 8 per cent. of home-grown are used. After seeing those in the stacks, I was surprised that any home-grown were used at all. I understand this poor lot came from a private estate in the north of Scotland. The foreign props were a very fine lot and at our best we could not compete with them for looks but the mining agent said that it has been proved by mechanical tests on the surface and by prolonged underground tests under hard conditions that when properly manufactured and seasoned home-grown props are equal to the best from abroad. Of the two important things, preparation and seasoning, I believe the latter to be slightly more important than the former.

The morning of June 10th was spent at the Eastern Sawmills, Leith, belonging to Messrs. Park Dobson & Co., and at Dickson's Nurseries, Craigmillar. At the sawmills extensive stocks of redwood, pitch pine, Douglas fir, yellow pine, cedar, mahogany, oak, teak, cottonwood and other timbers were on view. Seasoning methods in the open, under cover, and by stove drying were noted. An exhibit of home-grown and Empire commercial timbers specially collected for the occasion and arranged as far as possible geographically was also inspected. Nearly all the well-known and many of the less-known softwoods and hardwoods of the world appeared to be there. At Dickson's Nurseries of about 100 acres large stocks of ordinary forest trees were seen. It is evidently a good nursery on light soil and a good type of plant is turned out.

On the following day the party travelled to Dawyck near Peebles, the property of Mr. F. R. S. Balfour. The woods extend to about 2,000 acres, altitude between 700 and 1,500 ft., average rainfall 36 in. per annum. The present crops are mostly under 30 years of age. This was by far the

most interesting day of the tour, thanks mainly to the clear and vivid description of everything of note and the history of all the plantations and special trees encountered on the walk, given by Mr. Balfour who personally conducted the party. On starting off we saw near the house the surviving five of the first larches planted in Scotland in 1725, one of the first horse chestnuts planted in Scotland in 1650, some late 17th century silver firs, beech and sessile oaks of 1720–30 (fine trees) and specimens of the Dawyck fastigiate beech which never bears seed, all still flourishing.

Almost the first thing seen in the plantations was about three acres of *P. trichocarpa* planted at 6 ft. spacing, 12 years old, cleaned up but not thinned. The object of the spacing and treatment was pitwood, but the experiment has been almost a complete failure, the trees have not developed, and are not straight enough for pitwood. It is an interesting lesson showing that close spacing of poplars will not do.

In turn we saw 20–30 acres of S.S. and N.S. on the higher slopes planted P.26. Very little damage had been done by the May frosts of 1935; a small belt of C.P. and *A. grandis* with a group of monkey-puzzle, and several acres of hybrid larch, also P.26. We then inspected a plantation 21 years old, at about 900 ft., of *Pinus monticola*, a mixed plantation of *Tsuga heterophylla*, *Picea Engelmannii*, *Cupressus nootkatensis*, *Abies nobilis*, etc., an area of *Picea orientalis* and 1½ acres of Chinese spruce (*Picea asperata*), the latter, grown from seed collected in 1909, was stated to be the only plantation of this species in Europe. A good deal appears to have been done in growing these less familiar exotics under forest conditions. The younger plantations otherwise are mostly S.S. The Chinese spruce is notable for the dense branching habit of the trees. Special attention to the *Pinus monticola* plantation was invited by Mr. Balfour, who predicted a great future for this species, and said he recommended the Forestry Commission to grow it. The plantation certainly showed vigorous, healthy growth, and on account of the toughness of the branches would seem to be immune from snow damage. On the other hand there was an absence of self-cleaning.

Specimens of nearly all the world's spruces and most of the world's firs and larches can be seen on this estate.

On the Dalkeith Estate being visited we were informed that the total area of woods was 568 acres of which amenity woods accounted for 98 acres. The age classes of the economic woods are as under :—

1–20 years, 152 acres; 21–40 years, 50 acres; 81 and over, 268 acres. The absence of middle-aged woods will be noted, and to counteract this the general policy being followed is to fell and replant about ten acres a year of the old woods so that in 10 to 15 years the excess of these will have disappeared, and the areas now in the 21–40 years class will have filled the gap in the middle-aged woods. The woods are at a low elevation, mostly between 160 and 200 ft.

Near the avenue is an oak wood with 110 years' old standards, and an understorey of yew, holly and suppressed spruces. In one part there is a group of Black Italian poplar 25 years old, thinned to about 30 ft.

spacing and now showing an average height of 66 ft. This very promising patch contains good clean stems.

Northside wood consists of oak standards 110 years old heavily thinned 23 years ago and underplanted with beech and hornbeam. The underplanting so far as the beech is concerned is considered to have been a complete success. I am not so sure of this though undoubtedly there has been great improvement. The beech have not formed the height one would expect for their age, but have formed a dense canopy owing to the 4 ft. spacing. On the floor is an unusual thickness of raw humus in comparative darkness. Viewed from the outside of the wood one sees that many of the trees are dying and others are unhealthy. In my opinion a lower density of underplanting on this particular soil would have been all to the good as by admitting more light there would have been greater activity amongst the soil bacteria, less root competition, and better development in the crown and stems of the oaks. I think there is not perhaps, in general practice, sufficient study given to the effect of diffused light in plantations.

After seeing other hardwoods we came to a plantation in Lugton Haugh of about 12 years of age consisting of a mixture of 33 per cent. each of sycamore, ash and E.L. I was much impressed by this plantation with the three species all growing at the same rate. The spacing is about 6 ft. and the plantation gives a perfect picture of what I consider a plantation of this mixture should look like at this age, with the proper amount of light getting through to preserve the right balance of competition between root and shoot. I think one of the most striking features of this estate is the astonishing success of sycamore. It grows and flourishes everywhere and outstrips beech. From figures issued relating to plantings carried out in the last 25 years following fellings 50 per cent. have been in hardwoods (22 per cent. beech, 8½ per cent. sycamore) and 50 per cent. in larches (29 per cent. J.L.).

The week was a pleasant one of considerable value on the instructional side. It is good to be able to get away from the rut of one's everyday work and to meet and exchange ideas and experiences with others. I am very glad to have had, and much appreciate, the opportunity given me by the Commissioners of attending this meeting.

ASSESSMENT OF CHECKED PLANTATIONS.

(Silvicultural Circular No. 16 issued November, 1936.)

It is often difficult to decide from an ordinary inspection whether a backward plantation is emerging from or going deeper into check, or to decide whether a given method of treatment, such as additional drainage, is having any immediate effect.

The method of assessment described below will usually throw some light on such questions. It is based on the principle that it is possible to determine whether individual plants have moved at all and, if so, for how many years the movement has been in progress. With the most typical of checked plants—the spruces—the first sign of movement is the change of the foliage from short, yellow needles to long, dark green ones. We can say that such a plant has " moved one year ". Thereafter the plant may be expected to make annual shoots of appreciable length and one such shoot means " moved two years ", two shoots " moved three years ", and so on. There may be some doubt as to whether the greening and return to normal length of needle takes one year or longer, but the point is of minor importance.

A representative plot containing 200–500 trees is marked and the number of " moved one year ", " moved two year ", etc., checked plants and dead (or blanks) plants counted. For convenience these figures are worked out as percentages of the total number of trees originally planted.

Attached are some figures obtained by Mr. James Fraser from plots in Glenhurich Forest. A first assessment was made at the end of the 1934 growing season and repeated the following year. Let us examine those for Plot No. 4 N.S. planted in P.25. Considering first the 1934 assessment, 4 per cent. of the trees were " four years moved " the plantation then (four years ago) being seven years old : thus in the first six years there was no sign of movement at all. In the eighth year 15 per cent. more started to move, in the next 11 per cent., and in the next 27 per cent., so that in all 57 per cent. had moved by the end of the 1934 growing season leaving 42 per cent. in check, of which 12 per cent. are stated to have " gone back ", that is, are in a worse condition than the " checked " plants, while 1 per cent. was dead or missing.

On casual inspection such a plantation is a depressing sight, and apt to be condemned out of hand. If, however, the above figures are plotted in such a way as to bring out the cumulative changes there is seen to be ground for hope*. The data are arranged for plotting as shown in the table on page 53. If the curve had been drawn after the 1934 assessment and projected for 1935 the result would have been very similar to what actually occurred. If we project the curve for 1935 for 1936 we find that the remaining 11 per cent. of checked plants may reasonably be expected to move.

* The graphs which were issued with the Silvicultural Circular are not reproduced here.

Record of Checked Plantations.

Glenhurich Forest.

Plot No. Species. P. Year Compt.	Year of Assessment (End of growing season).	Moved.					Backward.			Dead or Blank.	Total No. of Plants counted.	Remarks.
		4 years.	3 years.	2 years.	1 year.	Total.	In check.	Gone back.	Total.			
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.		
(1) S.S. Planted in P. 32 on mounds C. 35.	P. 34	—	3	3	31	37	40	9	49	14	116	
	P. 35	3½	3	9½	30	46	28	10	38	16	116	
(2) S.S. P. 27, C. 35.	P. 34	—	6	3	14	23	60	11	71	6	116	Gone back plants have recovered.
	P. 35	2½	9	9	32	52½	41½	—	41½	6	116	
(3) S.S. P. 27, C. 36.	P. 34	5	3	10	11	29	26	30	56	14	97	Gone back plants have probably recovered.
	P. 35	11	12½	8	13½	45	30	12½	42½	12½	97	

Age of Plantation (Years).	Percentage Number of Plants which first " moved " in the Year.	Total Percentage Number of Plants which had " moved " by the end of the Year.	Remarks.
1	nil	nil	From first assessment 1934.
2			
3			
4			
5			
6			
7	4	4	
8	15	19	
9	11	30	
10	27	57	
11	21	78	From second assessment 1935.

It will be seen that a proposal to beat-up the area in P.35 was at least premature because the beat-ups would lag behind the plants which were either just moving or getting ready to move.

There are some anomalies in the 1935 figures for the plot, *e.g.*, how was it possible to have 23 per cent., four-year moved plants, but these are probably due to a slight change in standard in fixing the categories in the second assessment.

Divisional Officers should establish plots in their checked plantations, recording them in the above manner. The position of the plots or strips should be marked on the ground and entered on the forest plans. About 400 plants should be observed in each case.

R. L. R.

Plots were first set out in January, 1935. The ends of the lines taken were marked. Re-assessment was made in March, 1936 when each plant in the lines was marked.

Definitions :—

A checked plant has lost its original colour; its needles are abnormally short and its shoot growth is short, *viz.* less than one half inch.

A " gone back " plant is a checked plant that has begun to lose its short discoloured needles.

A " 1-year-moved " plant is a plant that has recovered needles of normal length even if there is no measurable shoot.

SAND-DISTRIBUTING MACHINE.

By J. A. B. MACDONALD.

Reports on this machine have now been received from all three Scottish Divisions. Generally the machine has proved very satisfactory for the distribution of coarse grit and road metal chips of about ¼ or ⅜ inch in size. Dry sand is sown easily but it is very difficult to obtain medium or fine sand which is at all dry.

The Divisional Officers' reports contain much interesting information regarding the results obtained in beds covered with : (*a*) nursery soil; (*b*) sand; (*c*) coarse grit, and (*d*) road metal chips, but direct comparisons between the distribution of these materials by the old methods and by the distributor are often lacking. Possibly the most interesting item in all the reports comes from the North-Eastern Division, where it is estimated that the time taken to cover beds by the machine (with grit) is only one-sixth that taken by hand. The loaded machine is heavy to push, and pneumatic-tyred wheels would be a great improvement.

EXTRACTS FROM INDIVIDUAL REPORTS.

(a) *The Northern Division.*

Inchnacardoch. In a comparison between the germination of Sitka spruce in beds covered with (*a*) sand by machine or hand, and (*b*) earth-covered, cuffed beds, there is over all a one-and-a-half per cent. advantage in favour of sand-covering, which is clearly not significant. With Norway spruce there is a five per cent. result in favour of earth-covered beds—again probably insignificant.

South Laggan. There was a 17 per cent. advantage in favour of sand-covering in this nursery. South Laggan soil is much heavier than that at Inchnacardoch.

In the Division it was found that the method of applying sand appears to have no significant effect.

The machine worked well when it was given chips or shingle to sow. It was unsatisfactory for the type of sand used at Inchnacardoch which tended to cling together if the slightest bit damp. Distribution was therefore uneven. Strengthening of the bottom plate above the roller of the machine, which tends to bulge outwards when the hopper is fully loaded, is suggested.

(Inchnacardoch). Mr Peirse is not convinced that sand from pits near the nursery has any value as a covering for seedbeds in that nursery. The nursery soil is naturally light and not inclined to cake. Moss does not tend to form and it is never difficult to extract weeds. There is no evidence that growth or numbers are appreciably increased by sand-covering. Chips have not been tried.

South Laggan. Covering with shingle seems definitely advantageous—more seedlings per square yard; better growth; less cracking of beds; less growth of moss; easier pulling of weeds. Mr. Peirse advocates the

covering of seedbeds with this type of shingle applied by the machine. (For this nursery.)

Mr. Fraser remarks (Inchnacardoch)—" The result is surprising when set against the results of the previous year which showed a definite advantage in favour of the covering with sand. . . . In the two years the same sand was used. This sand is probably not very different from nursery soil, except in humus content."

The Division will try the small gravel (shingle) already used at South Laggan, in Inchnacardoch Nursery next year.

Mr. Fraser remarks that cuffing appears cheap and satisfactory in this (sandy) nursery, and that a very big advantage would be necessary to make general covering with gravel repay the expense.

(b) *The North-Eastern Division.*

Machines were used at both Craibstone and Newton Nurseries. In both cases satisfactory results have been obtained: " The machine is easy to manipulate, and the distribution of the sand-covering is more even than can be obtained by manual labour. The depth of covering can be readily adjusted. The machine shows no sign of mechanical defects. No exact comparison of costs is available, but it is estimated that the machine can cover in a given time about six times the area formerly dealt with by hand. The machine was not efficient in the distribution of sand unless the latter was thoroughly dry. If the sand is moist, distribution is uneven."

Dr. Steven adds :—"At Craibstone $\frac{3}{8}$ in. granite chips were used and distribution was even and satisfactory, one ton of grit covering approximately 120 square yards of Sitka spruce and European larch. Improved results were obtained by the use of the grit, germination being a little earlier and more even. When loading the grit into the hopper it was found to be an advantage to pass through a $\frac{1}{2}$ in. riddle to keep out any large pieces of stone which tend to jam between the rotating prongs and the side.

" At Newton the natural granitic grit ex Glenmore was used. This is a smaller grit than that used at Craibstone averaging about $\frac{1}{4}$ in., and it covered approximately 130 square yards to the ton on Sitka spruce which was appreciably improved through its use. We have another type of grit which is broken Spey grit somewhat larger than the Glenmore grit, and trials have shown that it will cover approximately 95 square yards to the ton. It is estimated that the time taken to cover beds by the machine is only one-sixth that taken by hand. At Newton it was found that the machine would be improved by having a heavier metal plate as a check against the flow of chips. The bulging which has taken place on this plate is probably due to the lodging of larger pieces of stone. It would also be useful to have an indicator disc on the regulating bolt plate."

(c) *The South-Western Division.*

Tulliallan Nursery. The machine proved quite incapable of distributing sand of the type and in the condition used at Tulliallan, but worked excellently with ¼ in. whinstone chips. The sand could not be got or kept dry, and consequently there was cavitation or arching in the hopper resulting in the partial stoppage of the flow from the hopper. Mr. Sangar suggests the machine would handle such sand better if the shape of the hopper were altered or if more effective stirring arrangements were introduced. Results with the distributor are in no way inferior to riddle covering. The saving in time is very definite.

Mr. Sangar makes one important point, *viz.*, that the chip-covered beds are much easier to weed and to keep clean than the sand or soil-covered areas. Very complete counts were made on beds covered with different materials at Tulliallan. Soil and sand were applied by riddle, but in almost every case the chips were applied by the distributor. The following notes may be of considerable interest :—

Sitka spruce.—The average output per sowing was :—

Soil	14,000 per lb.
Sand	22,000 ,,
Chips	22,000 ,,

A comparison of directly comparable sowings shows the average out-turn to be : soil 10; sand 18; chips 21, where the three coverings were used side by side. The few cases in which a light covering of sand or chips was employed instead of the normal covering suggests that on the Tulliallan soils a good depth of covering (sand or chips) is necessary.

Norway spruce.—In general the increase due to the use of foreign covering material is much less marked than with Sitka spruce. For eight sowings made with each of the three coverings average output was :—

Soil	8,250 per lb.
Sand	8,750 ,,
Chips	9,250 ,,

In comparing soil with chip coverings alone, however, chips give on the average 25 per cent. more seedlings, while sand coverings show 16 per cent. higher out-turn than comparable soil coverings.

Scots pine.—For all sowings the average output was :—

Soil	7,000 per lb.	
Sand	9,000 ,,	
Chips	19,000 ,,	normal.
Chips	7,000 ,,	light.

Few of the sowings are, however, directly comparable, and the high " chips " out-turn may possibly be due to early sowing—dates were not available.

Japanese larch.—The average output per sowing was :—

Soil	1,000 per lb.
Sand	9,000 ,,
Chips	8,000 ,,

The remarks made in the case of Scots pine (above) apply here also.

Douglas fir.—Five comparable sowings gave as average output :—

Sand	12,000 per lb.
Chips	16,000 ,,

European larch.—In four directly comparable sowings the average output was :—

Soil	1,900 per lb.
Sand	3,150 ,,
Chips	3,100 ,,

Over all, however, the grand averages were :—

Soil	2,200 per lb.
Sand	4,600 ,,
Chips	4,200 ,,

BATH AND WEST SHOW AT NEATH, 1936.

By W. D. RUSSELL.

Since the Commission now stages exhibits at only a limited number of Agricultural Society Shows some account of the nature of the exhibits at Neath and the work entailed in their erection may not be out of place.

Neath is situated in Division 3, but owing to pressure of work in connection with the Special Areas the task of organising the exhibit was given to Division 7, where the facilities afforded by the Forest Apprentices' School are useful for such a purpose. The Special Areas Scheme further influenced the matter in that it was decided to give the Commission's exhibit a definitely Welsh aspect supported by statistics and plans of the Department's activities in that part of South Wales centring on Neath. This last was achieved by the provision from Headquarters of a large and exceedingly well-done poster giving some facts and figures of the Commission's normal activities in South Wales together with a brief outline of what the Special Areas afforestation scheme would be likely to mean to South Wales in the way of employment, both temporary and permanent. This poster was supported by a map showing all the existing estates of the Forestry Commission in the area in question.

When it became known that this poster and map were to be supplied we decided they should be the centre-piece of the bench space, 30 ft. of which was available. At the same time plans for the other exhibits were completed and submitted to Headquarters. On the bench the poster and map were to be flanked by an exhibit depicting the trees commonly planted by the Forestry Commission, in seed, seedling and transplant stages; by cages of forest insects; a large showcard drawing attention to a rabbit (stuffed) and a box of matches as "The Worst Enemies of Forestry"; together with sundry small specimens of general interest. The *pièce de résistance*, however, was to be a model, approximately to scale, of "A Section of a Typical Welsh Afforestation Area" to cover an area of about 375 sq. ft. and to be not less than 6 ft. high at the highest point.

As soon as approval was given by Headquarters to the proposals the preparation of material was put in hand. For the model this meant wrapping the roots of the necessary quantity of seedlings in sphagnum moss and lining them out in the nursery, so that they could be lifted and planted in May; making a very small-scale rabbit and stock fence with field gates, a model F.W.H. bungalow, outbuildings, etc. Some 7,000 seedlings of various species were prepared, netting 3 in. wide and $\frac{1}{4}$ in. mesh was obtained for the fence, larch was split to make fence stakes and posts and model gates, complete with hook and eye hinges, were constructed. At the same time the bench exhibits were put in hand, posters were painted and showcards printed.

Several days before the Show was due to open a party went to Neath to begin the building of the model. The 375 sq. ft. for the model had been boarded off in a corner of the gallery by the Show authorities, with

the outer boards cut to the contour of the model and some five or six tons of soil had been dumped in readiness. It was immediately apparent that much more soil would be required as well as other kinds of material to fill up space and raise the contours to their correct elevations. The Show authorities helped with three water tanks of about 20 cubic ft. each, more soil and several loads of batten ends, etc.; but still more was required. Every garage and petrol filling station in Neath and neighbourhood was visited for empty oil drums; empty boxes were purchased or otherwise acquired; loads of turf were picked up in the show-yard and disappeared into the insatiable maw of this vast space. Additional loads of soil were obtained, by means best left undescribed, and laboriously shovelled on to the ever-growing model. Then, when the high places had been built up at last, we began the shaping of contours, laying of turf for mountain top grazing land, erection of fences around the planting areas, building of rocky escarpments, making of roads and so on. As soon as the outlines were completed and the bulk of the construction done, planting began on the mountain sides, the moss-wrapped seedlings being planted into several inches of soil, with trowels. Gradually the model began to take shape as plantation followed plantation, rides, firelines and compartment boundaries were completed and a stream down the valley made (with cement, blue distemper, sand and gravel). Until, near the front of the model, we had reached the stage of erecting the F.W.H. bungalow and outbuildings within fenced-in fields. Next came the final touches of a bridge across the stream for access to the F.W.H., and the stocking of the holding with sheep, lambs, cows and poultry—little metal toys obtained in the ubiquitous Woolworths. This completed the building of the model, which, in its finished state, fortunately gave no indication of the nature of the " sub-soil " on which the flourishing plantations were growing.

Dressing the bench space, which by this time had been extended to over 50 ft., was child's play compared to building the model. Much of the space on each side of the poster and accompanying map was taken up by the exhibit depicting the chief types of trees planted by the Forestry Commission, composed of normal transplants (in pots), boxes of germinating seedlings and trays of seed. This exhibit had given a little trouble in getting the seedlings forward to the desired stage and on the night before the material was removed from Parkend to the show-yard, some of the notorious Forest of Dean sheep had broken into the School-yard and eaten the hardwood transplants. Replacements were obtained, but they failed to survive transplanting, which meant that on the day before the Show opened one of the local areas was called upon to produce good transplants of the missing species, " ex plantations ".

Also on the bench were several glass-fronted cages containing forest insects, *Hylobius abietis*—about 3,000 actively engaged in feeding on Scots pine—*Tortrix viridana* caterpillars at work on oak, cockchafer adults and larvae in a cage with seedlings growing in a bed of soil. Full credit must be given these creatures for entering into the spirit of things. They " did their stuff " remarkably well, the weevils feeding industriously

until the last day when they unaccountably died despite tempting tit-bits of freshly cut and resinous Scots pine; the chafer larvae feeding on the seedlings caused much amusement by the manner in which they made the plants rotate in the soil, as did the tortrix caterpillars busily engaged in leaf-rolling. One of the lighter moments of the Show was occasioned by the tortrix. Along with the caterpillars had been put in several specimens of the predatory beetle, *Silpha quadripunctata*, fairly common in the Forest of Dean, and an enemy of tortrix caterpillars. One afternoon some excitement before the cage drew my attention to three youths watching a beetle pursuing a caterpillar while they betted frenziedly on the result of the chase. Twopence changed hands because the caterpillar, when out on the end of a twig and apparently without hope of escape, spun a thread of silk and suspended itself about two inches below its enemy.

Considerable interest was shown in the various exhibits during the period of the Show and many questions, relevant and otherwise, had to be answered. A special pamphlet published for this Show proved so popular that its distribution had to be rigorously controlled. The Commission's leaflets also disappeared rapidly, and one suspects that many of the seedlings which this spring will be appearing in Welsh gardens owe their existence to the forestry exhibit at Neath.

FIRES ON COMMISSION PROPERTY: SOME STATISTICS.

By H. CHARTERS.

From 1929 the Commission has kept a record of all forest fires, and a few notes on some statistics compiled unofficially from it may be not without interest. (New Forest and Dean Forest are not included.)

During the eight years 2,650 fires were reported. Fortunately only one half of this number caused damage to the plantations, the others having occurred on unplanted or adjoining land. Nevertheless 7,800 planted acres were burnt with a loss approaching £100,000. An examination of the causes of these fires gives the following figures :—

Cause.	*Number.*	*Percentage.*
Railway engines	1,500	57
General public	400	14
Adjoining land	300	12
Road engines	110	4
Incendiarism	40	2
Other causes	100	4
Causes unknown	200	7
	2,650	100

Of those cases in which origin is unknown and those in which fire spread from adjoining land it is probable that a considerable number was caused by the general public.

The effect of rainfall on the incidence of fires is clearly shown from the following statistics :—

Year.	*Rainfall (inches).*	*Number of Fires.*
1930	29	150
1931	25	190
1932	23	270
1929	22	300
1934	21	450
1933	17	550

It has been found that on the average the worst months for fires are March, April, and July; as many have occurred in these three months as in the remaining nine. October, November and December are almost free from fires.

The risk of fire on Commission properties in England and Wales seems to be twice as great as that in Scotland.

Statistics show that fires increase in number with the age of the plantation up to 5 years, and then gradually decrease.

Age of Plantation. (*Years*).	*Average Frequency per* 10,000 *Acres at Risk.*
1	4
2	7
4	9
5	10
6	9
8	6
10	6
12	4
14	3

The average extent of fires also increases with the age of the plantation, the greatest size being reached in 9-year-old plantations.

Age of Plantation. (*Years*).	*Average Area.* (*Acres*).
1	2
2	5
4	6
6	6
8	9
9	10
10	9
12	7
14	7

Fires definitely or probably caused by the general public were responsible for nearly two-thirds of the total damage sustained. Although railway fires were by far the most numerous they caused less than 10 per cent. of the damage, *i.e.*, no more than was caused by incendiarism.

The average amount of damage per fire increases with the age of the plantation up to nine years; thereafter it tends to diminish owing partly to the older trees being less liable to be totally destroyed.

Age of Plantation. (*Years*).	*Average Amount of Damage.* (£)
1	6
2	36
4	59
6	64
8	117
9	159
10	158
12	113
14	133

Three characteristics of fires in plantations of various ages may be tabulated as follows :—

Age of Plantation. (*Years*).	*Number.*	*Size.*	*Damage.*
1	Few	Small	Little
2	Average	,,	,,
3	Frequent	,,	,,
4	,,	Average	,,
5	,,	,,	,,
6	,,	,,	Average
7	,,	,,	,,
8	Average	Large	Great
9	,,	,,	,,
10	,,	,,	,,
11	Few	Average	,,
12	,,	,,	,,
13	,,	,,	,,
14	,,	,,	,,
15	,,	,,	,,

It seems indicated that plantations 3 to 7 years old should be particularly well patrolled owing to the frequency with which fires occur, and that there is also great danger in plantations of 8 to 15 years of age.

Rates of insurance necessary to cover losses would vary considerably for plantations of different ages as may be seen from the following table :—

Age of Plantation. (*Years*).	*Average Loss per Acre.*	*Rate of Insurance* (*per* £100 *Value*) *necessary to cover Loss.*
	s. d.	s. d.
1	– 1	– 7
2	– 6	4 –
4	1 –	7 –
6	1 2	7 –
8	1 6	7 6
9	1 10	10 6
10	1 9	8 –
12	1 –	4 –
14	– 11	3 6

To meet losses the Commission has created in its accounts a reserve based on the total cost of its plantations. To 1934 the rate charged was 2s. 6d. per £100 per annum; in 1935 it was increased to 4s. 0d. During the period 1929–35, although the amount reserved was £40,000 it proved insufficient by £27,000. Had the rate been 4s. 3d. per cent. throughout, the losses sustained would have been just covered.

ROTATION OF NURSERY CROPS.

By B. GALE.

Centuries of agricultural and horticultural practice have evolved recognised systems of crop rotation which fulfil the object of maintaining soil fertility. This is a broad term as it implies a number of things. A few are :—(i) ensuring that the soil is not denuded of any particular constituent ; (ii) bringing the soil into the best possible condition as regards texture for the crop in view, or alternatively, choosing the crop in view according to the state of the soil left by the previous crop; and (iii) reducing costs by using weed-destroying crops, or in cases where the amount of weed renders the cost of weeding prohibitive, summer fallowing and burning.

Nursery crops, varying less in their requirements and habits than farm or garden crops, do not offer the same possibilities in results, but there is nevertheless a field for study in their rotations. Some species are more exacting in their requirements as regards quality, in others the texture is more important. Some have weed-destroying capabilities, others encourage weeds. These variations give an indication of the probable condition of the soil after the crop has been lifted and the succeeding crop can often be chosen accordingly. A few examples noticed are :—

1. *Weed-destroying Crops.*—Two-year conifer seedbeds, bedded-out stock, E.L. and J.L. lines and most other conifer lines in a lesser degree.

2. *Weed-encouraging Crops.*—One-year conifer seedbeds, oak and beech seedbeds, especially where undercutting is done as this destroys the top tilth, which usually cannot be recovered. Norway spruce and beech lines encourage couch grass which becomes entangled in the wide-spreading fibrous root system and cannot be removed by normal hoeing.

3. *Exhausting Crops.*—Douglas fir, larches, oak, ash and beech. The last-mentioned most probably denudes the soil of lime.

4. *Effects on Texture.*—Oak seedbeds or lines usually leave the ground closely packed and sour as the moist conditions suitable at the time of spraying are unfavourable occasions for trampling the soil. Beech and N.S. if well grown prevent access of sun and air to the soil and a similar effect results.

5. *Manuring Crops.*—Lupin leaves the soil open in texture and clean (in addition to its manurial value) after digging-in, but the winter fallowing which follows results in the soil settling to a more compact mass and where seed sowing or lining-out is done under sticky conditions, the soil is too dense to permit the development of good root systems. The only palliative is an expensive re-creation of tilth. The following of lupin by a winter crop such as rye or mustard to be dug-in in spring might produce ideal seedbed conditions by providing improved drainage and aeration. The same applies where potatoes are grown as a cleaning crop. Other root

crops if well manured leave the soil in good heart but closely packed and difficult to work-up to seedbed condition.

Certain practices seem to have been proved uneconomic and as such have been dismissed from good husbandry. Among them are : (i) a long succession of crops of the same type ; (ii) the production of crop and weeds in about equal quantities ; (iii) removal of soil, either with the crop or weeds, and (iv) planting or sowing under sticky unsuitable conditions.

The ultimate aim in the cultivation of any crop, is the production of the best possible plant with the minimum of expense, at the same time leaving the soil in a suitable condition for the next crop. It may therefore be possible to adapt some of the accepted rules of sound husbandry to our own purpose as they apply equally to trees and turnips.

CROWN FORESTS IN THE REIGN OF GEORGE III.

By N. W. Perry.

The Library has recently acquired a very large volume binding together the reports of the " Commissioners appointed to enquire into the state and condition of the woods, forests and land revenues of the Crown, and to sell or alienate fee farm and other unimprovable rents." There were three Commissioners, land surveyors, namely Charles Middleton, John Call and Arthur Holdsworth. They met from 1787–1793, during which time they presented seventeen reports.

The third of these reports is of interest as it deals with the " importance of preserving and protecting those nurseries of timber for the support of the naval strength of the Kingdom." The large-scale felling of the privately owned oak forests was deplored as the land was then usually given over to agriculture rather than replanting, owing to the more immediate profits. As the soil of the Forest of Dean " has always been deemed peculiarly adapted to the growth of oak and the quality of the timber produced there superior to any other," the history of this forest is given at great length. In the reign of Queen Anne it was thought the forest had been in its best state. From that time onwards it was much misused; trees were needlessly damaged, in many cases by those working the mines; thefts of timber took place with very little check, and those in charge of the forest often abused their privileges. The Commissioners interviewed the foresters and woodmen and drew up suggestions for the better management of the forest.

Another report shows the state of affairs in the New Forest. This is described as having the great advantage of being near several ports such as Lymington, Bewley and Redbridge, and within easy reach of the dockyard at Portsmouth. This forest had also suffered much from maltreatment and proposals are made for its improvement.

Alice Holt, Woolmer, Salcey, Whittlewood, Rockingham, Whichwood, Sherwood and Waltham (Epping) Forests are similarly dealt with in separate reports.

It is lamented that no " general survey was ever made of the whole of the timber growing in England at any one time." In the reign of William the Conqueror the woods were " still so numerous and extensive as to be valued, not by the quantity of timber, or of what could be annually felled, but by the number of swine which the acorns could maintain." The first attack of any consequence on the timber resources of the country was made by Henry VIII who seized the possessions of the monasteries and disposed of the timber on them. As mentioned above the Commissioners viewed with alarm the shortage of timber suitable for the Navy, which existed at the time of their reports, although the demand for it was increasing. It is suggested that larch would be an excellent substitute for oak in ship-building.

The last report summarises the position generally and suggests improvements in the management of the Crown forests. Dissatisfaction was felt particularly with the faulty system of management which allowed of questionable tactics and neglect on the part of the officers in charge of these forests.

From the numerous appendices to the reports it is clear that the Commissioners carried out their task very thoroughly, had surveys made and collected detailed information from many and varied sources.

COMMISSION'S LIBRARY: NEW BOOKS.

The following books were acquired during the past year :—

" The Design of Experiments " (pp. 252), R. A. Fisher.
" Trees of Britain " (pp. 430), Barbara Briggs.
" Why the Weather " (pp. 295), C. F. Brooks.
" Welsh Timber Trees: Native and Introduced," 2nd Edition. Revised (pp. 107), H. A. Hyde.
" The Identification of Trees and Shrubs " (pp. 326), F. K. Makins.
" The Study of the Soil in the Field " (pp. 142), G. R. Clarke.
" The Dean Road " (pp. 55), A. W. Trotter.
" Wild Flowers of the Wayside and Woodland " (pp. 352), T. H. Scott and W. J. Stokoe.
" Reports 1 to 17 of Commissioners of Woods, Forests and Land Revenues, 1787–93."
" Afforestation in the Lake District " (pp. 97), H. H. Symonds.
" A Survey of the Agricultural and Waste Lands of Wales " (pp. 142), R. G. Stapledon.
" Deserts on the March " (pp. 231), Paul B. Sears.
" Applied Entomology " (pp. 405), H. T. Fernald.
" Seeding and Planting in the Practice of Forestry," 2nd Edition (pp. 507), Toumey & Korstian.
" Forest Insects " (pp. 463), Doane, Van Dyke, Chamberlin, Burke.
" Waldmoose," Wurt Forstl. Versuchsanstalt, 1935 (pp. 26).
" Astung " (pp. 138), Dr. Hans Mayer Wegelin.

A list of the Journals regularly taken was given in last year's Journal.

COLLECTION AND PACKING OF PATHOLOGICAL MATERIAL.

By W. R. Day and T. R. Peace.

For the proper diagnosis of plant disease it is desirable for the pathologist concerned to see the plant growing undisturbed in its natural habitat. Unfortunately owing to considerations of time and distance this is often impossible, and it becomes necessary for those on the spot to send material to him in his laboratory. Under these circumstances diagnosis inevitably becomes more difficult, so the sender should make every endeavour to ensure that the material arrives as nearly as possible in its natural condition, and that the specimens and the information supplied give as complete a picture as possible, not only of the extent and nature of the disease, but also of the conditions under which the trees are growing.

Choice of Material.—In making a selection of material to be sent it should be borne in mind that the ideal specimen is the whole tree and, if this is small enough to be conveniently packed, it should be carefully lifted and sent. Even if it is almost certain that only the leaves or needles are affected, it is of interest to the pathologist to be able to see for himself the condition of the roots. If, because of the size or value of the tree, only portions can be sent, these should be of reasonable dimensions and show if possible all stages of the disease. A moderate quantity of material should always be sent, if it is available, for the pathologist may require some for examination, some for culturing—in an endeavour to find a causal fungus—and possibly some for other purposes such as permanent collection, or dispatch to others interested in the disease. On several occasions we have been expected to base a diagnosis on a single leaf or the dead end of a twig. Few doctors would be prepared to base a diagnosis on a small portion of their patient, and since the state of knowledge of forest pathology is far behind that of human disease, it is all the more necessary that the forest pathologist should be properly informed. It is absolutely essential that the material sent should be typical of the damage done; if exceptional specimens are sent they should be marked as such, and if the injury takes more than one form, specimens of each should be sent and an indication given of their relative importance. When only part of a tree is sent, a description should be given of the remainder. For instance, if the leading shoots of conifers were dying, and the trees were too large to send whole, a number of typical diseased leaders should be sent, together with notes on the condition of the branches and roots. In general a dying tree is much more valuable for diagnosis than a dead one, and dying material containing the joint of live and dead tissue is more valuable than that which is wholly dead. In the case of specimens of rotten timber the piece where sound and rotten wood meet should always be included. With trees, however, it is safer to send some specimens of dead ones as well as the diseased, for it does not always follow that the diseased trees are dying, the injury to them may be due to

some cause other than that which has brought about death. It is useful to have two or three uninjured specimens, when these can be spared, for comparison.

Description of Specimens and Site.—The specimens sent should be accompanied by information on the conditions under which the trees are growing, the age and past history of the trees, etc. Details, as accurate as possible, should be given of the nature of the soil, and the extent to which it is liable to drought or bad drainage, also of any climatic peculiarities such as excessive exposure to wind or frost. It is useful, when specimens are sent from a plantation, to give a short list of the plants in the herbage covering the soil; all available information about the course of the disease should also be stated. If the sender himself has any idea of the cause of the injury he should say so, preferably giving reasons for his conclusions.

Collecting and forwarding Material.—In summer the early morning is the best time for collection, as soft tissues are more turgid at that time and therefore less liable to dry-out in transit, but even on a hot day if material is carefully collected and quickly and properly packed it should arrive in good condition.

In the event of a large number of different specimens being sent together numbered labels should be attached, details corresponding to the numbers being given on a separate sheet. These details and any other notes on the disease and the conditions under which it occurred are probably best sent separately from the material. Letters enclosed in large packages are in danger of being discarded with the packing material. in any case details sent by letter usually precede the parcel and form a useful warning of its subsequent arrival.

The aim should be to keep material as far as possible in the same condition as it was when collected. In packing, roots should be kept wetter than the shoots. In addition dead wood or dead leaves are more liable to go mouldy under damp conditions than live wood or leaves, and therefore dead tissues should as a rule be packed drier than live ones. Specimens when small enough should always be sent in a strong cardboard box or tin, never in an envelope, which leads to drying and breaking. If the material is too big for a box, it should be protected by several layers of soft material, such as sacking or padded in damp moss to prevent damage in transit. Roots should be packed in damp moss and the tops covered but not packed in anything damp. When seedlings, the roots of which have to be examined, are being despatched it is often better to send the plants with a ball of earth around their roots, having taken them up and packed them so that the earth was never removed from their root systems. When seedlings are sent in this manner the earth should be packed in soft paper or moss, and the tops, so far as possible, protected from the earth by the same materials. Specimens of actual fungi, or of twigs with fungal fructifications on them should be wrapped in soft paper—not in newspaper which is apt to stick to specimens and cannot be peeled off—and then packed in moss to prevent breakage, and enclosed in a tin or strong cardboard box. Cotton wool should never be

used as a packing material, as it adheres to the specimen and is difficult to remove; also if a few strands are left they can be deceptively like fungal hyphae.

Material should be sent by the most rapid method of transit available provided the weight does not render this too expensive. Wood specimens can safely be sent by goods train, but live plants should be sent by a speedier method of transit.

We regret having to give so many directions, but more general attention to the selection and packing of material would benefit all parties concerned.

FORESTRY COMMISSION SOCIAL SERVICE ASSOCIATION.

England and Wales.

The following report has received the approval of the Departmental Whitley Council.

An appeal dated 22nd March, 1936, was issued officially to all members of the staff asking for regular subscription to a fund to enable a centre to be adopted. Up to date there are 116 subscribing members who have promised subscriptions at the rate of £95 per annum, and on 31st December, 1936, £72 was in hand.

After a few preliminary meetings of representative members of the staff a Provisional Committee was set up consisting of Sir Francis Acland (Chairman), Mr. W. H. Guillebaud (Secretary), Mr. F. Chadwick (Treasurer), Mr. J. Butcher, Mr. B. R. Davies and Mr. S. W. Edwards.

Communication was established with the National Council of Social Service, and after full consideration of all possible alternatives, it was recommended :—

(*a*) That Chester-le-Street, Durham, should be adopted as a centre.

(*b*) That the Provisional Committee named in paragraph 2 should be appointed with full power to carry out the scheme.

(*c*) That a banking account be opened in the name of The Forestry Commission Social Service Association and that the Secretary and Treasurer jointly be authorised to operate the account.

(*d*) That the draft rules attached be approved.

The budget for the first year is on the following approximate basis :—

	£
Handicraft materials	20
Repairs and renewals Premises and equipment	15
Heating and lighting	10
Women's section materials	5
Total	50

In addition, approximately £40 would be granted to the Durham County Community Service Council to provide instruction in handicraft, physical culture, music, drama and lectures. This payment towards instruction will enable the Council to provide the part-time services of a warden for the centre.

The above figures are given only as indication of the manner in which it is proposed to help the centre. The Committee will be guided by the needs of the centre in making grants from the Fund.

There follows the draft rules, and a report on Chester-le-Street by Durham County Community Service Council.

It is proposed to invite Mr. Hopkinson (or his deputy) to represent the Commission on the local Committee of the Chester-le-Street Centre,

and Sir Francis Acland has also promised to keep in personal touch with the work of the centre.

Draft Rules of the Association.

1. *Name.* The name of the Association shall be The Forestry Commission Social Service Association.

2. *Objects.* The objects of the Association shall be to alleviate so far as may be possible the distress occasioned by unemployment—

(*a*) By the adoption of an area, in which a centre will be erected or created, or if a centre be already in existence, will be maintained or assisted, the centre to be mainly occupational and/or educational in character, and, to a lesser degree, to provide recreational facilities.

(*b*) By such other means as may be found desirable, having regard to the general functioning of Social Service Associations in the Civil Service.

3. *Management.*

(*a*) The Association shall be managed by a Committee of six members.

(*b*) The Committee shall have power to fill casual vacancies among their numbers and to co-opt one additional member if found advisable.

(*c*) The Committee shall appoint a Secretary and Treasurer, and, subject to the provisions of sub-paragraphs (*d*), (*e*), (*f*), (*g*) and (*h*) hereof shall make rules for governing their own proceedings. All the above offices shall be honorary.

(*d*) Three members of the Committee shall form a quorum at Committee meetings.

(*e*) If at any time any difference shall arise between the members of the Committee as to the interpretation of any of these Rules, or to any other matter connected with the Association, the decision of a majority of the Committee shall be binding upon them all.

(*f*) The Committee shall have power to expend the funds of the Association for the purpose set out in Rule 2 above.

(*g*) The Committee will present an annual report to the Departmental Whitley Council and circulate a copy to all members of the Association. The Departmental Whitley Council will appoint the Committee for the ensuing year and also an Auditor.

(*h*) On a requisition by not less than 20 members a General Meeting of the Association shall be called, which may, if it is considered desirable, make recommendations to the Departmental Whitley Council. If those requisitioning the meeting desire to amend the rules specific notice of the amendments proposed shall be given in the notice convening the meeting.

4. *Membership.* Membership shall be limited to persons serving on, or who have served on, the Staff of the Forestry Commission, including Commissioners, and who have within the year made a subscription or a donation to the funds of the Association.

5. *Finance.*

(*a*) It shall be competent for the Committee to appeal for donations or subscriptions, provided always that the methods adopted for the collection of funds are approved by the Department.

(*b*) Each member of the Association shall determine the amount of his (or her) contribution to the funds of the Association. Such contribution may be by donation or, preferably, by regular subscription.

(*c*) All funds collected shall be devoted solely to the objects set out in Rule 2.

(*d*) If and when it is deemed necessary to terminate the Association, any funds that may at that date be remaining shall be disposed of to such charitable organisations as may be decided by a General Meeting of members. In this connection the claims of the Civil Service Benevolent Fund deserve to be stressed.

(*e*) Accounts shall be kept of all monies received and expended, and after audit, presented to the Departmental Whitley Council.

6. *Alteration of Rules.* These rules may be altered as shown in 3 (*h*) above, or in a case of urgency, by resolution of the Departmental Whitley Council on the recommendation of the Committee.

Durham County Social Service Association.

Report on Chester-le-Street.

Chester-le-Street lies on the Great North Road about half-way between Durham and Newcastle. It is an interesting old town with historical associations, being the original seat of the Bishops of Durham. No doubt for this reason and because it is a convenient halting place for travellers it has an air of enjoying greater prosperity than other towns in Durham. However, coal-mining employs the greater part of the population here too. Chester-le-Street was at one time surrounded by 20 pits and 8 of these are still working. The field here is not as worked out as in the south-west of the county. It is difficult to estimate accurately the insured population of the area, for many live outside and only come in to work. It is thought that there are some 1,600 unemployed in the town of Chester-le-Street, and that these represent 30 per cent. of the employable population. One factory in the neighbourhood employs a number of girls and women, but that is the only alternative work available. The position has improved very slightly on what it was a year ago and is now almost stationary. The urgency of the unemployment problem is shown by the fact that those out of work are rapidly becoming unemployable; there are situations waiting to be filled down the pits, but the unemployed are not strong enough to take them.

A Social Service Committee was formed in March, 1935, which raised the question of a club for the unemployed men and women of the district. Various people of standing were co-opted on to this Committee and a really good working body was the result. Straight away a plan was formed to raise funds, and a matter of £36 was raised before the application to the National Council of Social Service for a hut was granted. A membership of 150 men was formed; the hut was built on land which was situated just behind the shops on the main street. The position is good and get-at-able. The men right from the start met with very serious difficulties in their work, as the site was really a mound which had been thrown up by the building of a large cinema. With hard work, however, they overcame their difficulties and a first-class hut was the result. A certain amount of political opposition was met with, and though this in a small way continues, the club has made a name for itself in the town and has the backing of the town as well.

The latest figures for Chester-le-Street are: total population of about 14,000; total insured population of about 5,000; average unemployed figure for the past three years, 30 per cent.

The club is an exceedingly good one and very active. A women's section has been started, which is doing well and the usual activities of social service centres have quickly expanded; beside the usual cobbling and upholstery, there is a good choir and dramatic group, the physical training class is popular, and is able, in the absence of a leader from the Community Service Council, to carry on itself through having an Instructor

of its own. During the winter a concert is held once a fortnight, and there are whist drives and dances once a week. The membership has increased and now is in the region of 250 men and 60 or 70 women.

This club is at the moment unadopted and is making fine efforts to pay its way, though the fact of its being unadopted is tending to hold up its handicraft activities, owing to the fact that the average unemployed man cannot afford to pay the amount of money which has to be asked for timber and leather, etc.

NOTES ON FORESTRY IN SOUTH AFRICA.

By A. P. Long.

The Forestry Department is in possession of 3,132,000 acres subdivided as follows :—

	Acres.
Indigenous high forest	450,000
Afforested	287,000
Suitable and available for afforestation	350,000
Scrub forest and protective land ..	2,045,000
	3,132,000

The Indigenous Forests are widely distributed and have for the most part been depleted of valuable species. An effort to increase the stock of valuable hardwoods is being made by conservation and by planting.

The most interesting features of the work on the growing of indigenous hardwoods are (1) the comparative failure of trees to grow in the open, (2) the establishment of shade by hardwood plantations is a long drawn-out process, but as soon as it is achieved the trees begin to grow more rapidly, and (3) pine is a thoroughly satisfactory, and indeed much liked, shade-giving nurse for hardwoods—even for such light-demanders as eucalypts. We were shown examples of prolific natural regeneration of hardwoods under the canopy of plantations of, *e.g.*, *Pinus pinaster*.

Possibly South African experience may be applicable to our own conditions, *e.g.* (1) The justification of the use of mixtures for the raising of hardwoods. (2) Pines and other light shade-casting conifers are satisfactory as advance crops or nurses for hardwoods of light-demanding species. One hears a good deal of the supposed impoverishment of the soil by growing conifers; the natural regeneration of hardwoods mentioned does not suggest impoverishment; on the contrary it seems to support the planting of conifers as an advance crop on poor sandy soils.

Afforestation.

The first Government plantations were started in 1876 and by March, 1933 the area planted was 251,285 acres, the present average planting programme being 16,000 acres per annum. Virtually all the plantations are of exotic species, two thirds being conifers and the remaining one third hardwoods.

The climate of South Africa is complex and the search for suitable species for each climatic zone has been a wide one. Speaking generally, gums (eucalypts) form the bulk of the hardwoods and pines the bulk of the conifers. European and temperate region pines do best in the winter rainfall zone, Mexican pines succeed better in the summer rainfall areas.

A few other genera have been tried on a small scale but larches, Douglas fir and spruces have no place in the selection of species.

Two features of the locality conditions stand out very prominently. Firstly, according to our standards the quality of most of the soil was very good—possibly too good for forestry. It consisted of deep, free loam, without pan, of good humus content and yet free from peat. We saw only a few examples of soil that was at all comparable with our mountain forest areas. The second was the absence of a prevailing wind and, although occasional winds are experienced, it is possible to plant to the extreme tops of mountain ridges at high elevations without feeling the effects of exposure.

In the formation of plantations there is considerable divergence from the methods adopted at home. The principal variations in practice relate to preparation of ground, plants used and nursery practice.

With unimportant exceptions all ground is prepared by complete cultivation, generally either by means of a pick where rocks and stumps occur or by ploughing and disc-harrowing either with or without the cultivation of some agricultural crop, *e.g.*, maize, where conditions are suitable. Until recently it was held that cultivation enabled small plants to get away rapidly and, although further cultivation is practised during the first year or so after planting, it was maintained that the saving in weeding costs made for ultimate cheapness of establishment. Lately the research branch has been testing the effect of different degrees of cultivation, coupled with the use of larger plants, and although results are not yet complete there is some evidence to support the view that complete cultivation is both unnecessary and unduly expensive. Surprisingly little drainage appeared to be carried out.

Plants used hitherto have been almost exclusively only a few months old. The seed is sown in boxes and the resulting seedlings are transplanted in twenty-fives into boxes a few weeks after germination at the stage when roots " break " for the first time. By the planting season the transplants are usually 9–12 in. high and the boxes are transferred intact to the plantation site where the plants are extracted one by one and immediately planted in situ. During the past few years seedlings have been raised on an experimental scale in beds and transplanted in accordance with our usual British practice.

The use of such small plants raised in the manner described involves a nursery technique totally different from ours. The soil used in the boxes is all " made up," the nursery site is a matter of no importance and special methods of shading and watering are adopted, in fact the practice is closely allied to that of a horticultural nursery. There are no nursery problems and, so long as the season is properly chosen, no defects in the system seem to present themselves. No difficulties are experienced in the transport of the boxes of plants in very large numbers—even with an afforestation programme of nearly 20,000 acres per annum (part of which, however, is direct sowing). As we are tending to increase the planting of seedlings, notably in the case of spruces on turfs, it is possible that

some such method as is described may be adaptable to our conditions and possibly overcome some of the difficulties, *e.g.*, unsuitable type of seedling, drying-out, etc., now encountered.

Direct sowing is also practised with those species whose seed is obtainable in large quantities. The seed is sown in drills four or five feet apart or broadcast, occasionally in spots at varying spaces of three to five feet. Formerly the seeding was very heavy, being as much as 40 lb. per acre, more recently this has been reduced to about 15 lb. per acre, which is considerably heavier than we have sown. In all cases the soil is previously cultivated and within a few months of their appearance the seedlings are drastically thinned to leave only the best at a density comparable with planting. The method is claimed to be as economical as planting and causes no check whatever (important in the case of such bad transplanters at *P. insignis* and *P. pinaster*) whilst the large number of resulting seedlings provides abundant selection, ensuring that the best plants only are retained.

Silviculture.

To appreciate the difference between South African conditions and those at home it is necessary to bear in mind that tree growth there is extremely rapid and results equivalent to ours are obtained in about one third of the time. Hence thinnings will normally begin at a much earlier age than at home. These thinnings are fairly comparable with those in our own plantations height for height, if anything they are possibly lighter.

In the zone of winter rainfall of Cape Province the principal species grown are *Pinus pinaster*, *P. insignis* and *P. canariensis* and at 30 years of age they produce heights of 60 ft., 90 ft., or more, and 70 ft. respectively. At this stage they stand at about 240, 190 and 220 stems per acre giving approximate volumes of 3,000 cu. ft., 6,000 and 3,000 cu. ft. respectively. In the zone of uniformly distributed rainfall *P. insignis* grows more rapidly, but is subject to fungus, and is having other species substituted for it.

In the summer rainfall zone, that is the majority of South Africa, the most widely used species is the very rapid *Pinus patula* and one commonly finds plantations 90 ft. in height with a standing volume of more than 6,000 cu. ft. per acre at only 20 years of age. Other pines grow rather less rapidly.

The only hardwood we need consider is Acacia, or wattle, which is grown in plantations primarily for bark, and has had considerable influence upon silvicultural tendencies. Acacia is an extreme light-demander. For long it has been grown at a spacing comparable with our own plantations. A few years ago it was shown that heavier thinnings, *i.e.*, leaving 250 stems per acre as compared with the usual 750–1,500 stems, resulted in considerably increased production and much earlier yield of pitprops without any apparent disadvantages. From this it is argued that light-demanders respond to plenty of room and, so long as pruning is the method used to procure clean timber, the best yield is obtained by keeping

very open conditions throughout the life of the plantation and restricting the crop to nothing but the most rapidly growing trees. These methods have been partially applied to conifers, leading to a gradual increase in plant spacing and to somewhat heavier thinnings. More recently it has been further extended on a small scale and trees are planted at spacings of 8–9 ft., first thinnings are made about 3–4 years of age and are of such intensity that at 13 years there may be left only 100 stems per acre, at which time the height of *P. patula* would be about 64 ft. (In comparison a Quality I European larch stand with a height of 64 ft. would normally carry about 420 stems per acre in Great Britain). It is contended that the plots so far achieve earlier production of timber of utilisable sizes without any diminution of mean annual increment.

Pruning is now general throughout the Union. Close examination of its effects have led to the conclusions (1) branches larger than 2 in. diameter do not occlude rapidly enough to make it worth while, and (2) pruning should be completed before the diameter at the point of pruning reaches 6 in. In other words, pruning is not justified if branches are larger than 2 in. diameter and if the defective " core " is larger than 6 in. diameter.

Protection.

Fire is the most important hazard. Methods of protection are similar to those adopted by ourselves. The principal variations are :

(1) Extensive use of rapidly growing hardwoods (eucalypts) as belts for dividing areas and for use as spark-catchers.

(2) All fire belts or traces are swept absolutely clear. Vegetation is uprooted and piled in ridges on the plantation side of the belt. Where pine forms the belt the trees are pruned and branches are piled similarly.

(3) Universal adoption of the telephone for communication.

Insect pests are unimportant.

Fungi have caused the abandonment of *P. insignis* in some districts. The presence of fungi is regarded as an indicator of conditions unsuitable to the species concerned.

Timber Utilisation.

There is a brisk demand for pitprops for the gold mines. Props consist entirely of hardwoods (gums and wattles) which can be produced in a few years and as a consequence the supply is more than ample and sales are difficult when distances are great and delivery rates are high.

There is no demand for coniferous props and large quantities of thinnings are valueless. Utilisation is now proceeding towards the production of box shooks and boarding, thinnings down to 5 in. top diameter being used for these purposes. Government sawmills have been experimentally organised on novel lines, using high speed circular break-down saw with travelling log carriage, highly efficient re-saw benches, edger and moulding machine—in fact all the machinery of an up-to-date

sawmill dealing with prime large timber is being used for the conversion of small props. One such mill had an output of from 1,500 to 2,000 cu. ft. per day. The essence of continuous working is an ample supply of round timber which is obtained by using motor transport drawing from a number of sources. Figures submitted showed that the expense was justified by prices realised for material produced—it being understood that the only alternative is imported material at enhanced prices.

The timber of *Pinus patula* is soft and like Corsican pine, " blues " rapidly. Discoloration is completely overcome by (1) hauling to the mill and converting the poles within three days of felling, and (2) passing the sawn timber through a bath of fungicide immediately after conversion.

FOREST OF DEAN THINNING COURSE.

By J. L. Shaw.

To those who are familiar with the Forest of Dean and its many interesting features six days may not seem a very long time in which to make a study of thinning, and disposal and ultilisation of thinnings, but I had the privilege of spending a week there along with other colleagues, and I feel certain I speak for all when I state that not only was the week interesting but it was most instructive.

All foresters will agree that thinning operations are possibly the most important in the development of a forest and as we watch plantations grow into the pole stage we wonder how soon we will have to start thinning and when we go in to mark a thinning how much we will take out. As a preliminary to thinning we brash (remove all lower dead branches) either with saw, or edged tool and in many cases remove all dead and dying trees at the same time. We may decide that such treatment is sufficient for two years or so. We then may mark all trees of the suppressed type, paying attention to spacing and breaking up groups. At this stage specially in Douglas fir it is difficult to see what is happening in the crown of the forest, in regard to even height growth, and percentage of dominant type of trees.

Most of us on areas established by the Forestry Commissioners are just at the first thinning stage and so our troubles commence in deciding how heavily to thin; whether to remove the dominant or undesirable type of tree at this stage, or leave it until a second thinning. My own experience is that it is generally left until by the third or fourth thinning the problem has become a menace.

In the Forest of Dean we inspected first of all plantations which had been thinned four times and worked back to third, second, first and unthinned plantations. In this way we were able to see the undesirable trees in each stage and try to form an opinion whether these could have been removed earlier. Undesirable or " wolf " trees which we inspected after the third thinning and even after a second thinning were difficult to remove as in several cases as many as seven trees were dominated. In one instance two were beyond assistance, but four of the others were still of good shape and growth although weakened by suppression. To remove the wolf meant making a large gap, leaving four poles which in their weakened state would be likely to bend badly under snow, etc. Possibly the best method to adopt in such cases would be a severe pruning of the wolf (as a preliminary to its removal later) thus allowing the weakened poles time to stiffen, and its removal when the dominated poles had filled the gap and recovered some of the lost branch formation.

These undesirable or over-dominant trees can be seen in almost every plantation, and the question arises how soon may one remove them. We saw trees in a ten-year-old Douglas fir plantation which were obviously affecting from three to five others, but no definite rule could be laid down

for their removal at this stage. Every area would have to be treated on its merits, and possibly severe pruning of these undesirable trees would tend to check them sufficiently to allow the dominated trees to get away. Careful thinning can be adopted to assist dominated trees which must be left to avoid making too great a gap. We often find groups which have been left from one thinning to the next and as I stated earlier, the longer we leave them the more difficult it becomes to break them up.

On inspecting a Japanese larch area which had been thinned at least three times, many of us thought that the crowns were too small and that a heavier thinning should have been carried out to allow better crown development, but on felling a few trees which had been marked by us as a thinning, I think most of us were surprised to find that the crown (live branches) covered from 25 per cent. to 33 per cent. of the trees. In the absence of my notes I cannot remember the length of these trees, but we all agreed that it was a very nice stand of Japanese larch. As soon as it is possible (probably after a first thinning) selected trees (300–350 per acre) should be pruned up to the first live branches; pruning can be heightened as the plantations grow on. This pruning is of great assistance to the forester when marking as he can see at once which trees to favour.

We also inspected, marked and thinned plantations of other species, then followed a discussion on the treatment carried out, which could not fail to be of assistance to us all in the treatment of our own forests. Utilisation of thinnings was another point which we discussed and the best tools for conversion and felling were tried out.

In conclusion I think the Commissioners are to be congratulated on such a scheme which allows a body of foresters to meet and discuss thinnings and other problems in such an interesting forest as the Dean.

COMPARTMENTING HILL FORESTS.

By F. C. Best.

Compartment boundaries have two main objects: to form compartments and to form useful rides. A good compartment is uniform in character and compact in shape.

Rides may be required for extraction, inspection, fire protection, severance, communication and amenity.

The lay-out of compartment boundaries may cause the following troubles:—unnecessary waste of volume and quality production, risk of windfall, and inaccuracy in fixing position on ground and on maps, or waste of time in doing so.

Requirements of Compartments.—For prescribing and controlling operations, for records, returns, working plans, thinning plans, plantation census, etc., uniformity and compactness are desirable characters, but owing to the difficulty in knowing conditions of growth and probable species' boundaries only a general degree of uniformity can be aimed at in hill country and on ground of variable character. Many compartments in our forests show so great a variation in growth, condition and species that subdivision becomes necessary before units can be dealt with uniformly.

Requirements of Rides.—A great difficulty in laying-out rides is in not knowing what means of transport will be adopted to extract timber. In the absence of such knowledge the best one can do is to lay-out rides along lines which can, at a minimum of expense, be used for tushing or light timber wagons. If metalled roads, tramways, flumes, chutes, etc., are proposed, special rides will be wanted in steep mountain country which would be quite useless for ordinary methods of extraction without considerable expense in bridging, blasting, cutting or laying sleepers across bogs.

Generally speaking the main extraction rides will have to be below the timber they are designed to extract and steeper tushing rides will run into them.

For inspection purposes contour rides will be wanted and where these can be combined with species' boundaries so much the better. Slanting paths, where these are not already provided in the form of tushing rides, are useful as connecting contour paths with the main ride system. Special rides may be needed for fire protection if they cannot be combined with other uses. Wide severance rides between species and crops of different age or type may be wanted. Rides connecting small holdings, danger points, fire look-out stations, etc., are sure to be useful for visibility and access.

For hunting, shooting and control of vermin plenty of contour rides and some straight up and down ones are best. Access along river banks for fishing and rides up the smaller streams in woodcock country will increase the sporting value. Wide rides allowing views of beauty or

interest such as waterfalls, monuments, mountains, rivers, etc., may be important in some localities.

Points to avoid.—The unplantable area of rides may amount to 10 per cent. or more of the planted area and represents a considerable loss in quality if not in volume of timber, and the more exposed the area the greater the loss, so an unnecessary length of wide rides is to be avoided. The loss due to narrow rides is inconsiderable so economy in inspection paths is not necessary.

Rivers, rock ridges, scree slopes and other unproductive ground may conveniently be used for compartment boundaries.

Accurate mapping of rides is not always possible without detailed surveying in advance of planting in desolate hill country where ordnance maps show few definite features. If time does not permit of surveying all useful rides it may be better to sketch them in approximately and use purely arbitrary straight lines or easily identified streams, etc., for compartment boundaries. This also simplifies the lay-out of rides on the ground from the map by Foresters and Foremen at the time of planting. It is really a question of whether accurate but useless compartment boundaries, in addition to other useful rides, are preferable to approximate but useful ones.

Procedure in Compartmenting.—(1) Sketch in roughly all essential rides. (2) Add others of less importance where they help to form compartments. (3) Amend or confirm the position of rides to be used as compartment boundaries. (4) Complete compartments by adding other rides which, if of no other use, can be as straight and short as possible.

Lay-out of Rides when Planting.—Before planting, the ride system has to be transferred from the map to the ground and there may be the following reasons for deviating from the map : (1) Planting line may be raised slightly causing planting line compartment boundary to become an internal one serving no useful purpose as a ride. (2) For experimental plots or other reasons an unbroken uniform block of plantation may be required necessitating omitting a compartment boundary. (3) For reasons before mentioned accurate mapping may not have been possible in the first place. (4) Slight alterations may be desirable.

There is no difficulty in altering the position of rides other than compartment boundaries as maps can always be amended, but compartments are permanent divisions and cannot be altered. In such cases where it is desired to alter the position of compartment rides it seems permissible to do so as long as such deviation is recorded on the map and the original boundary can still be retained though not recorded on the ground. If such alterations, which are unavoidable, are not recorded on the map, inaccuracy and confusion may result at a later date.

Compartment Schedule.—A brief schedule of compartments in tabular form recording allocation of area and acreages is very easily made out when first a forest is compartmented and once made is easily kept up to date and forms a readily accessible record of areas for working plans, plantation census, P. forms and other purposes and prevents acreages

from going astray. In forests of many years progressive planting and acquisition, where this has never been done, the disentangling of acreages becomes almost impossible.

Conclusion.—This article is intended to show some of the difficulties encountered, methods tried to overcome them and objects aimed at in compartmenting in hill forests in Wales. The ideal compartment and ideal ride are in practice usually unobtainable but in plantations reaching the thicket stage one realises only too well the need for some foresight in the matter of laying-out rides and for recording them correctly on forest maps.

AFFORESTATION AND AMENITY.

By F. C. Best.

Now that our plantations are beginning to show up, the public is realising that the countryside is being changed in appearance. The preservation of rural amenities is becoming of increasing importance and we cannot ignore it in laying-out our plantations. It seems to me that the right way of approaching the problem is by trying to make plantations fit into the landscape and look as natural as possible, and not by merely decorating the forest roads and rides—action which may even increase the artificial appearance.

Regularity and uniformity of outline, colour, shape and form may be silviculturally desirable for individual blocks, but there is no reason why an area as a whole should present a uniform and artificial appearance. Plantation boundaries can be broken by amenity belts serving, in some cases, also as fire or shelter belts.

Since the object is to avoid the appearance of regularity, such belts could be of indefinite and irregular outline or of species of contrasting form and shade of green. Conifers show to advantage when contrasted with lighter shades of green, and the rounded crowns of hardwoods. Beech, birch or white poplars growing among dark conifers afford a pleasing contrast in shape of crown and colour of foliage and stem. Copper beech, though an unnaturally coloured tree, would effectively break up the evenness of a pure larch wood. The most suitable species for amenity belts may be those that thrive best rather than those of special decorative value, and on some sites conifers may be preferable to hardwoods. For instance, white spruce, Sitka spruce, *Abies nobilis* or one of the pines may achieve better results on an exposed edge than many hardwoods if the latter become windblasted and deformed.

For roadside fire belts rapid growth is needed to form canopy quickly and kill down surface vegetation. Amenity belts look better when widely spaced which is contrary to the requirements of fire belts, but the dual result might be achieved by heavy thinning after canopy formation. For permanent shelter belts wide spacing is desirable, and an irregular crop of mixed conifers and hardwoods is probably the best.

In hill country planting lines are usually hard, conspicuous edges which greatly detract from the beauty of wooded valleys or hill-sides. Much might be done by establishing and maintaining permanent shelter amenity belts above the normal planting line. Such belts might consist of mixed windfirm trees likely to regenerate naturally such as Sitka spruce, Japanese larch, pines, birch, sycamore, rowan, etc., and would be quite widely planted, thinning out gradually to a few scattered trees at the top or running up irregularly into rocks and screes. This would necessitate the inclusion of some unplantable land within the plantation fence but the possibility of raising the economic planting limit would be greatly facilitated if it were required to do so at a later date. Such belts could be excluded from records and returns of areas planted.

In amenity belts of all kinds there is great risk in the use of ornamental trees to achieve a result reminiscent of suburban gardens such as variegated varieties of conifers and trees of bizarre or formal shape like *Araucaria*, *Wellingtonia* and most of the *Cupressineae*. Small-growing trees may become overtopped by their neighbours and many of the flowering and berry-bearing hardwoods are liable to suffer in this way.

Single rows of different species along ride sides often get suppressed by the main crop and a wider belt is more successful so far as appearance is concerned, and a row left out between the belt and the main crop is often advisable.

In hill country certain non indigenous conifers fit naturally into the landscape and look quite at home so long as we do not treat our plantations too much on the lines of agricultural crops.

Public opinion is against our straight rows and regular spacing and the appearance of ringed scrub hardwoods, but these are only temporary effects and in time all trace of them disappears, but it seems to me that permanent effects are worth some consideration. The expense and loss of timber production are trivial, but anything of this kind is bound to add to the duties of all supervisory staff.

SEED SOWING AND PLANT LIFTING.

By H. Williams.

Seed sowing on a large scale is now limited to a few Forests in each Division. When the Forester knows his seed allocation, he plans the distribution of the seed to the most suitable parts of the Nursery. These points are worth aiming at :—

(*a*) To keep the seeds of the same species in complete sections, or in as big blocks as possible, as Foresters demand a certain species at or about the same time ; the whole section or block can then be lifted, and the ground prepared for another sowing.

(*b*) The 2-year-old Douglas fir is a big seedling and when lifted a great deal of soil adheres to the roots. As it is injurious to shake off all this surplus soil, the result is, that a load of these seedlings is heavy, and if removed in wet weather (which is ideal for loading) will badly cut up the rides. It is an advantage therefore to have this species near a gateway.

(*c*) The haulage of laths, wire and stakes to erect a protection adds to the nursery cost. It is of some advantage then to sow the pines, which are not protected summer or winter, in the most distant part of the suitable seedbed ground.

In regard to (*a*) and to a lesser extent (*b*) and (*c*), to attain these objects the Forester must have the ground free from seedlings. Often however he finds himself lifting seedlings, preparing ground for seedbeds and sowing on the same section, and if the seed is " in soak ", he cannot wait until the whole section is ready, consequently he has to sow where the ground is available.

About the end of April he may find himself behind with the programme; it is then necessary to employ fresh men who are as a rule inexperienced and require a great deal of supervision. Even then the work is not up to standard, and the cost is very much higher. If receiving Foresters could demand their seed just a little earlier, weather being favourable of course, it would solve most of the sowing problems.

I do not think that seedbed ground requires so much fallowing as lining-out ground, for the reason that in the lines the roots spread from row to row or very nearly so, whereas in the case of the seedlings, the roots do not spread into the paths between the beds. As it is necessary to have these paths, this can really be called fallow, because they have to be kept free from weeds like the beds. If it is the custom to start each sowing from the same end of the section, and the width of the beds does not vary, the path comes to the same place with each sowing. A good plan would be to arrange the sowing so that the path comes to a different place each time, this can be done by sowing the first bed 3 ft. the first year, 2 ft. the second sowing, and 1 ft. the third sowing, the paths being 12 in. wide. In this way the whole section can be fallowed in 2, 3 or 4 years, depending upon how long the seedlings remain in the beds.

The lifting of seedlings or transplants provides the Forester with the same old problem year after year of how to obtain the 100 per cent. bundle. The following method is by no means perfect but a definite system will achieve results. Plants are usually graded into three sizes, so for this plan a gang of four is required, we will call them A, B, C and D, A, B and C to lift grade 1, 2 and 3 respectively, and D to tie the bundles and heel in. The main idea is to keep the lifters to their own grade, and if one finishes before the others, he can be put on to prise up more plants, or even if he has to lift another grade his dump should be kept separate from the others.

Constant checking is necessary and if a bundle is found to be short, wrongly graded or containing bad plants, the culprit is easily found.

THINNING OPERATIONS.

By G. W. JONES.

The time has now arrived in the life of some of the Commission's 138,000 acres of plantations of the 1920–29 decade when both silvicultural and financial considerations present a problem of very great importance, many of the earlier plantations, especially larch, having reached the second stage of development. At some forests where these early plantations were established the era of draining and planting is about to be replaced by an era requiring sound silvicultural considerations, and practical skill of the man in charge, in carrying out the process of cleaning, pruning, and thinning. He will now have the happy feeling of being (and indeed will require to be) a forester in reality, able to undertake these operations with self-confidence, having regard at all times to the future improvement of the crop, and earnestly desiring with unstinting effort to use or sell the resulting produce quickly, which is necessary to the financial success of the forest. This is by no means an easy matter, the sale of thinnings in itself being a problem of the first magnitude especially from first thinnings, when the produce taken out is of small size. It is not generally appreciated that the produce from first thinnings, will, if properly prepared, and a reasonable market is available, bring in enough receipts to cover costs, and even register a small profit. If markets are not available, huge quantities of material will be wasted, with heavy debit costs against the forests, and herein lies a job for some one of genius and enterprise. From examination of the Commissioners' Annual Report it will be seen that some 20,000 acres per annum is being planted, so that it is no stretch of the imagination to say that in the not far distant future, a thinning programme of 40,000 acres per annum will have been reached. Have we any idea of the possible costs, yields, or receipts from such a programme? Some foresters may have a fair idea, through actual experience, but the majority cannot have had any experience whatever. For this reason, and with a view to contributing something to the Journal of definite result, I submit the following data of a 29-acre block at Delamere planted in 1908. The area is occupied to the extent of 23 acres by Corsican and Scots pines, and six acres by pure Scots pine. May I say that the figures are not by any means exceptional, and in fact are from a moderate plantation only, as over six acres consist of very poor S.P. on low land and much of the material taken out of the C.P./S.P. was rough and unshapely, having probably got into the crop by beating-up during establishment. Fair stands of any of the main conifers should give better results in quantities, and with larches and spruce, better financial returns. We can therefore be pardoned for peeping into the future, and reading something like: Thinning, etc., £200,000. Receipts from thinnings £300,000. Profit on operation £100,000.

Nature of Operation.	Cost. £	s.	d.	Out-turn and Receipts. Nature of Produce.	Quantity.	£	s.	d.
1st Thinning 1930.								
Cleaning ..	28	8	9	Grade 2 poles ..	277	10	0	5
Thinning ..	71	7	6	Grade 3 poles ..	6,993	132	16	0
				Grade 4 poles ..	1,645	15	19	6
Delivery and haulage ..	64	4	10	Wireless poles ..	2		7	6
				Packing rods ..	170	1	14	0
				Fruit tree stakes ..	12,057	54	10	10
				Bean rods	350		12	0
				Firewood	5½ tons	2	9	0
Total Cost ..	164	1	1	Total receipts ..		218	9	3
				,, cost		164	1	1
				Profit on operation ..		54	8	2
				,, per acre ..		1	17	3
2nd Thinning 1936.								
Thinning ..	147	3	6	Grade 2 poles ..	2,932	104	0	9
Delivery and haulage ..	64	0	9	Grade 3 poles ..	3,757	128	10	1
				Grade 4 poles ..	2,842	34	2	6
				Fencing stakes ..	100	1	15	0
				Fruit tree stakes ..	75		7	6
				Firewood	13 tons	6	16	0
				Timber poles ..	66 cu. ft.	1	13	4
				Pitwood	4 tons	3	10	7
				Peeled pitprops ..	14,773 lin. ft.	55	17	10
Total cost ..	211	4	3	Total receipts ..		336	13	7
				,, cost		211	4	3
				Profit on operation ..		125	9	4
				,, per acre ..		4	5	11

PINE WEEVIL.

By T. A. Robbie.

The following are a few notes made from weevil collection at Inglismaldie Forest, N.E. Division, Scotland.

In 1933 an eighty-year-old Scots pine wood was clear felled and all lop and top burned. The ground covering was moss and pine needles with some fine grasses. In adjoining young Scots pine plantations there were no signs of weevil damage. In March, 1934, weevil traps of two types were laid down in the cleared, unplanted ground about 15 yards apart and in two rows, one running in a N.E. direction, and the other in a N.W. direction. The two types of traps were :—

(i) *Billet Traps.*—These consisted of thin-barked Scots pine about 2 ft. long and 1 in. to 1½ in. diameter. A turf was removed, the billets inserted in the hollow, and the turf replaced on top of the billets so as to leave about 6 in. of the billet projecting uncovered.

(ii) *Bark Traps.*—These comprised a few slabs of fresh pine bark laid on top of one another with the inner side downwards and with a turf on top.

The traps were renewed periodically as they dried up. Douglas fir twigs were placed underneath and proved an added attraction. Hand picking of the weevil from the traps started in April, 1934, and was continued regularly until the middle of October when very few weevils were found. Fresh traps were laid on this cleared unplanted area early in April, 1935, and hand collecting restarted. During the summer, damage to the adjoining young plantations was visible. The dominant vegetation was then *Deschampsia* (*Aira*) *flexuosa* with mosses, etc. Collecting stopped at the end of September when few weevil were found. In March, 1936, traps were again laid in rows in the same direction, but in new positions. Collection started at the beginning of March, but had to stop about the end of September as weevils were so scarce.

The results obtained showed that billet traps were far superior and more attractive than bark traps. More weevils were collected per trap from those running in a N.E. direction. The main weevil collected was the large brown pine weevil (*Hylobius abietis*). In this respect I might also mention that this species has also been found to be most injurious in Morayshire. The largest number of weevils was collected in 1935, the second year after felling.

Graphs were drawn for each year, plotting the numbers collected per week against the dates of collection. The three graphs follow each other closely. In the 1935 graph about the middle of May there is a sudden fall for one week, but it returns the following week to its former average. This fall coincides with a very cold spell of weather when snow fell and so arrested the flight of the weevils. From the graphs it is seen that from the end of April, 1934, the number of weevils collected rose rapidly to a maximum about the middle of May, when the numbers grew less until

during the month of July very few weevils were found. At the beginning of August the number of weevils collected rose (due to a second younger brood) to a maximum about the first week of September approximately twice as big as the maximum in May, 1934. The numbers then fell off to nothing. In April, 1935, the number of weevils collected rose rapidly to a maximum about the second week in May which was about six times the maximum of May, 1934. Then came the fall in June and July, with a rise at the beginning of August to a maximum about the first week of September approximately equal to that of May, 1934. The numbers again fell off towards the end of September. When collecting started in April, 1936, the numbers caught rose to a maximum again about the second week of May approximately equal to the maximum of May, 1934. The numbers fell off in June and July, and no second brood was apparent at the beginning of August, and hand collecting of weevils stopped in September. This gives one an idea, for this district, when to expect an attack from weevil and shows that, at the end of three years after felling, the weevils were very scarce. No attempt was made to destroy breeding grounds or to remove bark from old stumps. This area has not yet been replanted, but should be safe in another year. Unfortunately, I cannot give records of cost of trapping.

SPRUCE ON MOLINIA.

By N. Smith.

The formation of spruce plantations on the less favourable molinia areas is a problem likely to increase with any expansion of the planting programme. The normal method at Tarenig has been a system of main and surface drains from which turfs have been spread over the area. These turfs have then been planted with transplant trees usually 6–9 in. in height and, I assume, of normal quality. This method has in parts proved satisfactory, but there remain many difficult areas which extend from a few trees to several acres, due to poor soil conditions and exposure. On these sites many of the trees go into check and each year the death percentage has increased, while other trees grew normally, making beating-up and weeding difficult.

The procedure here has been to beat-up actual deaths in the first or second year using the original turfs, and where necessary beat-up again in the fourth, fifth or sixth years, cutting new turfs of extra large size. This has the following disadvantages :—

1. It is expensive and needs constant supervision and also intelligent workmen.

2. Any trees still in check may die out subsequently.

3. The turfs are difficult to find after being cut.

4. Weeding is prolonged and detailed.

5. The beating-up must be done in autumn or winter when weather conditions are at their worst.

6. It is difficult to treat as piecework.

7. The use of the best trees for beating-up can cause a shortage or reduce the quality for new planting, and so can indirectly cause further expense.

8. The plantation tends to become very uneven with trees in various stages scattered over the whole area.

Weeding is a problem from the first planting until establishment. In the past weeding has been done only where the vegetation was dense or had fallen over in masses, but the need varies almost from week to week and it is easy both to over- or under-weed (with resulting waste). After weeding strong winds tend to cover the plants again with dead molinia and repeated attention is required.

It will be seen therefore that these areas need careful and detailed attention over a period of at least eight years and any slight neglect in weeding, continuation of check or failures after beating-up may mean further expense. At present such areas appear far from satisfactory.

The solution appears to be to provide trees which will not require beating-up or weeding in a detailed manner, at a cost of establishment

below the present method. In the planting of these difficult areas I would therefore suggest that a trial be given to the following method :—

Have the usual system of drains, turfs to be inverted in rows on the sides of the drains without being spread. These would be planted in situ and, when out of check and of sufficient height, could be cut out and spread over the area, care being taken to put suitable trees near each other and extra large trees in the heaviest vegetation. If deaths were expected the quantity of turfs planted initially could be increased. Only three-quarters of the trees planted would need to be moved. The advantages of this method are :—

1. Planting, weeding, beating-up and attention would be confined to one quarter of the area and therefore would be cheaper; trees would be saved in beating-up and weeding.
2. Where plants remained in check treatment would be easier.
3. Work could proceed outside the normal planting season, giving more regular employment and easier supervision (having transplanted many trees 1–2 ft. high by cutting them out with a piece of turf, I have found that they continue to grow; this may be done in July).
4. Any extra drainage necessary would be less liable to do damage.
5. Trees on drain sides are less liable to check.
6. Smaller trees could be used if required.
7. Less supervision would be needed and the resulting plantation should be more even.
8. A definite saving of money until trees were ready to move.

I would emphasise that I only refer to certain difficult parts (*i.e.*, heavy molinia). There is a great difference between the average cost of a whole area beaten-up and the real cost of these special parts. For example, cost per thousand may be low due to heavy deaths where it is easy to cut turfs, and cost per acre also may be low because the remainder of the compartment had comparatively few deaths.

In giving costing figures I shall probably lay myself open to criticism; I shall however look forward to a future Journal in the hope that more experienced foresters will give their own experience and so help to solve one problem of this forest.

ESTIMATED COSTS.

(*a*) *Present Method.*

	Acre.		*Thou.*	
	s.	*d.*	*s.*	*d.*
Laying of turfs for first planting four rows	35	–	20	–
Planting trees, four rows	13	2	7	6
Weeding until establishment	15	–	—	
Beating-up second year 10 per cent.	2	1	12	6
Cutting turfs and beating-up fourth, fifth, or sixth years 15 per cent.	10	6	40	–
Total	75	9	—	

(*b*) *Proposed Method.*

	Acre.	
	s.	*d.*
Laying of turfs single rows	22	–
Planting of trees single rows	8	9
Beating-up second year 15 per cent.	1	3
Beating-up fourth, fifth, or sixth years 15 per cent. ..	7	–
Weeding ($\frac{1}{4}$ of present method)	3	9
Lifting and moving established trees ($\frac{3}{4}$ of area) ..	33	–
Total	75	9

DEER, FOXES AND BADGERS IN DIVISION 5, 1937.

By J. MACDONALD.

Some time ago I asked the Foresters in this Division if they could give any information on the status of these animals in the forests under their charge, *i.e.*, whether they were present and, if so, whether in increasing or decreasing numbers.

The information is summarised below in the hope that it may be of interest :—

Deer.

Fallow deer are present in Clipstone 2, Bourne and Harling. At Clipstone, the Forester estimates that there are 12 fallow deer and states that they are on the increase; at Bourne there are one or two in Bourne Wood and at Kirkby Underwood, but the numbers appear to be stationary. A pair of fallow deer are still reported to be at Harling where they have been for many years. The buck is sterile.

Roe deer are much more widespread. One has been seen at Rendlesham during the last year and at Bourne there is a floating population in Bourne Wood and Pickworth. Forester Birkitt reports that at Bourne there are about 20 deer both roe and fallow with the roe increasing in neighbouring woods.

At Thetford, roe deer are generally distributed and appear to have spread from Lord Iveagh's woods at Elveden. On the Elveden beat it is estimated that there are about 40 roe deer and that there is a definite increase. They are more numerous in winter when the coverts on adjoining land are being shot. At Mildenhall there are probably 6 or 8 deer generally present but when shooting is in progress at Elveden there is always a temporary increase in their numbers. The shooting tenants at Mildenhall have killed 33 roe deer in the last three seasons. At Lynford the roe deer are increasing but the population is migratory. At times as many as 30 deer may be present but they may disappear altogether for three weeks or a month at a time. At Downham there are occasional roe deer and the numbers are increasing. No deer have been seen on the Methwold beat for two years and there are no roe deer either at Harling or Hockham. At the King's Forest roe deer come in from surrounding properties but the population more or less resident is increasing. It is estimated that about 20 deer are present.

There are no deer at Swaffham, Sherwood, Bawtry, Dunwich, Swanton, Clipstone 1, Laughton or Bardney.

Foxes.

In the East Midlands, a hunting country, foxes are generally encouraged but in East Anglia, in the interest of feathered game, their numbers are kept down.

At Sherwood there are three earths inhabited at breeding time and foxes are reported to be increasing in our plantations. Bawtry generally

holds two foxes and there are usually several on Clipstone 1 but there are no earths in either forest. On Clipstone 2 there are three inhabited earths, six or seven foxes being usually present and the Forester reports that they are increasing in numbers. At Laughton there are five inhabited earths with numbers on the increase but at Bourne where there are generally about 20 foxes lying-out there is no known earth. At Bardney there are six inhabited earths and again an increase in numbers is reported.

In East Anglia the number of foxes present in our plantations is small and is not increasing very much except at Methwold where they are no doubt attracted by the rabbits in the plantations. On this beat they are definitely increasing and one earth is known. At Lynford there is one inhabited earth but the numbers are not increasing and at Downham, Elveden, Harling, Hockham and Mildenhall there is only a small floating population which moves from place to place. There are no foxes at the King's or at Dunwich, but one or two visit Swanton and Rendlesham, and Swaffham generally holds four or five which are lying-out.

Badgers.

There is none present on our areas in East Anglia. At Bawtry there is reported to be one badger and at Clipstone 2 three badgers—an increasing number. At Bourne they occur at Pickworth and at Twyford where there is one long-established earth.

This record is of considerable interest and is likely to be valuable in the future as a reference to our forest fauna and their status in Division V. in the early stages of our work. Similar records from other Divisions will prove equally useful by and by and should be prepared.

W. L. T.

FOREST WORKERS' HOLDINGS, CLIPSTONE FOREST.

By J. M. Ross.

The workers' holding has become a well-established factor in our forest policy and presents problems of a peculiar nature to the field officer, whose training has been directed towards silviculture rather than to agriculture. These problems are difficult enough on those forests in which the number of holdings created has been regulated in accordance with the immediate supply of work available on the area, but are of increased perplexity on older units, in which the essential aspect of the establishment of holdings was land settlement. Such a forest is Clipstone, which extends to some 5,000 acres of plantable land and carries thirty-three holdings. It is proposed in this article to give a brief account of the progress of this settlement up to the present time and to indicate possible lines of future development.

Seven of the holdings stand on outlying beats, where the presence of a resident worker or foreman is desirable from considerations relating to the forest and may, thus, be regarded as being outside the scope of this survey. The remaining 26 were established in 1928 on Working Sections 1 and 4, which extend to some 3,500 acres, the last of which will be planted in the present season. Beating-up, weeding, fencing upkeep and a considerable amount of thinning in acquired plantations will provide work for some of the tenants for a few seasons, but it will be seen that nothing could be more desirable for all concerned than the presence of a majority of holders independent, or approaching independence, of work on the forest as a means of livelihood. Unfortunately, no such state of affairs exists and problems of more than local interest arise from the extant conditions, the evolution of which is worthy of study, as a guide to future treatment.

Looking back over the past eight years, we find that the average Clipstone tenant took possession of eight acres of semi-derelict, sandy, arable land, full of weeds, especially couch grass, and desperately deficient in lime and phosphatic and humus-forming manures. The buildings provided equipped him with housing for pigs, poultry, a horse, foodstuffs and tools. To this estate, he brought a meagre amount of monetary capital and, generally speaking, an asset in the shape of a wife prepared to assist in its working. Situated in a region of colliery villages and having the considerable town of Mansfield practically on his doorstep, he was well-placed for markets.

He decided to keep pigs and poultry, and to raise cereals and roots. For this cultivation, he acquired a plough, cultivator, etc., and, most important, a horse. Before long, almost all his working capital was locked up in stock and implements. He probably realised this, but remained cheerful. What he did not realise was that the horse was a mill-stone and that the pig-and-crop raising scheme had closed a particularly vicious circle upon him. For the horse had to have four acres of the scant, weed-foul " pasture " allotted him for summer keep and expected

oats and " chop " from an acre of the cultivated ground for his winter diet, while the land which was to yield pig and poultry food, demanded manure, which only the pigs, awaiting food, could supply.

Still cheerful, he contrived to divert part of his forest wage to the purchase of pig and poultry food, and commenced to break up his land. He ploughed up quite a lot and seeding-time was upon him before he could properly clean it. The resulting cereals fared badly in the struggle with weeds, but the roots did better in response to his activity with hoes. Both, however, felt the lack of lime and manures and yields were small. Winter arrived. He sold the pigs and bought others and food to feed them. His first season was over and he had bought his agricultural experience dearly.

Before commencing his second season, he approached his neighbours with the sensible proposition that they reduce the number of horses in the colony and non-owners give their labour in return for the communal use of the animals retained. Unfortunately, the spirit of rivalry, in which all had shared in the first year, had engendered an atmosphere not at all conducive to the growth of co-operation and the suggestion was abandoned.

Our smallholder struggled on and, in his second year, found that, by breaking up less ground, cleaning thoroughly as much of the cultivated portion as possible and manuring it heavily with the materials supplied by his pigs, he got better returns. His capital, however, had almost given out under the strain of buying expensive foodstuffs in small quantities. Prices of both fattened pigs and piglets fluctuated chaotically and made both feeding and breeding very risky operations. His poultry, situated in a rather bleak district, refused to lay in winter when prices were remunerative. The chances of his becoming independent of the forest, which absorbed so much of his working time and energy, steadily lessened.

Each year saw a further decline in the prices realised by his produce and he found that, after disposing of his horse and giving help to a neighbour, he either did not obtain the use of a horse in return or received it too late in the season for much work to be done. Worse, however, was to befall him, for in 1933 three drought years set in, during which his crops failed on the light, sandy soil. Today, we find him with practically no stock and only a tiny patch of land in cultivation.

The foregoing is a reasonably accurate description of a typical holder's struggle to make good. There have been exceptions, by reason of whose efforts, the Clipstone holdings do not present a picture of unrelieved gloom, but it is significant that the Holding Census has shown a decline in livestock value of £60 in each of the last two years.

Having traced the unhappy history we can easily see where our holder made mistakes. Discounting the handicap of lack of capital and experience, we see a fundamental error in his too ambitious efforts in the first season. The outlay involved in the purchase of a horse and implements could only be justified if the holding was of the ideal " family " size of 30 to 50 acres and the land in a condition to give quick returns. Even, however, if he had avoided this mistake, he would still be faced with the difficulty of breaking into the circle, represented by hungry

land and hungry livestock. Two things were essential to success—capital sufficiently large to carry him over a year of practically no return for his efforts and knowledge of the situation before commencing operations. Both of these he lacked and failure was inevitable.

It is obvious that his successor will have to adopt a totally different line of attack upon this problem. His first step should be the acquisition of a breeding sow and a few head of poultry, while his capital must be sufficient not only to buy their food, but also manure for an acre of ground and a second sow, due to farrow when the first litter is ready for sale. With luck, he would thus be well set to breed four litters of piglets per annum, this being the best system of pig management on such a holding.

In the meantime, he should have started to cultivate his land. If capital permitted, he could hire horses and a plough, but a sounder method would be to rely on his own efforts with a spade. This may sound obsolete and slavish, but slavish toil is essential to success on a Clipstone holding. By spade-work he could clean an acre of ground and crop it with potatoes, cabbages and peas. The peas would find a ready and remunerative market in the nearby village of Bilsthorpe and furnish a quick return. The potatoes and cabbages, surplus to his own household needs, would be used in the following winter as pig and poultry food respectively, the latter being fed to intensively-housed pullets, reared during the season.

In his second year, he would have accumulated a considerable quantity of pig and poultry manure and be justified in hiring horses and implements to double his acreage under cultivation and to add barley to his list of crops. Henceforward his aim should be the cultivation of a third of his land and the increasing of his stock of poultry on the remainder. The area broken up should be extended progressively over the holding, a corresponding area, previously cultivated, being, with the help of his landlord, laid down to pasture. In effect, as far as his ambitions as a cultivator are concerned, he should regard his holding as being only three acres in extent, the point being that once he has exceeded this limit, he will have committed himself to an outlay for a horse and implements, which only a holding of thirty to fifty acres can justify. He must avoid this and, at the same time, endeavour, by home production, to lower his bill for foodstuffs.

Such is the tenant's best procedure, but if he is to succeed, there must be complementary action on the part of his landlord. In an age in which land of high quality has to be nourished with subsidies from the State, the Department cannot escape some after-care of tenants placed on land below the margin of economic cultivation. The provision of lime and, to a less extent, manures; permission to hire, at cheap rates, such implements of cultivation as are available on the forest, for example, tractors, ploughs and rototillers; loans in aid of fallowing weed-ridden soil during the first two years of the tenancy and the erection of rabbit-proof boundary fences would help tremendously towards successful establishment.

Opportunity to help towards this end is not lacking to the District Officer. Several holders recognise the benefits which would accrue from co-operative buying of foodstuffs and the communal use of implements, but each one says that none of his neighbours will collaborate. Courses of lectures are willingly given by County Agricultural Advisers to organised bodies of smallholders. Only a non-holder could hope to break down the atmosphere of distrustful rivalry which stifles the growth of such co-operation and organisation.

Granted action, by all concerned, on the lines suggested, there is some hope of successful development at Clipstone, but the difficulties promise stubborn resistance. The salient fact which emerges from a survey of the position is the confirmation of the wisdom of restricting the formation of holdings to conform with the actual working needs of the forest and of recognising the dangers inherent in the holding, which is at once too large and too small.

SOWING OF BIRCH, OAK AND BEECH.

By W. Tribe.

The following procedures and experiments took place at Rendlesham P. 35–6. When possible ripe seed only was collected. Unripe seed was laid out on hessian sheets in the open, weather permitting, or if wet spread thinly on a board floor in a shed with doors open, and turned alternate days.

Birch.

Pre-treatment.—The ripened seed was stored in suspended sacks in a cool, well-aired shed until 3rd January, when it was stratified in sharp moist sand, ratio one part seed to 2 parts sand, placed in boxes and well churned. Afterwards it was stirred well twice weekly, and if signs of dryness were noted the mixture was watered, the consistency being such that when some of the mixture was crushed in the hand it barely held together.

The seed showed distinct swelling towards the end of March and was sown complete with sand on 31st March at the rate of 1 lb. to 18 sq. yd. seed weight only. The method employed was the pushing out and covering with cuffing boards, the lightest possible covering being considered sufficient. To do this it was necessary to have a very fine tilth free from stones. After covering, the beds were rolled with a medium-weight roller, lath shelters then being instantly erected. When the beds showed any signs of dryness they were watered, not lightly but thoroughly. Constant moisture content, we consider, is the most important item.

Weeding was necessary almost immediately after germination in order to remove the weeds in their young stage for it was found that hundreds of seedlings were pulled out with the weeds if they were allowed to reach any size, particularly with the annual poa grass.

Oak.

Pre-treatment.—When the acorns were thoroughly ripe (in November) a site was selected on a little-used path in the nursery, next to a section previously allotted for oak beds, care being taken to see that it was well drained. A pit was dug and lined with boards, the seed put in and mixed with sufficient sand to keep the acorns separate. The pit was two feet deep and the sand covering on top to soil surface was six inches, so the length and width varied according to the bulk of seed. With small quantities a box placed in a pit is an ideal arrangement.

Periodic examination was made in case of damage by rats or mice. The seed was examined about the middle of February when pre-germination had commenced, a few acorns showing a radical of ½–1 in. However, sowing was delayed until the first week in March when practically all seed had pre-germinated. Care was taken in removal of seed from pit

to bed but even so some radicals which had attained a length of 2 in. were broken off. It was later found, however, that an acorn which had its radical broken off, afterwards sent out two and sometimes three more roots and ultimately produced a good seedling. The method of sowing was as for birch with the exception of the covering which was 2 in.

Owing to the quick germination after sowing the seedlings are liable to late frost damage. In May, 1935, seedlings were 1–3 in. high and were frosted; on 29th May, 1936, seedlings were 2–4 in. high and again were cut down, though in both cases they recovered to reach a maximum height of 15 in. Therefore protection is advocated. 600 lb. were sown, stocktaking showed 47,000 in 1936.

Beech.

Pre-treatment.—Partitions three feet high were put in a shed and a false floor inserted, and into these partitions beech seed, thoroughly ripe, and sufficient humus to keep the seed separate were placed on 2nd January. The mixture was turned regularly to prevent heating. It was at first thought that watering would be necessary to hasten pre-germination, but the humus retained a sufficiency to bring about pre-germination in the first week in March.

The method of sowing was as for the two former species, only the covering in this case was ¾ in. Prior to this some seed was stratified in the same way on 31st October, but by March pre-germination was well advanced and some doubt was entertained regarding ultimate germination. However the seed germinated well but much sooner than the later stratified lot. In consequence, although the beds were covered with lath shelters immediately after sowing, a frost on 29th May damaged 22 per cent. for 6 in. on the south side of each bed, most of which never recovered. So it will be seen that stratification the first week in January is the ideal time in order to get correct pre-germination for March sowing. It must also be noticed that in spite of the frost damage to the earliest pre-germinated seed, stocktaking showed an equal number of seedlings per lb. of seed for both lots, *viz.*, 510. Further damage to the sides of beds was prevented by laying branches of birch or broom down alley-ways.

PLANTING DERELICT COPPICE AREAS.

By C. A. CONNELL.

Much interest has been taken in the recent article on the stroll method and lane method of planting, probably because the problem of successfully tackling coppice areas, especially derelict coppice, is one which has engaged the attention of foresters all over the country.

The Forestry Commissioners have during the past 15 years acquired many derelict coppice areas in various parts of the country, and it is thought that a general account of how they have been dealt with in the past and of the more recently developed practice will be of interest.

It appears that the stroll and lane methods described by Mr. Hiley have been devised and used for the replanting of hardwood coppice areas with conifers. The Commissioners have always held to the view that derelict coppice areas should, where possible, be maintained as hardwood areas, and the following descriptions refer to the re-stocking of coppice areas with commercial hardwoods.

The most suitable technique in any forestry operation is not found quickly, but is derived from a study of results achieved with different methods, and from a critical investigation of other countries' methods, viewed in the light of the meteorological, biotic and soil conditions encountered in this country. The problem to be tackled in the United Kingdom has very few counterparts in continental countries, since the initial state of the woodlands and their ultimate use are rarely the same as in those countries. Therefore, although foresters here have been long indebted to our French, Swiss and German friends for many guiding principles, in this case it has been necessary to work very much within our own circle and to devise methods by studying Nature as we find her here, analysing the results and applying the conclusions reached.

In this quest for a really satisfactory technique the Forestry Commissioners first tackled the problem of re-stocking coppice areas by completely clearing the area and replanting. Saplings and old standards were felled by axe or saw, the stems being sold, if possible, for turnery work, firewood or chemical distillation. If sale was impossible, owing to long and expensive haulage, any suitable material was converted into stakes, strainers, and struts for home use. This type of conversion, however, rarely gives much usable produce, since one is generally confronted with birch, hazel, sycamore, etc., totally unsuited for insertion in the soil unless creosoted. The large amount of bunched coppice shoots, 1 to 2 in. thick and up to 10 ft. high always encountered, was utilised, so far as markets permitted, as pea sticks, and bean rods. All the remaining vegetation, blackthorn, bramble, dead bracken, wild rose, elder, dogwood, etc., was cut with hooks and collected into heaps. These heaps after having added to them the remnants from the above-mentioned saplings and coppice shoots, were then completely burnt. Thus a clean-swept area was achieved and over this the planting was carried out with the chosen species of hardwood. Occasionally a larch nurse was included,

and the spacing varied from 5 ft. × 6 ft. to 8 ft. × 4 ft., depending on local factors.

It will be appreciated from the foregoing that the new crop had to start its growth in the face of complete exposure. The combined effects of frost, wind and scorching sun resulted in many deaths, so that beating-up had to be done yearly for the first two years to a minimum extent of 15-20 per cent. The weeds, of course, grew faster than the crop, and owing to the closeness of the plants it was necessary to cut most, or sometimes all, weed growth between the plants to prevent their being suppressed. It was a costly operation since luxuriant coppice and bracken vegetation necessitated two or three weedings per year, at costs varying from 5s. 6d. to 15s. per acre at each operation. In spite of these weedings it was generally the case that the hardwoods required several years in which to establish themselves and give an annual growth of more than 6 in.

After the above type of replanting had been tried out for a few years, there were no doubts as to its objections, which may briefly be summarised thus :—

(*a*) *High initial Cost.*—Cutting and burning everything is a laborious business, costing up to £5 per acre on blackthorn areas.

(*b*) *High maintenance Cost.*—Coppice growth even a year after cleaning is generally very great, so that extensive weeding is inevitable. A balance has to be maintained between cutting out coppice and vegetation to give head and lateral room in which the plant can develop, and leaving sufficient coppice and vegetation to provide adequate shelter for the crop. To achieve this balance skilled workmen are required or else more supervision of average workmen than is generally possible or available. Beating-up, too, is slow work, and therefore costly, since although at the time of planting a proper distance may be kept from stools it soon becomes difficult to distinguish whether an original plant has died or one had not been put in owing to the proximity of coppice.

(*c*) *A usually fairly high Percentage of Failures in the first Year, due to entire lack of Shelter.*

(*d*) *Slow Growth of the planted Trees.*

However, before the above conclusions were reached definitely, enough data had been collected to show that a change would have to be made before long, and so transitional experiments were carried out. The experiments were based on the use of existing coppice shelter.

At a unit in north Notts. a small area of 2–3 acres was kept out of the main operation. On this area strips 12 ft. wide were cut through the existing coppice (10 to 15 ft. high) every 12 ft., everything on the strips being removed. Ash, sycamore and larch, of size over 15 in. were planted, mixed in blocks of 16 plants, 6 ft. between the blocks and plants 2 ft. × 2 ft. in the blocks. The 1932 season's growth was substantial, considering that the plants had to establish themselves, being not less than 9 in. In the 1933 season the growth was 12 to 18 in. for all plants, while the 1934 season's growth averaged 24 in. No beating-up had to be done and the first relieving from shade of the coppice strips was done in the 1935 season.

At another unit, also in north Notts., a five-acre piece was tackled, all the undergrowth being removed, leaving the ash, oak and hazel coppice stems. Ash, sycamore and larch plants were planted in lines through the area as symmetrically as the presence of the coppice would allow. Their development was good and superior to the growth of the plants on the adjoining cleared area. Weeding was done once each year in the undergrowth, while the relieving from coppice shade was done in the second spring after planting. The beating-up was confined to the replacement of some larch by sycamore.

On a unit in south Lincolnshire a one-acre experiment was carried out. Small blocks of ash and larch were set out among the original scrub and coppice stools which had been cleared in 9 ft. squares, 18 ft. apart, to accommodate 5 ash and 4 larch, equally spaced at 3 ft. × 3 ft. The blocks of plants were relieved from any excessive coppice shade once per season at low cost. The growth was approximately 66 per cent. greater than that of similar plants on the cleared area. Later in these experiments the use of larch nurses was abandoned.

More recently the methods have been systematised and the current technique carried out by the Forestry Commission is known as " the group and strip methods of planting ". Differentiation between the group and strip method is based on the height of the coppice crop. Coppice up to 12 to 15 ft. is replanted by group method, coppice over 15 ft. by strip method.

The Group Method.

Over the area to be replanted groups of plants are arranged, 24 oak or 16 ash or 16 sycamore being planted in a circle of 12 ft. diameter or square of equivalent area. This circle is completely cleared of vegetation and is kept clear by subsequent weeding. Approximately 100 of these groups are set out per acre, no symmetrical lay-out being rigidly adhered to but the groups being spaced as equally apart as is compatible with the density of coppice stools over the area. Where a stool or number of stools likely to afford good shelter is found to be occupying the space where a group would be set out if in symmetrical formation, the group is set out beyond such coppice in a place more open. In theory this would seem to give very scattered spacing of the groups, but happily in actual practice it has usually been possible to obtain a fairly regular lay-out while full scope has been given to the coppice to develop adequate shelter.

The spacing of the plants in the group is such that 3 ft. is left between all outside plants and the edge of the clearing. Where a mixture of species is used, such as ash and sycamore, each species has a group to itself, thus, one group ash, one group sycamore, one group ash, and so on. Subsequent treatment includes the trimming back of any coppice growing or falling over the cleared group, while all bramble, grasses, etc., in the group are cleared with a sickle. When these grouped trees have reached a height rather more than that of the coppice, the coppice between the groups will be either severely thinned out or completely ringed, and the ground planted up with beech.

The above technique may be considered as a basic one which can be adapted to varying conditions. Thus it lends itself admirably to the replanting of dense blackthorn areas, the tackling of which has always been considered too costly to be worth while. A start can be made at one end of the area, a three-quarter circle being cleared. A narrow alley-way is then cut from this to the site of the next circle, which is formed by cutting progressively outwards from the centre, and pushing the cut material into what is to be left standing. Thus each circle is connected with its neighbours by an alley-way. Expensive clear-felling and burning up are thus avoided, and it is a very cheap operation to remove any particularly vigorous blackthorn shoot springing up later on inside the circle. A certain amount of slicing through the roots with a spade may be necessary at the time of planting, but this presents no difficulties. Areas of solid blackthorn, 9 ft. to 10 ft. high, have been successfully planted on these lines.

Areas covered, even rather patchily, with coppice clumps only 2 ft. 6 in. to 3 ft. high can successfully be planted up by the group method; in fact good results have been obtained when the coppice has been only a few inches higher than the plants put in. In these cases it may generally be assumed that in the first year the coppice will grow much faster than the plants, so that by the second year the shelter is anything up to 3 ft. higher than the plants. It is very easy, too, by this method to incorporate large or small areas of natural regeneration. Groups of plants may be put in wherever gaps in the natural crop occur, provided of course, that the natural crop is at least as high as the planted trees. One area successfully tackled had natural ash, 10 ft. to 15 ft. high, mixed among coppice of hazel, birch, etc. The ash was in medium-sized patches, so that when most of the adventitious species had been removed gaps more or less of the correct size were left, into which planted ash were put, sometimes more and sometimes less than 16 per group. Occasionally the space between natural ash would have been too great, so a patch of adventitious coppice was left in the middle.

There are situations where the group method is admirably suited, even though the coppice crop is over 15 ft. high. Groups of natural sycamore saplings for instance, of almost any height, may form the coppice shelter for grouped oak, ash, etc., in the intervening gaps. The only restriction is when the ages of both crops come outside, say, a 20-year age class, as then it is probable that the older trees will be felled at a different time. Within a 20-year age class the sapling crop and planted crop can finally be felled as one crop.

It will thus be seen that this method meets the case for almost all types of small- and medium-sized coppice areas, and for certain types of large coppice, by appropriate adaptation of the basic method.

The Strip Method.

Throughout the area strips are laid out 12 ft. or 18 ft. wide and 12 ft, or 18 ft. apart, at right angles to the prevailing wind. The choice of 12 ft. or 18 ft. rests on the height of the coppice, 12 ft. being suitable for 15

to 20 ft. high coppice, and 18 ft. for taller stuff. Treatment of the strip may be governed by local conditions. If it consists largely of birch for which there is a turnery market locally, 75 per cent. of the birch on the strip may be removed for sale, the remainder, together with other coppice shoots, being ringed and left standing. If there is no saleable species or no markets, then all the coppice shoots are ringed and left standing. In both cases all undergrowth, including small thin coppice is entirely removed. Nothing is touched in between the strips.

The planting is done with either three or five rows 4 ft. apart, depending on width of strip, the plants being 3 ft. apart in the rows. In the case of mixtures, the two or more species can be alternate plants in a line, alternate lines in a strip, or alternate strips. Thereafter weed growth and small coppice shoots are cut back as necessary, and when the planted crop has reached a height of 12 ft. or over, the coppice between the strips will be treated in exactly the same way as in the group method.

As in the case of the group method, modifications in detail will enable this method to meet the exigencies of various types of devastated woodlands.

For both group and strip methods the actual planting of the trees should be carefully done. Expensive pit planting is not called for, but on the other hand, notching of ash, sycamore and chestnut should not be permitted. A very satisfactory method is to cut out the sides of a rectangle with an ordinary planting spade, divide it by another cut into two squares, then remove each square to its own side of the rectangular hole left. If necessary churn up the bottom of the hole; place the plant, held in the left hand, in the hole with its roots suitably disposed, then with the spade held in the right hand push back the two square sods into the rectangle. Firming is then done in the ordinary way. With long straight-rooted ash, a different method may be employed. Cut a deep "T" with an ordinary planting spade, then insert the spade at the bottom of the leg and pull backwards; this opens up the two sides and the plant may be inserted at the top of the T. The roots are then covered properly by the soil which has been crumbled by the action of the spade, instead of being pinched or nipped between two clods of earth. The plants used in these methods must not be less than 18 in. in height, except in the case of oak, when 1-year seedlings are usually employed.

It would be wearisome to enumerate the actual results achieved on all the Commissioners' areas thus treated, but a typical example of each method may be mentioned.

Near Lincoln an area felled off in the early twenties has had the relevant parts replanted on the group method with oak and ash. Formation is boulder clay, with overlying ancient river gravel in parts. One-year oak, 24 per group, and transplant ash, 16 per group, were used. Failures have been less than 5 per cent. and only odd groups of oak have required any weeding. Growth has been entirely satisfactory.

In north Notts., on a magnesium-limestone formation, a birch coppice area has been replanted on the strip method. The strips were set W.S.W.

—E.N.E., 12 ft. wide, 12 ft. apart, and the coppice shoots ringed. The planting was done with ash and sycamore, part tree about and part alternate lines. This plantation has required no attention beyond weeding over three acres at a cost of 2s. 9d. per acre.

From experience of these methods there is every indication that the growth in coming years will be good and consistent, and that beating-up will be entirely unnecessary, while the fact of fast growth will reduce weeding costs considerably.

STRIP PLANTING IN COPPICE AT WHITWELL.

By W. V. Jackson.

Whitwell Wood, which is part of Clipstone Forest, affords a compact and illuminating illustration of different methods of treating coppice areas, prior to planting with hardwood species. From 1930 until 1934 the procedure adopted was to allow contractors to remove all the tall birch and sycamore coppice, provided that they left the area clear of undergrowth, etc., ready for planting. Ash and sycamore, interplanted with larch nurses, were then introduced. Results have been disappointing. The larch fared badly in a smoky atmosphere and coppice, blackberry and briar growth involved us in costly weeding, in order to save the hardwoods, already suffering from frost damage.

In P.34 and 35, strip planting in tall—20 to 25 ft. high birch—coppice was resorted to on a fairly large scale. Strips 12 ft. and, in P.35, 18 ft. wide were run from N.E. to S.W. through the planting area, alternate strips being prepared for planting and those intervening being left alone. A considerable number of poles was felled in the prepared strips, the lop and top being thrown into the untouched strips alongside; an approximately equal number of stems were ringed and left standing in the strip and all undergrowth was cleared out. These were then planted with sycamore and ash, the mixture being sometimes by complete strips of each species and sometimes by alternate lines or alternate plants within a strip. The whole area was then recorded as being 75 per cent. planted, the intervening strips being left for later filling up with beech or, if possible, the same species as those in the planted strips.

On completion, conditions looked ideal and the response of the sycamore in the first season was remarkably good. During the past season, however, it would seem from observation that modifications of the original scheme are necessary. In small bare patches and others in which overhead shelter is very light, growth in the second season has been far superior to that in places which we had considered were ideally shaded. Furthermore, a cleared compartment alongside the strips shows good growth of sycamore in a belt about a chain wide sheltered on the east side by the coppice in the " stripped " area, while the rest of it is very poor. It would appear, therefore, that the strips are not wide enough, and that overhead shelter has been excessive. This can be improved considerably by the immediate removal of the ringed stems standing in the strips and a certain amount of ringing of stems in the untouched strips. The disposal of the ringed stems is easy in those places where the planted sycamore have reached a size that permits the cessation of weeding, as the stems can be laid between the rows. Such conditions, however, are by no means widespread even in the case of the sycamore and entirely absent amongst the ash, which have scarcely begun to grow. The ultimate clearing of the undergrowth in the intervening strips for planting has been made more difficult by the piling therein of lop and top, which has still to show signs of rotting away.

My conclusions are that, if strip planting is repeated, the strips should be at least 30 ft. wide, felling of all stems therein should be carried out and that the strips should run north to south, as shelter from the east only is necessary. Alternatively, the strips could be a chain wide if a few stems are to be ringed and left in the cleared belt. Management would, thus, be much simplified in that expenditure on preparation of ground and weeding would be reduced, sales of produce increased (by felling instead of ringing) and the thinning-out of coppice, now necessary in the third season after planting, would be obviated. Damage caused by ringed stems breaking off would be avoided—a considerable item when the ringed stems are small as they quickly rot at the ring and fall in a piece (unlike bigger trees which fall piecemeal in portions) doing little damage to the undercrop.

Complete clearing of undergrowth and the thinning out of the tall coppice to about 150 to 200 stems of small diameter per acre, followed by underplanting is a better method than stripping. Tested on a small scale in P.35, it has proved successful and is being adopted in the present season.

Experience gained from clearing, stripping and underplanting confirms the soundness of the principle of avoiding clearing and I feel that underplanting is both better silviculture and better economics than strip planting.

PRE-THINNING.

By R. B. Gilson.

As is well known, large areas of conifers, mainly Scots pine have been established at Thetford Chase. Owing to the dry conditions prevailing, these plantations have been at times severely damaged by insects, chiefly *Tortrix*, *Myelophilus* and *Lophyrus*, which were practically impossible to check. In addition, many of the earlier plantations contained trees grown from seed of doubtful origin. As a result the plantations contain a varying proportion of undesirable trees which would, if left until the time for thinning arrives, add to the difficulties. It was therefore decided last summer to try what is termed " pre-thinning " in the oldest plantations—(P.22). Only wolves were taken for it was important that attention should be focussed on what was to be preserved and not what was to be removed. It was essentially a cleaning operation and was charged to that head accordingly.

As may be imagined, the canopy of P.22 plantations had formed, but the crop was not ripe for a proper thinning. As a result of the pre-thinning no thinning will be necessary for at least three years, and it is to be hoped that by then the poles to be removed will be more marketable than at present. The plantations have reached that stage when the wolves are beginning to make their presence felt.

The method adopted was to brash every third row to a height of about 6 ft. with a sharp bill and to trim off some of the dead branches of the fourth row where these were protruding too far to keep extraction paths clear. The dead trees in the third row were cut down as the easiest way to deal with them, but all the small live trees were left as occasionally a sale is found for them as flower stocks, plant rods, etc. Some foresters prefer to brash only the two adjoining sides of the third and fourth rows so as to make a clear path in between, but as one of the main objects is to help the selection of wolves as well as to make extraction paths the first method is much to be preferred. In marking the trees the marker walks along the brashed row and selects the wolves there and in the unbrashed row on either side; the removal of live branches is not recommended, therefore all patches that are backward and not out of the thicket stage are left alone.

The cost of brashing per acre varied considerably according to the quality of the crop, but on the average worked out at approximately 14s. The number of wolves removed varied considerably but averaged 30 per acre. The cost worked out at 11s. 3d. This high figure was due to some extent to wet weather, but mainly to the big compartments—50 acres each. The poles removed are at the moment being converted into various kinds of fencing and though the amount of waste resulting therefrom seems very great the material was certainly poor. Wolf trees do not improve with keeping, but it is a ticklish problem sometimes to decide whether to retain them as soil cover or have them out and leave a huge

gap. Pre-thinning treatment simplifies if it does not remove altogether such difficulties.

Some difference of opinion exists as to the right stage at which the pre-thinning of pines should be done. The view has been expressed that potential wolves may well be removed before the canopy forms, or even before the thicket stage is reached, thereby saving money. It would seem that circumstances prevailing in each district have to be the guide. The limited experience of pre-thinning treatment at Thetford Chase suggests that on dry sandy soil the right time is just after the canpoy has formed. It cannot be stressed too much that no undesirable tree is a wolf until it begins to injure one or more desirable neighbours; up to that point it has some silvicultural value.

PRE-THINNING AT RENDLESHAM.

By G. D. Rouse.

It has been clearly shown in the Commission's Bulletin No. 16 that, merely by virtue of their greater size and their greater quantity of foliage, the incipient wolf trees in a young Scots pine plantation are more likely to be attacked by tortrix than their neighbouring smaller trees. Whilst the caterpillars, and hence the galleries they make, are all roughly the same size, this is by no means true of the leading shoots which they may attack. Generally speaking, the largest trees put on the leaders with the greatest girth, and thus, when weakened by a larval gallery this large leader is not so likely to be completely broken off as is the case with smaller shoots. For this reason, the " posthorn " type of damage very frequently occurs in the predominant trees of a plantation, and it is unfortunately this type which is most objectionable.

When marking the trees to be removed in the pre-thinning the following points are borne in mind :—

1. The operation is not a thinning and only wolf trees are to be removed.

2. It is probable that the first true thinning will be made in 3–5 years time, so that doubtful cases may usually be left for removal then if necessary.

3. A wolf tree is only removed where, by so doing, a good type of tree which was previously in danger of being suppressed is set free.

In some cases the wolf tree has already done its damage and nothing is to be gained by its removal; in others, it is surrounded by trees which have been deformed by tortrix or some other agency, and here again there is no advantage in removing it.

At this age (P.20–P.22) the compartments are usually impenetrable, and before the marking can be done, it is necessary to cut racks, which are essential for the carrying out of the poles. Originally every third row of these was completely pruned to a height of 6 ft. the idea being that by this method the butts of some of the final trees would be greatly improved. If there are to be 220 final crop trees to the acre, only about one in every nine of the pruned trees will be left to the end of the rotation. As the cost of this method of pruning was very high, it was considered that the benefits derived were not commensurate with the expense incurred, and after other methods had been tried, the method of roughly brashing up every third space between the rows was adopted. This has reduced the pruning cost by about 7*s*. 6*d*. per acre. During July, August and September the average number of men kept at this work was nine; they completed 133 acres, extracting 5,000 poles at a total cost of £218 14s. 10d. (excluding insurance). This is roughly 37 poles per acre and a cost of 32s. 9d. per acre. The average market value of the poles on the ride-side is 1½d. each, so that the net cost of the operation per acre was 28s. 1½d.

Owing to the improved methods more recently adopted, the costs for the first two months of this year have been reduced considerably :—65 acres have been completed, producing 2,753 poles, *i.e.*, 42 per acre, at a total cost of £92 9s. 1d.; this is equivalent to a gross cost of 28s. 5d. per acre or a net cost of 23s. 2d. A further reduction will result from the practice of rough brashing.

SIBERIAN LARCH IN FINLAND.

By JAMES FRASER.

During the course of a holiday in Finland last year the opportunity was taken to visit the Raivola plots of Siberian larch of which some accounts have appeared in European journals during recent years. Some will remember the account of the tree and its growth given by Heinrich Mayr in his text-book published in 1906 and they will remember also his final verdict on the unsuitability of the tree for British forestry. The impressions given by a visit to the Raivola plots however might well excuse a suggestion that a further trial of the tree in a carefully chosen locality in Great Britain might supply later generations of British foresters with a stand of which they might boast as proudly as their brother foresters in Finland do at the present day about their plots.

What Americans might call the first reactions to the plot were such questions as—what influence does wide-spaced planting of the trees have on the production of straight-growing high quality timber; what support can our statistically minded foresters, including those of Finland and our own research department, find for root competition theories; what support is given to the theory of sustained high volume production by means of early thinnings at frequent intervals; and—what faith must we place in one of the first learned rules of thinning—" Break up all groups "? An excellent account of the growth of the tree in Finland may be obtained from an account published by Lappi Seppala in 1927 and from the official guidebook to the Raivola plots written by Olli Heikinheimo. Lappi Seppala's work is an account based on all plots in Finland and part of the material collected by him is used in the official guidebook to Raivola plots. Careful consideration of the accounts given by the foresters in Finland may serve to restrain first enthusiasm but it can do nothing to diminish the feelings of admiration inspired by the Raivola plots and if super-sensitive students of nature and natural beauty refer to such plots as " pole factories " we may well ask these people to tell us exactly what they mean by natural woods and ask them to study a very interesting account of natural woods written in another publication by Lappi Seppala. At all events the " pole factories " of Raivola must be among the best of their kind and they are more pleasing to the eye than many much reverenced woods reputed to be natural and beautiful. The standards of beauty of many of our critics may be found to be very arbitrary and artificial.

The volume production of the tree in its natural home has been investigated only on a very limited scale but such figures as are available indicate that the tree both in natural unthinned plots and in heavily thinned cultivated plots is a bigger volume producer than is European larch grown under favourable conditions in Scotland. The differences are not very striking and more careful comparison based on a wider set of measurements in Russian plots might diminish the apparent superiority of the Siberian larch.

Cultivation of the Siberian larch in Finland began in 1738 in the Raivola district. In the sixties of the last century cultivation extended to other regions of Finland. At that time the attempt was made to grow it in mixture with other species that are indigenous in Finland. The plantations did not receive the necessary care and attention and some of these were unsuccessful. Certain woods, however, notably those of Raivola, Punkaharju, Kitee and Vesijuko, gave very good results The oldest plots are at Raivola and in 1907 a Russian forester established seven permanent sample plots there and investigated past growth by means of stem analyses. Later Ilvessalo published the results of investigations made by him on the growth of the tree in Finland. Most of the data about the growth have been got from Raivola and Punkaharju.

In those two places the climate shows a great degree of similarity. Rainfall is low and amounts only to about 23 inches in the year; the average monthly temperature is below freezing point for five months of the year; very intense winter frosts are common; summer temperatures are moderately high. Strong winds have caused many windfalls in Raivola and late frosts are common there.

At Raivola the mineral part of the soil consists of glacial deposits which vary in their character. The average height of the land is about 165 feet above sea level; the area occupied by the Siberian larch plots is much cut up by fairly deep valleys especially in the section of the wood lying to the east of the Lintula river. On the west side of the river the land is more level and the valleys are shallower. In places the sandy surface layer contains a good deal of clay and the larch roots do not penetrate deeply but spread out in a flat horizontal fashion. In other places the soil consists of hard fissured clay in which the roots spread out flat in the fissures and penetrate to a depth of about three feet. In other places the upper soil covers a fine loose sand in which the trees can develop their naturally deep rooting form. In still other places the loose sand layer is very thin and lies on the top of a hard layer which is not more than 18 inches from the surface. In patches the soil is a typical moraine soil. It has been noted that wind resistance is largely governed by the nature of the soil. More than half the total area of the Siberian larch wood is on soil of a very rich character.

The wood forms a small part of an area of about 15,000 acres of the forest which is in charge of the Forest Research Department. The wood is divided by the river Lintula and is about two miles from Raivola railway station. It is very close to the Russian frontier. The formation of the wood was planned by the Czar Peter I although he did not live to see the beginning of the work. An important part of the formation work amounting to about 13·2 acres, was done by a German forester Fochnel, who published an account of his methods. The work began in May, 1738. Two areas were sown with Siberian larch seed that had been collected in the neighbourhood of Archangel. One of the sown areas had been burnt over in the previous year and had carried a crop of oats. After the oat crop had been taken the soil was worked and the seed was sown broadcast and was covered by harrowing. The second seeded area which had been

covered with a thicket of scrub and coarse grass was cleared and burnt and strips 10 ft. wide and 10 ft. apart were broken up and sown broadcast in the strips. In the following year plants were taken from the sowings and these were planted out on an adjoining area to the south of the sown plots. The planting distance was 14 ft. between the plants and 14 ft. between the lines of plants. In places the planting space was irregular. A large part of the wood, 30 acres, dates from 1770. The planting distance was 14 ft. as before or 13 ft. No information is available about the formation of this part of the wood. A third section of the wood dates probably from 1811–1812. The pure larch of this period is about 3·9 acres and the planting spacing was partly 14 × 14 ft. partly $10\frac{1}{2} \times 10\frac{1}{2}$ ft. At this time also an area of about 4·1 acres was planted at 7 × 7 ft. spacing. There were a large number of deaths in the closer spaced plots and natural regeneration of Scots pine and spruce gave rise to a mixed crop. Other patches amounting to about $2\frac{1}{4}$ acres may have been formed by sowing of larch, spruce and Scots pine. The total area of wood that is regarded as a pure larch crop is about $45\frac{1}{2}$ acres. The Siberian larch seeds freely and naturally seeded trees can be found at a distance of over a mile away from the present plot.

To all appearances no fellings or thinnings were made in the pure larch plots. Windfalls and dead timber and fallen branch wood were removed but no thinnings were made. The treatment contrasts strongly with that given to the Punkaharju plots.

Some idea of the volume production of the tree may be obtained from the following figures. On the heaviest volume-producing plot there was a volume per acre of 15,000 cu. ft. at an age of 183 years : the average volume per tree was $78\frac{1}{2}$ cu. ft. and the mean height of the trees in the plot was $122\frac{1}{2}$ ft. Some measure of comparison of the volume production of European larch and Siberian larch may be made as below :—

	Average Volume per Tree.	Age.	Height.	B.H. Diam.	Stems.	True Volume.
	(Cubic feet.)	(Years.)	(Feet.)	(In.)	(Per acre.)	(Per acre.)
Section IV Raivola ..	65	110	114	15·6	119	7,500
Drummond Hill Elevation 1,450 ft.	$43\frac{1}{2}$	119	87	16·6	210	9,150
Drummond Hill Elevation 850 ft...	59	125	78	19	185	10,940

The Punkaharju area is fairly well known as a tourist centre. There is a research station here also, and the Siberian larch crops are in this area. The oldest Siberian larch there dates from 1877 and is partly on land that was formerly cultivated and partly on a moraine heath. The area of the oldest wood is about four acres. The wood was formed by planting; four-year-old plants were used. In 1880 the plantation was beaten-up with three-year-old plants and at the same time two-year-old Scots pine

seedlings were interplanted between the lines of larches; these seedlings died as did also one-year-old seedlings which were planted in the following year. The wood therefore has been to all intents a pure wood throughout life. In 1924 two permanent sample plots were formed : these represent two high quality types of soil. A short comparison is made below between these plots and 1st Class quality European larch plots of Great Britain.

Age 47 Years.	*Trees per Acre.*	*Av. Ht. (feet).*	*Av. B.H. Diameter. (in.)*	*True Vol. per Acre U.B. (Cu. ft.)*
S.L. (OT)	186	76½	11·8	3,800
S.L. (OMT)	200	74½	10·5	3,540
E.L. (1st quality)	295	78	10·75	5,550

A comparison has been made between the dominant trees of the Raivola plots and the Punkaharju plots by Lappi Seppala; the results are given in a very summary form here.

The maximum current height increment at Raivola is reached about 25–30 years. The mean annual height increment is highest between 40 and 45 years. The current height increment falls off slowly. At Punkaharju height growth has been more rapid : the current annual height growth reaches its maximum about 15–20 years. Thereafter the current height growth falls off rapidly; the average annual height growth is greatest about 30 years. For the period during which a comparison is possible the superiority of height growth is in fact at 20 years 14 ft.; at 30 years 17 ft.; at 40 years 12 ft., and at 50 years 10 ft.

The difference in breast height diameter measurements is in favour of the Punkaharju plots up to an age of 50 years. The statement below gives the comparison between trees of the second richest quality class in the two places.

At 20 years	2·1 in.
,, 30 ,, ...	2·24 ,,
,, 40 ,, ...	1·38 ,,
,, 50 ,, ...	·71 ,,

The current diameter increment at Punkaharju shows a quick fall off at an age of 40–50 years.

At Raivola the current annual volume increment was reached about 60 years; the current annual increment falls off very slowly after the maximum is reached. The maximum average annual increment had not been reached at 180 years. At Punkaharju the maximum current annual increment had been attained between 20 and 30 years.

DAMAGE BY RED DEER IN THE HIGHLANDS.

By K. MACKAY.

Red deer (*Cervus elaphus*) are on the increase in the Highlands in spite of various reports regarding the activities of illicit sportsmen with electric spot lights and various other weapons.

Damage caused by deer may possibly be accounted for by the three following main causes :—(1) food shortage, (2) seasonal changes in the life of the deer and (3) mischievousness.

(1) *Food Shortage.*—Under this head may go three distinct types of damage, as follows :—(*a*) cropping or nibbling buds and shoots; (*b*) uprooting, and (*c*) gnawing.

(*a*) Cropping or nibbling is carried out in an irregular manner as the animal wanders through the plantation, the damage being greater or less according to the age of the plantation.

(*b*) Uprooting. This is found in roughly circular areas mainly due to the animal taking a bite, or hold, of the plant at a point that does not break or yield readily and withstands a greater strain than the possibly recently planted root system, which is thus torn completely out of the ground and is left lying about.

(*c*) Gnawing. This is carried out in older plantations and usually done during hard weather, heavy snowfall and hard frost, or more likely a combination of both and great shortage of food generally.

2. *Seasonal Changes*, in the life of the deer (stags especially) may account for :—(*a*) rubbing posts and (*b*) fraying spots.

(*a*) Rubbing posts. These when caused by wild deer (deer not fed by hand during winter, spring and early summer) are fairly isolated and are found at a good view point, sometimes above a rocky face. They are used mostly when casting the antlers and " coat ", and possibly on account of warble fly. The young tree is badly scratched by the antlers first and the work of destruction is continued during the coat casting, by which time the tree is completely girdled and generally has a definitely polished appearance.

(*b*) Fraying spots. This is a minor type of damage and these spots are generally found in quiet hollows—rushes, bracken and branches having the appearance of being thrashed about when the stags are casting the " velvet ".

3. *Mischievousness.*—Stripping and peeling. This type of damage is found in the quiet and more sheltered parts of the plantings before or about the rutting season. Opposite sides of the plant are stripped or peeled of bark and usually the best type of tree in the locality suffers most.

Trees attacked. All trees planted in the northern forest areas are liable to the destructive attention of the wild deer. These being in the main, pines, larches, spruces and firs.

Remedial Measures.—Apart from that "canny" individual, the forest trapper, fencing is the best cure, except, of course, wholesale slaughter. The best type of deer fence may be erected from the following specifications :—

Six ft. high, six wires (5 P. and 1 B. wire) No. 8 P.W. and 2 strand 4 pt. and 6 in. apart B. wire. Rabbit netting 42 in. $\times$ 1$\frac{1}{4}$ in. $\times$ 18 gauge. Sheep netting 24 in. $\times$ 4 in. $\times$ 17 in. gauge. Tying wire No. 18 gauge. Fencing staples 1$\frac{1}{2}$ in. Dropper staples 1 in.

Stobs 8 ft. 6 in. $\times$ 3 in. $\times$ 3 in. or round 3 in. dia. at small end, 18 ft. apart and 5 droppers between 3 ft. 6 in. $\times$ 1$\frac{1}{2}$ in. $\times$ 1$\frac{1}{4}$ in. Two droppers above and three below. Top wire barbed and above sheep netting. Fence gauge :—from ground level 5 in., 15 in., 16 in., 12 in., 12 in., 12 in., and straining posts to be 10 ft. 6 in. $\times$ 9 in. dia. at small end.

The above fence is the best defence against the Highland forester's three "R's"—Red deer, Roe deer and Rabbits.

TREATMENT OF BIRCH.

By F. W. A. Oliver.

The following notes are meant to refer in particular to forests of the Highland type, but may have a somewhat wider application. There appears to be no topic or operation in forestry about which a first-class discussion—or, less politely, an argument—cannot be started. The treatment of birch is no exception and, as a topic of discussion, is coming more into prominence every day. The following remarks, therefore, are personal opinions only and do not describe official technique or beliefs.

There used to be an explanatory note concerning Part I of the Progress Sheet. It declared that the operation of "cleaning" covered the "removal of weed species". Birch is usually regarded as one of these weeds. This is a most unhappy state of affairs. Birch should rather be regarded as one of the forester's firmest friends. The person who lays about him so zealously and lustily with his slasher may quite often be doing as much harm as good.

Birch may be considered as having a double significance: aesthetic and silvicultural. (Its direct economic value in British forestry is, at present, slight). While ideas of beauty may differ on most subjects, there is general agreement about birch. Its aesthetic value, particularly in Highland forests, is undeniable. Singly, or in masses, in spring, in autumn, or indeed in any season, birch adds enormously to the scenic value of the country. It mellows the rugged landscape and gives life to the flat one, and the early Commission policy of wholesale birch extermination can be justified only by the urgency of the planting programmes. To devastate an area at the present day by such methods would be almost criminal and would, in any case, be quite unnecessary. From the point of view of beauty, then, birch should not be got rid of before planting, and should in fact be retained as long as possible.

The silvicultural significance of birch is a real bone of contention. Even its stoutest opponents, however, admit its initial advantages as cover. Chief among these are shelter and non-disturbance of natural drainage. The sheltering effect is very marked. Every forester must have seen, for example, plants of *Tsuga heterophylla* green and happy in birch scrub, while just outside they have a jaundiced and miserable appearance. As regards drainage, the felling or girdling of a birch wood has a definite harmful effect, particularly on slopes. The reasons for this are not entirely clear, but are probably allied to retention in the soil of part of the water that was formerly transpired, and to the death and decay of the roots, thereby closing up drainage channels. In certain cases, slopes of a good grass type, under open birch wood, have been observed changing to wet sphagnum types within a remarkably short time after killing of the birch. On such sites it is often found after planting that heavy drainage has to be done before the young coniferous crop can be induced to grow.

The " soil improvement " effect of birch on inferior sites is also controversial. It is probably due as much to root action as to the beneficial effect of the leaf-fall. From general observation it seems fairly certain that soils under past or present birch woods are not podsolised or impoverished, and are more desirable from the forestry point of view, than adjoining soils where birch has long been absent. This may be a cause as much as an effect. Able scientists, however, have some faith in the ability of birch to enter and ameliorate the upper layer of hard drift which is such an effective barrier to the roots of most trees.

These are a few of the points in favour of birch. Coming to its treatment before planting, one can say that no hard and fast method has yet been tried and found successful in this country. Complete removal by felling or girdling can be ruled out. Complete retention is nearly always impossible, except in old, very open, birch woods. The old British method—compromise—must be adopted. This indicates a method of partial clearance, which can be carried out in a variety of ways. One can give only an extremely brief outline of some of these ways.

One method is to thin out the birch, leaving a fixed number of stems to the acre; then to plant through the wood at the normal spacing, with the intention of removing or girdling the remaining birches when the conifer crop has reached a suitable age. That age, presumably, will be reached when the crop is fully established and has received the benefit of the shelter but is not yet being hampered seriously by the overwood. This method has the merit of simplicity and seems to be the one most favoured by the powers that be.

Another method, more particularly in strong young birch, is clearance in strips or rides. The cleared strips are planted at a suitable spacing. Full shelter is retained and the method is simple to carry out, but is limited in its scope and is likely to involve rather expensive treatment after a few years.

A third variation, on a somewhat different principle, is group-planting or " grouping ". It is the most involved method and requires intelligent work and close supervision, which only add to its interest. In birch scrub there are invariably gaps or blanks of varying size. These, where not on unplantable ground, are used as the foundations of the groups. They are modified and enlarged where necessary by girdling or felling. Brush disposal is simple, as the trees can be felled clear of the groups. The groups need not be uniform in shape or size. The formation of groups is described in this Journal by one who has practical experience of the work.

The future treatment of group-planted areas will have to be developed as the problems arise. At present one believes that on soils of medium and inferior quality it is highly desirable to retain a substantial proportion of birch in the conifer crop as long as possible. This may prove difficult and may mean encouragement of young birch later on to replace the original birch between the groups. It will mean, also, that the best type of birch must be encouraged—a very different tree from the normal unit

in old birch scrub. How the conifers on the edges of each group will be affected is not yet known with certainty. The future culture of the mixture will be difficult and of the greatest interest to those responsible. One declines to prophesy, but when one considers, for example, the successful treatment and involved technique in the Danish " thinning " forests of hardwoods, one cannot doubt that the problems will be successfully solved.

NATURAL REGENERATION OF SCOTS PINE IN GLENLOY.

By W. N. GIBSON.

In most countries where forestry work has been systematised, natural regeneration is recognised as being of great importance in re-establishing felled woodlands. It is worthy of note, however, that in all these countries there appears to be a tendency in recent years to give more careful consideration to the formation of woods by planting.

Natural regeneration can and does present certain advantages, but it is debatable whether low formation costs is one of these advantages especially when the length of the formation period is considered. In certain cases it may be possible for us to make use of the advantages offered by natural regeneration in this country. For example in this Division " browning " and loss of needles in young Scots pine plantations have naturally directed attention to the choice of a type of Scots pine which may possibly be resistant to browning, or to a system of formation which may give some protection to the young crop. The effects of browning are most severely felt in West Coast conditions and as there are remnants of old, natural forests on several of the forest areas, it appears reasonable to expect that the produce of these trees will be more resistant than the imported, planted stocks. The following observations were made in Glen Loy which is fairly typical of West Coast conditions where an attempt is being made to regenerate naturally one of the areas of native Scots pine :—

General Description of the Area.—The area extends to about 50 acres and this has now been set aside for natural regeneration purposes. The trees vary in age from mature to very old trees which are now beginning to die-back. Stocking is poor and in only a few places does it approach that of a normal forest. A fairly high proportion of natural birch occurs in mixture, especially on wetter ground. The wood was for many years used as a deer sanctuary and at the time of its enclosure in 1933 there were practically no signs of natural seedlings.

Soil and Vegetation.—The ground consists of a number of comparatively dry knolls and ridges with intervening wet hollows. Surface peat occurs over the whole area varying from shallow black peat drying-out hard on the ridges, to deep well-decomposed material in wet hollows. Strong leaching is evident on the knolls with a distinct grey layer and strong iron deposition above the underlying drift. Calluna is dominant over the whole area with molinia, myrica, scirpus and patches of sphagnum on the flushes. On the ridges *Vaccinium myrrillus* occurs in patches. Sparse bracken, hynaceous mosses and clumps of sphagnum also occur.

Preliminary Steps to assist Natural Regeneration.—In the spring of 1935, after the area had been enclosed for over a year, some signs of natural seedlings were found and it was decided to lay down a simple experiment to find out if natural regeneration could be accelerated by artificial assistance. The experiment consisted of preparing about 60

plots, the turf being removed and the soil broken up. A light dressing of ammonium phosphate was applied to about half the plots. Each plot was about a yard square and they were all placed on the drier knolls. No sign of any seedlings was observed during the summer and it was not until September that they began to appear in any number. Plots which had been treated with ammonium phosphate did not appear to be any more successful than untreated plots. Counts of the seedlings in the plots were made at intervals as follows :—

November, 1935		72 seedlings.
April, 1936	..	67 seedlings.
November, 1936	..	428 new seedlings. 34 two-year seedlings.

The second count in April, 1936, was made in order to find out whether any seedlings had germinated during the winter and also to determine the death rate due to frosting, as the winter had been very severe. From the result it is seen that the number was approximately the same as in the autumn count. A few dead seedlings were found, deaths being due to frost lifting, but no new ones were in evidence. From the third recount it is evident that 1936 was a much better seed year than the preceding year. Also germination occurred much earlier, being first evident in May and June. The reason for the earlier germination in 1936 was in all probability the dry weather in early spring which allowed early opening of the cones. In the previous year each of the first four months had a higher rainfall. It is also interesting to note that of the seedlings which germinated in the first year less than 50 per cent. survived as two-year seedlings. The loss appears to be largely due to frosting and drying out. At the first count seedlings were found in 50 per cent. of the plots, while at the third count 90 per cent. of the plots contained seedlings. The number of seedlings to the plot at the last count varied from 0–27.

Factors influencing Germination.—The reason for certain plots having more seedlings than others, and some being without any, is not readily apparent, but in all probability the factor of greatest importance is sufficient soil moisture at the time of seeding. This will be largely dependent on the weather and on the water-retaining capacity of the medium for germination. It was at first thought that germination was more successful in plots where there was a proportion of mineral material mixed with the peat, but on the results of two years experiments it appears that germination is equally good where no mineral material exists, provided the peat is of the non-compacted and well-decomposed type.

More intensive Efforts to assist Natural Regeneration.—In the early spring of 1936 it was decided to proceed with more intensive treatment than had previously been tried. The treatment of the ground was as follows :—

Flushes.—Half the wet ground was drained intensively and inverted turfs were put out in blocks of 6–8. These turfs and the bottoming material spread along the drain sides were then sown with birch seed which had previously been stratified for a month in sand. The seed was

covered with a thin layer of mineral soil taken from the side of one of the knolls. A portion of the turfs was previously treated with ammonium phosphate. The birch was sown with the idea of getting a crop on the more unfavourable ground and it was hoped that a certain amount of Scots pine would also come in. The result was excellent, germination of the birch being extraordinarily good over all and a large number of newly germinated Scots pine also appeared. The effect of the artificial manure on germination was negligible, results being equally good on the untreated ground. The remainder of the flush was drained at wide spacing, the turfs being spread as before. This was done in order to compare the results with those on the intensively drained ground, it being thought that intensive drainage might have an adverse affect on germination by drying out the ground to too great an extent. So far it is impossible to assess the relative efficiency of the two methods.

Knolls.—These were drained with deep contour drains, the mineral material being thrown out clear of the drains and spread over a three feet wide strip.

(*a*) Heather burnt off. One of the knolls treated as above was burnt clear of heather and vegetation with a Hauck gun.

(*b*) One knoll was burnt and top dressed with ammonium phosphate.

(*c*) A further knoll was treated by tearing up narrow strips about 4 ft. apart.

The results obtained from the above methods did not show any appreciable difference, germination being good over all the ground where the surface soil (including peat) was exposed. In the case of the knoll with the screefed strips—this method had the advantage of being much cheaper than the others, but it did not prove very successful. This was due to the working of the strips being too shallow, only the top layer of peat being exposed and this was of a fibrous nature containing little humus. The result was that the surface of the prepared strips having no water-retaining qualities, rapidly dried out and left a poor medium for germination. It is proposed to give this method a further trial, but care will be taken to work the strips deeper if the surface layer is unfavourable.

Although seedlings germinated freely over most of the prepared ground, wet or moist conditions appeared to be most favourable, and seedlings were found in numbers even on the sides and bottoms of the drains.

Natural Regeneration outside the prepared Ground.—Although most abundant on the prepared ground the seedlings were by no means confined to it and germination is now evident over most of the ground with the exception of dry *Vaccinium* knolls and patches of bracken. Regeneration appears to come equally well on knolls and flushes—representing both driest and wettest conditions—but generally the best regeneration is on bare patches including old paths, short heather and also short sphagnum of the tight cushion type and usually red in colour. Where the sphagnum is of the open type and ranker in growth few seedlings occur. The most successful regeneration on untreated ground was found on a small knoll

with a dominant vegetation of calluna and patches of short cushion sphagnum. Seedlings averaged five to the square yard, and were aged from one to six years.

Conclusions.—One of the most striking facts regarding natural regeneration on the area as a whole is the large number of seedlings which have appeared since the enclosure of the area against deer. Not all of these have germinated since the enclosure, but many existed before and are only now appearing through the vegetation. It is, however, certain that the ultimate survival of seedlings was previously impossible on account of the severe cropping by deer and this is also evident from the fact that few young plants between heights of 5–15 ft. are to be found anywhere on the area.

In the study of the effects of artificial assistance on natural regeneration several factors which might be of importance were investigated :—

(i) *Nearness of Parent Tree.*—Germination was often quite good even when the prepared ground was well away from any old tree, and on the whole the best results were obtained on ground which was not directly shaded by an old tree. The drip from parent trees was found to wash seedlings completely out of the ground in places. The drying effect of the surface roots of the pine may also exercise an unfavourable effect on the germination conditions. Those unfavourable circumstances are probably more important than the light demands of the germinated and germinating seedlings.

(ii) *Soil Conditions.*—Pure peat, especially when of the well-decomposed type, appeared equally good to mineral soil as a medium for germination. When the peat was of the fibrous or black, not decomposed type, drying out hard, few seedlings appeared on it and these usually occurred in cracks or crevices. In several cases the only seedlings found on a turf of this kind occurred in the holes left by the prongs of the draining drag. A loose medium readily penetrable to the roots of seedlings and with a fairly high moisture content seems to be most suitable for the germination of Scots pine seedlings.

(iii) *Application of Ammonium Phosphate.*—This did not appear to have any appreciable effect.

(iv) *Burning-off Heather.*—No advantage was evident.

The high death rate of seedlings between the first and second years is probably inevitable as many of the seedlings first germinating are very insecurely rooted and are, therefore, liable to drying-out and frosting. It will be interesting to observe the death rate of the now two-year-old seedlings, but in all probability this will be negligible as they will by now have established a satisfactory root system. As regards the time of germination this will always be dependent on weather conditions in the year in question. Careful treatment will be necessary in the flushes where the birch has been sown and a certain amount of thinning out will be necessary in order to preserve a mixture of Scots pine. The management of this natural mixture should provide scope for some interesting observation later on.

It is recognised that the conditions which have been described and also those which prevail at present in most West Coast pine areas are not typical of the normal forest. The physiological conditions necessary for germination are well established, and in bringing about the natural regeneration of any area the foresters' problem is to establish these conditions in the easiest and quickest way possible for the particular area. The regeneration of a normal forest area would introduce similar factors to those which have been dealt with, certain variations which would have to be met by corresponding alterations in the methods of procedure.

MISCELLANEOUS NOTES.

Description and Removal of Wolf Trees.

Wolf trees may be described as being large, dominant trees with spreading branches and crooked or deformed stems which do great harm in a crop by suppressing more valuable trees. Wolf trees which do injury by thick and wide-spreading branches must not be confused with very fast-growing trees with narrow, fine branches. The latter may be an extremely good type. The sooner injurious wolf trees can be taken out the better; most of them should be removed in the first two thinnings. It is a common error in thinning to leave wolf trees in a young stand from a fear of breaking the canopy, but in a young stand an occasional hole in the canopy is quite harmless. At a later stage a much more serious gap is caused and it may often be necessary to keep a tree which will never be good for anything but firewood merely because it has been allowed to grow too big to remove safely.

J. M. Murray.

On this subject Mr. J. Macdonald writes :—

"To my mind the most important thing is the distinction to be drawn between wolf trees proper and very fast-growing trees of good type. The latter are often found to be suppressing smaller trees in their vicinity, and I have had on several occasions to check foresters who were inclined to treat such trees as wolves and remove them. Actually these fast-growing trees ought to be regarded as possibles for the final crop and it is remarkable how they improve in appearance when pruned. Foresters must judge a wolf tree not only by what it is but by what it does. They have to be satisfied that a tree which they intend to remove is either doing damage to better trees or is capable of doing damage before the date when the crop will next receive attention."

Sessile or Pedunculate Oak?

When establishing new oak plantations I consider it advisable to use as many plants of the sessile type as can be obtained. When, as often happens, it is impossible to obtain sufficient sessile, and pedunculate have to be used as well, the former should be distributed so that enough of them would be planted as would form the final crop. The advantages of the sessile are that it grows much faster than pedunculate, is usually cleaner and is less susceptible to the ravages of caterpillars. Whether the quality or durability of the wood is as good is more doubtful. If, when the Forest of Dean was planted, sessile had been used, I consider the volume per acre would have been practically double what it now is, and with the bigger girth the value per cubic foot would have been increased some 25 per cent.

As to what our predecessors thought, the following article may be of interest :—

(From the *Quarterly Review* of January, 1829) :

> "We may here notice a fact long known to botanists but of which our planters and purveyors of timber have no suspicion that there are two distinct species of oak in England, the *Quercus Robur* and the *Quercus Sessiliflora*; the former of which affords a close-grained, firm, solid timber rarely subject to rot; the other more loose and sappy, very liable to rot and not half so durable. This difference was noticed so early as the time of Ray; and Martyn in his *Flora Rustica*, and Sir James Smith in his *Flora Britannica* have added their testimonies to the fact. The second species is supposed to have been introduced some 200 or 300 years ago from the Continent, where the oaks are chiefly of the latter species, specially in the German forests, the timber of which is known to be very worthless. But what is of more importance to us is that the impostor abounds and is propagated vigorously in the New Forest and other parts of Hampshire, Norfolk and the counties about London; there is too much reason to believe that the numerous complaints that were heard about our ships being infested with what was called improperly enough, dry rot, were owing to the introduction of this species of oak into the naval dockyards, where we understand the distinction was not even suspected."

It is noticeable that most of the few remaining old oaks in the Dean are of the Robur species and although most of them are past their prime there are some fine specimens amongst them up to 15 ft. in girth.

F. Smith.

Pine with Spanish Chestnut.

It has been noticed that areas most favourable to young Corsican pine plantations are producing good chestnut from the stools of the previous crop of mixed hardwoods, and the two species are growing well together. There are doubtless similar areas where chestnut might be introduced with advantage in what would normally be pure Scots or Corsican pine.

Chestnut poles removed in thinnings are often more remunerative than pine poles of similar size. The stools after thinning usually coppice strongly enough to maintain the canopy, forming a second storey which should obviate the necessity for underplanting. There are instances of mature Scots pine and chestnut in mixture on similar soils so there are grounds for assuming that the best chestnut might be allowed to remain to the end of the rotation and marketed at a time when little oak is available.

B. Gale.

Frost Lift Experiments.

Experiments have been made in Rhinefield Nursery, New Forest, with a view to preventing frost lifting of Sitka spruce and Norway spruce seedlings.

Experiment suggested by Mr. D. W. Young.

A layer of moss was shaken lightly over and between the lines of seedlings, thick enough to cover the soil and seedlings. Up to the present there has been no discoloration or harm of any kind. The plants are looking extremely well. On another occasion the moss should be collected earlier in the season in readiness for the winter.

The main difficulty has been to prevent the moss being blown away by the wind. We found that where the seedlings were deprived of their covering a certain amount of damage occurred, although the moss was replaced and slightly weighted with leaf mould as quickly as possible. Where the moss remained in position, the seedlings kept perfectly. The moss was left on until frosts were over for the season and when removed, the seedlings went away well.

Experiment suggested by Mr. F. Scott.

Small Douglas fir twigs closely stuck in to form a windbreak were used so as to form a canopy over the young seedlings.

This method seems to be quite effective. No harmful effects were noticed and the seedlings were quite good, but there was less height growth than where moss was used. The chief advantage of this method is that it is not very costly.

Experiment by Forester.

Good beech leaf mould was taken from ditches and holes. A fairly fine sieve was used in sifting it directly over the seedlings. It was found quite easy to do and it formed a covering for the soil.

The seedlings were not lifted by frost and showed specially good root systems. Height growth was not quite equal to the moss-covered beds.

The method is not costly to carry out in districts where leaf mould is obtainable, no expense is entailed in removing the mould as it does not cover the tops of the seedlings and acts as manure in addition to keeping down weeds.

It is only fair to mention that the season did not prove particularly suitable for the tests as we had no long or severe frosts and very little frost lift.

O. R. T. Aston.

Intensive Nursery Production.

A note in the 1933 issue of this Journal discussed a semi-bedding-out system for the production of nursery transplant stock. As a somewhat similar method has been employed in Wykeham Experimental Nursery during the past three years, some further observations may be of interest.

During the first two years seedlings were lined-out at a spacing of 6 in. by 1 in. in beds 4 ft. wide separated by alleys of 1 ft. Transplanting was carried out by the board method, the boards being marked off to allow space for alleys; lining-out was, therefore, carried out in the usual way. This method gave 17,280 plants per 100 square yards, alleys included, as against 6,500 for the more usual spacing of 10 in. by 2 in.

During the summer all weeding and hoeing was carried out from the alleys, treading of the beds being avoided. The species employed were one-year Japanese larch, Scots pine, Norway spruce, Sitka spruce, *Pinus contorta*, and two-year Sitka spruce and Norway spruce. In the case of the pines and larch it was found that the less vigorous plants were suppressed. Such instances were, however, infrequent, but from general observations it was decided that a spacing of $1\frac{1}{2}$ in. in the lines would be preferable for all species.

In the third year the beds were increased to 8 ft. in width and the alleys to 1 ft. 3 in., the spacing in the lines being $6 \times 1\frac{1}{2}$ in. This gave a density of stocking of 12,640 plants per 100 square yards, alleys included. The resulting stock at the end of the first year was equal in size and root development to that raised at a spacing of 10×2 in.

To sum up one would say that the method is not primarily intended as a means of disposing of small or weakly stock. Rather does it commend itself to the use of strong one-year seedlings of pine and larch, and both one-year and two-year seedlings of Norway spruce and Sitka spruce. It is, however, essential that the plants do not remain for more than one year in the beds.

Up to the present the method has shown no disadvantages. It is as cheap as normal lining-out. By arranging the plants in beds, practically all cultivation takes place from the alleys, thereby avoiding treading on the soil, between the plant lines.

J. WEATHERELL.

INCREASE IN RABBITS, CYNWYD FOREST.

Owing to the enormous increase in rabbits during the last two years it has been very difficult to keep them out of the plantations. Once in, it is still more difficult to get them out, especially in the older plantations where dogs are unable to hunt them owing to the thick undergrowth. I find that the following are the chief causes of rabbits getting inside the plantations :—

(i) From adjacent land where no netting has been used for fencing (only plain wire fencing). This is the main cause.

(ii) Through wall fences where stones are loose and open and over the netting that has been put along the top of them and pegged in the wall.

(iii) Gates being left open, if only for a short time, even during the day.

(iv) Streams running through the plantations lifting the netting during floods.

(v) Farmers, who may have a grudge, throwing young rabbits in.

(vi) Climbing the wire netting. (I have seen this done.)

(vii) Burrowing under the netting. This happens where the rabbits are numerous.

From the above it will be seen that it is more or less impossible to keep rabbits wholly out of the plantations, and they can only be kept down to a minimum through snaring and trapping. Should this increase continue, I am of the opinion that some drastic steps should be taken to exterminate rabbits on land outside the plantations. It is quite true that hundreds of rabbits are destroyed by farmers and keepers during the winter months, but far too many are left for breeding purposes.

D. T. EDWARDS.

FENCING: GETTING THE RIGHT MAN.

One of the first operations in a new acquisition is to enclose part of the area and it is essential that the Forester gets hold of at least one good fencer. A fence badly erected means a lot of worry and fencing upkeep is costly. However, the Forester may be living in an isolated spot and may find it difficult to obtain a good man. The vicar is sure to call and the Forester may mention that he requires a good man for fencing. The vicar is equally certain to know the right man. He is a sidesman, sings in the choir and is handy at garden fetes, etc. The vicar gives him a few jobs in his garden, but being a poor man, cannot afford to pay much. This man is not in regular employment but is just what is wanted. The Forester may take a stroll to the nearest village after tea and he may mention his requirements to the landlord of the "Pig and Whistle." The landlord knows the right man. This man has had a long spell of unemployment and has 20 or more pints on the slate; but he is a splendid fellow. The village grocer also knows the right man for the job and has his reasons for making the recommendation. The Forester may fix up with one of these men, but he will have to watch him for a week or two and make him do all shoddy work over again. The Forester will be lucky if, when he goes round his plantation he finds no trace of sheep or rabbit damage.

G. H. BROWN.

FENCING STEEP SLOPES.

At Beddgelert Forest we have an experiment on a steep slope known as the "Exposure experiment." The altitude at the bottom is 1,350 feet and at the top 1,820 feet; the length from bottom to top is 15 chains, so that it rises 1 in $2\frac{1}{8}$. This was planted in 1927. Last March this experiment was severely damaged by a snow avalanche. Both side fences were dragged from top to bottom, one of them coming through the experiment severely damaging trees on its way down. In future if the adjoining area or any other very steep slope is to be planted we shall have

to do everything possible to put straining posts down twice as deep and have twice as many, strainers to be placed not more than 40 yards from one another. This fence will cost more to erect than the ordinary fence, but it will be the cheaper in the end, as I think that a good strong fence should hold a terrific weight of snow, thus saving your fence and plantation. In this small area about 2,000 trees were staked.

J. E. Evans.

Pruning.

There seems to be some difference of opinion as to the advisability of pruning trees. One of the objections is that the pruned branches sometimes leave small hollows in the timber which fill up with resin. No doubt this is the case, but I have not found it to be so bad as to lessen the value to any great extent. In my opinion, one big advantage in pruning is the clean look it gives to the trees, and if the article you have for sale looks clean and well, it will sell well. In one plantation, 28 years old, at Sherwood Forest, a strip of two acres of selected Corsican pine has been pruned. The method adopted was first to cut off the lower branches with a sharp slasher to a height of about seven feet and finish off with the pruning saw to about 18 feet. The cost worked out at about 25*s*. per acre, pruning approximately 350 to 400 trees. A very great improvement was seen. I would advocate pruning Corsican pine, especially as judging by the mature trees I have seen, the dead branches seem very reluctant to fall, and consequently give the timber a very coarse appearance. It is more than possible that the original cost of 25*s*. per acre for pruning, would lift the price of the timber £10 to £20 or even more when it was ready for the market amply justifying the extra expenditure.

R. Bewick.

Gyrotilling of Forest Land.

P.36 saw at Clipstone what I understand to be the first large-scale utilisation in forest practice of a " gyrotiller," a machine which has come into considerable favour on large farms. The area so treated extended to a hundred acres and carried a strong *Aira flexuosa* vegetation, which consisted of tussocks some 18 in. to 2 ft. in depth. Before treatment it presented a most unattractive appearance and much thought was given to procedure.

Immediate planting would obviously entail costly cutting out of a thick turf, leaving a deep hole in which Corsican pine would be exposed to frost danger and smothering from grass and bracken fronds, which would inevitably collect there each winter. Ploughing was impossible unless the area could first be burned. This, in turn, was impracticable in winter as the thick turf rarely dried out sufficiently and in summer the claims of nesting birds and the danger to surrounding plantations ruled it out.

A demonstration of a gyrotiller was carried out by a firm of salesmen in April and convinced us that here lay the solution of the problem. The machine which ultimately churned up the area, consisted of an 80-horse-power, caterpillar tractor, in the rear of which were incorporated two tillers, each bearing five " scythes " or arms. These tillers could be raised and lowered hydraulically when the machine was in operation. When lowered to the ground, the rotating arms buried themselves to a depth of two feet and stirred the soil round, " as though it were porridge," as a Scots spectator remarked. Personally, I was not reminded of this delicacy and was more concerned with what was happening to the turf. I had hoped that it would be broken up and buried in the eight-foot track of disturbed soil. Comparatively little, however, was actually buried. Instead it was wrenched up, whirled round and partly disgorged at either side by the tillers. Much of it collected between the tillers and the rear of the driving mechanism, from which it had to be cleared by the raising of the tillers. These continued to rotate in mid-air and quickly flung out the clogging mass, whereupon the machine was reversed to catch the piece of ground missed in the clearing process and the scythes again lowered. This clearing was necessary every 15 yards or so, but the driver soon became expert at the operation and good progress was made. Work proceeded night and day, as the tractor was equipped with powerful headlights, and the area was completed in a fortnight, at a contract price of 30*s*. per acre.

Six months have elapsed since the area was treated and the soil has begun to settle down fairly completely. A small portion will be planted late in the present season, but the loose state of the soil confirms the wisdom of carrying out the work a year ahead of planting. Practically all the grass has died and the area should be in ideal condition for P.38.

L. Wyatt.

New Uses for Fencing Wire.

It sometimes happens that a forester finds himself in the paradoxical position of being surrounded by a million or two of young trees in his nursery and yet not having suitable wood for making tally pegs. An easily made and permanent substitute can be fashioned from plain fencing wire. The procedure is as follows :—Take two pieces of No. 8 gauge wire, one 3 ft. and the other 8 in. longer. Double each piece in the middle, making a loop $1\frac{1}{4}$ in. wide at the bend, and place them together in a vice keeping one loop four inches above the other. Twist the " legs " projecting from the vice, working the twisting down to about 6 in. from the free ends. This leaves a " spread " of four wires, to insert into the ground to hold the peg upright. At the other end are the two loops. Bend the longer one, which projects 4 in. above the shorter, 2 in. down and 2 in. up. This forms a " U " backed by the shorter, unbent loop, with a certain amount of tension in it, whereby it will close firmly on a wooden tally, 7 in. $\times$ 4 in. $\times$ $\frac{1}{2}$ in. Painted white and bearing the plot legend in black,

this tally looks neat and will last for many seasons in company with the wire peg.

A further use for similar wire is the making of small rakes, which are very handy for the weeding of drill-sown beds and transplant lines. Take two pieces of wire, each two feet long, double them, place the looped ends in a vice and plait the legs as before. Leave about 2 in. of each of the four wires unplaited, bend them downwards and splay them slightly outwards from each other. These form the " teeth " of the rake. A piece of sacking, wrapped round the twisted portion, will prevent any blistering of the hand when using.

J. MacGlashan.

Pre-thinning of Scots Pine, Swaffham.

After an area of approximately 135 acres has been gone through on the pre-thinning work I wish to pass on some of the points which have occurred to me when marking trees which were doing considerable damage to the surrounding crop.

The first thing I wish to mention is the importance of seeing in the first three years of the plantation's life that beating-up with plants suitable in age and uniform in size and quality is done to ensure that when the stage of pre-thinning arrives, which is 14 to 16 years after planting has been done, there should be no breaches in the rows. It is from this source that the undesirable class of pole is derived. In addition there is still remaining the awkward problem, what is the forester to do? This breach has caused some very strong branch development in the adjoining trees which are spreading over the neighbouring crop, and if these trees are taken out the gap is increased out of proportion to the remaining crop. Beating-up in time, therefore, is the safety valve.

Another very important fact to be kept in mind in assistance to pre-thinning is graded planting. It is quite clear that in some of my compartments two grades of trees have been planted (Grade I and Grade II together). This means that in one row is the average Grade I at 16 years, approximately 22 ft. high, and in the adjoining row Grade II, same age, approximately 16 ft. high. Results are easily noticeable—disaster to Grade II plants. In my opinion it is undesirable to have a Grade II plant in close proximity to a Grade I.

In conclusion the whole life and constitution of the forest depends on careful and systematic planting, early beating-up, combined with consistent weeding for the first four years.

T. Hendrie.

Group Planting of Coppice Areas.

An article on the planting of coppice areas in the East Midlands, written by the then District Officer, appeared in Journal No. 14, 1935 (page 93). In that account, Mr. Connell mentioned that P.34 saw the

adoption of the " group " system on eight acres of hardwoods at Bardney. Since then we have had two seasons in which practically all the planting has been done in this way, and the following notes are based on observations made during these years.

A brief description of the area is essential to a proper understanding of the technique. Elevation is nowhere more than 50 ft., and is frequently less than 25 ft. As a result, the forest is subjected to severe and, often, unseasonable frosts, which have caused much damage to oak and ash planted on areas previously cleared of coppice. This coppice, which covers almost the whole of the forest, consists of dense hazel, blackthorn, birch and lime, entwined with strongly growing blackberry and briar. Group-planting has entailed the partial clearing of approximately 100 circles, 12 ft. in diameter and 21 ft. centre to centre. The clearing has been partial, in so far that, frequently a single stem of birch, standing in the circle, has been ringed and left. The circles are then planted with 24 oak seedlings or transplants. Areas so treated are regarded as being 75 per cent. planted, leaving one quarter of the area, represented by the coppice between circles, to be planted later with beech.

To my mind, the great snag in this system is the difficult and costly task of dealing with this remaining 25 per cent. The intervening scrub does not contain a useful, naturally regenerated species—save an occasional birch—which could be utilised. In view of this, the heavy expenditure on preparation of ground, planting and maintenance, necessary to the final filling up of the area, can easily be imagined. One very real practical difficulty will be the disposal of the cut material in a planted area, on which burning will, of course, be out of the question.

My main conclusion is that, wherever possible, planting should be completed at the first operation. To this end, I suggest that the number of groups per acre be increased, with proportionate reduction in the size of the circles and the number of plants per circle. If 150 or, better, 200 groups could be cleared and shelter still be retained, we would have, at the rate of one final crop oak per group, a stocking sufficient to justify showing the area as 100 per cent. planted. At 200 groups per acre, the number of plants would be reduced from the present 24 to 12, a number sufficient, I think, to clean the best stem during the years which will elapse before trees in neighbouring groups begin to influence each other.

Apart from this question of later filling up, I have been convinced from the experience of the past two seasons that the group method of treating such areas marks a great advance on the former practice of clearing all coppice.

G. H. Button.

Experimental Planting at Glenhurich.

In Journal No. 13, 1934, page 126, measurements dealing with a sample plot laid down by Mr. Scott were given. The trees in the plot have been re-measured and the figures dealing with Scots pine, Corsican pine, *Pinus contorta* and Japanese larch are given below. It will be noted

that the order of height growth remains as in autumn, 1933. The measurements were taken at the close of the growing season in 1936.

Species.	Percentage of Death.	Total Average Height.	Current Year's Growth	
			Extremes.	Average.
		ft. in.	in. in.	in.
Scots pine	7	7 0	½ 22	12½
Corsican pine	23	4 6	½ 19	10
Pinus contorta	15	6 6	1 25	12½
Japanese larch	61	9 4½	4½ 27	16½

The figures as arranged above allow a comparison to be made with the figures published in 1934. In arriving at those figures given above the total length of each tree was measured and also the lengths of the shoots of the last three years. It was found in 1935 the average length of shoot was shorter than in 1936 and 1934. This is true for all four species. The 1934 shoots in all species except Scots pine were shorter than the 1936 shoots. The Scots pine shoots of 1934 and 1936 are the same length.

The table given below shows the distribution of the heights of each species of tree over the height classes. Height measurements have been rounded off to the nearest half foot and the percentage of trees occurring in that class is given opposite to the height class. The average height class for each species is indicated by a horizontal line. The grouping of the Scots pine height classes brings out the more even development of the Scots pines as compared with the other species.

Height Class (feet).	S.P.	C.P.	P.C.	J.L.
½	—	2½	—	—
1	1	14	3½	—
1½	2	5	2½	—
2	—	5	3½	—
2½	2	9	1	—
3	3	1½	3½	—
3½	4½	1½	8	10
4	1	6½	2½	2½
4½	1	4	3½	2½
5	7½	4	6	—
5½	5½	5	7	8
6	5½	16	7	5
6½	10	4	7	2½
7	4½	2½	5	—
7½	10	9	6	8
8	4½	4	5	2½
8½	7½	1½	5	—
9	7½	4	3½	—
9½	7½	1	3½	10
10	2	—	7	—
10½	7½	—	3½	—
11	2	—	1	2
11½	3	—	1	10
12	—	—	2½	—
12½	—	—	1	16
13	—	—	—	5
13½	1	—	1	8
14	—	—	—	—
14½	—	—	—	8

WM. MCCLYMONT.

Distribution of Seed by Wind, Inverlael.

During April, 1936, I came across a young sycamore seedling at an elevation of 800 feet on the slope of P.36, at Inverlael. The aspect is westerly, slope steep and well exposed. Vegetation is mainly heather and patches of bracken. The nearest sycamore trees are 700 yards S.S.W. and at an elevation of 100 feet above sea level. The next nearest trees are 1,000 yards due west and at an elevation of 20 feet. From the configuration of the ground in the neighbourhood it is more probable that the winged seed came from the farthest point or source, and has been borne along by one of the small whirlwinds which are fairly common in the locality during the late autumn and winter months. Ash and sycamore seedlings are frequently to be met with on the lower and gentler slopes (100 ft.–200 ft.) and yet ash seedlings have not been found anywhere near the 800 feet level, though ash trees of mature age are at either point mentioned for the sycamore seedling. The farthest ash seedling observed is 550 yards or so from the nearest probable parent tree, which is due west of it and about 50 feet below as regards elevation.

Other views on the subject would be interesting as regards height and distance carried from probable parent tree and whether this is beaten by any other broadleaved or conifer tree.

K. Mackay.

The Bird Cherry and Folk Lore.

The bird cherry has been put to a purpose which, maybe, is peculiar to the north-west of Scotland and the Hebrides. In the not so very long ago, when the people used to believe in witchcraft to a greater extent than now (?) a small twig of the bird cherry used to be carried hidden about the person by the more superstitious members of the community, especially sailors. About 30 years ago it used to be a common practice to procure a small piece of bird cherry twig about 4 in. long, and tie it well hidden in the cows' tails to protect them from the spells of those with the " Evil Eye."

K. M.

Damage by Deer.

Eilanreach Forest, like several others in the North-West Highlands, adjoins a large deer preserve, and the successful prosecution of forestry is greatly hindered by the ravages of deer. Very little damage is done in the earlier stages of the plantation, but when the plants reach a height of about 3 ft. even one red deer can cause havoc. Norway spruce, and Scots pine suffer most during winter and larches in the summer. Only fences erected at a very high figure can keep out starving deer during a severe winter; on large forests where bigger returns are expected, higher initial cost of fencing may be permitted, but on smaller forests where the

fencing cost is proportionately high in relation to the acreage, the cost of deer-proof fences forms a " snag."

Deer, and especially red deer, are exceptionally cunning and are extremely difficult to drive out as they soon learn to take advantage of the cover provided by scrub and rocks. It has been my experience during a deer drive to see men passing within 10 feet of a stag. Incidentally I may mention, I have found collie dogs very useful on such occasions. Driving out only affords temporary relief as sooner or later the deer find their way back again, so that they must be destroyed. This takes up a good deal of time, as it is possible to spend hours and not get within shooting range.

In proposed State forests, where deer are numerous, a compromise should be arranged with the owner whereby the fencing cost is shared, or at least the upkeep cost, as the deer problem is of vital importance to the owner. In the course of a few years if deer are being destroyed in the plantation he will probably lose many fine " heads " and thus the rental of his preserve depreciates.

J. A. MACKAY.

DAMAGE TO JAPANESE AND EUROPEAN LARCHES.

During the autumn of 1935, a peculiar form of what was at first thought to be wind damage was observed among the Japanese larch in Eilanreach Forest in P.29 and 30. Further investigation revealed similar damage among European larch of the same age. Both affected species have a N.N.E. aspect on a steep slope at an altitude of 300 to 500 feet, and are comparatively well sheltered. No damage was found on trees bordering or near ride sides; nearly all of the damage noted was among Japanese larch, European not having suffered to the same extent, the affected trees were in most cases isolated, being more than thirty feet apart. One Japanese larch specimen noted, was 18 ft. in height, breaking off at 4 ft. from the base, the diameter being 4½ in. at the breaking point. The smallest specimen observed was 8 ft. 9 in. in height, breaking off at 3 ft. 9 in. from the base, the diameter at breaking point being 2½ in. In various specimens noted the breaking point varied from 3 ft. 6 in. to 7 ft. 6 in. from the base. Although wind is responsible for the actual breaking, this does not appear to be the primary or only cause. In each case a swelling was noticed at the breaking point which suggests damage to the outer tissues at some earlier period.

J. A. M.

AT WORK ON A SCRUB AREA.

There is commonly a desire for knowledge sometimes from a natural curiosity and inquisitive appetite; sometimes in order to entertain the mind with variety and delight, but most often a man's wish is for deeper knowledge of his profession. In forestry, however, new conditions with their resultant difficulties and problems often arise, and to meet those conditions new methods must be devised and applied. A good example

of this may be found in the treatment of an area which carries a heavy crop of birch or other scrub. It would be a very simple matter to get rid of the scrub, so far as the actual work of doing so is concerned, by cutting it down and burning it, but fortunately, other and more economical methods present themselves, and happily in the interest of the economic side of forestry many new methods are being tried out.

The group system, such as is being done on this area, has much to commend it. The groups are formed by simply cutting down a number of trees, and ringing others, leaving a narrow fringe of the scrub untouched round the edge of each group—the fringes serving some very useful purposes. For instance, instead of gathering the branches of the cut scrub and placing them in heaps for burning, they are simply thrown among the fringe of the groups thus saving an immense amount of time and labour. When the groups are being planted, the first man plants round the edge of the group keeping his row of plants just clear of the shade of the fringe of the group—usually this means keeping the plants 3 to 6 ft. away from the trunks of the trees which form the fringe; then the next man follows, and so on, finishing off the group in the centre.

Large groups are planted at normal spacing, but the spacing is reduced in the smaller ones, about the usual number of plants are thus planted per acre. The groups vary very much in shape and size, but the larger groups with the thinnest fringe of scrub around them are, it would seem, more likely to give the best results. The work of forming and planting the groups is extremely interesting, as is also the observance of their progress, and although it is just rather soon to write about the merits of the system, the results so far are very good, and the outlook promising.

R. Murray.

Scottish and English Pines.

In P.30 at Findon part of the Scots pine supply came from England (Rendlesham Nursery). They were planted in a block by themselves with Scots pine of Scottish origin alongside of them, under the same conditions so that results could be compared later on. Up to the present time little or no difference is to be seen, the only thing is that the English lot is as good as, if not better than, those of Scottish origin which were raised in the home nursery and planted out at the same time, in the same type of ground.

One would think that the home-grown plants would have an advantage as they are usually better adjusted to the climate and soil conditions of the planting site, whereas the English lot had a long way to come by rail, thence per lorry from nearest station to the planting area and had to be handled a good deal, the result being that the roots were very dry with little or no soil attached to them when planted.

I may mention that both the Scottish and English pines were 2 + 1.

W. Mackay.

I think some of the Commission fires might be avoided or less damage done if more tact were used in dealing with the local people.

In my part of the country, where the climate is a dry one, water is very scarce during the summer months. Some of the local people are allowed to go to springs on Commission land. I always find it pays to have stiles erected where fences cross a path leading to those springs, thus saving the netting being torn, also to have gates which can be easily opened. Far better to give a man the key of a gate in order to get water than to cause bad feeling.

After all, in a place like this one's neighbours could, and doubtless would, be very helpful if at any time a fire happened to break out. Of course, I do not maintain that all fires can be avoided in this way as there is always a certain amount of risk in all forests and more so where a railway goes through or near plantations but I think some of them might be.

W. M.

LIST OF TECHNICAL STAFF.

HEADQUARTERS.

At 9, *Savile Row, London, W.*1.

Story, Fraser, Education and Publications Officer.
Guillebaud, W. H., Chief Research Officer.

At Imperial Forestry Institute, 18, *Museum Road, Oxford.*

Sanzen Baker, R. G., 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.
Pearson, F. G. O., District Officer (Utilisation).
Wynne Jones, E., Chief Land Acquisition Officer.
Cownie, F., District Officer (Acquisitions).
Smith, R. H., District Officer (Acquisitions).
Chapman, D. H., District Officer (Acquisitions).
Edwards, S. W., Chief Estates 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.
Thom, J. R., District Officer.
Forsyth, W., District Officer.
Good, G. H., Estate Officer.

Division 2 (15, *Belmont, Shrewsbury*).

Popert, A. H., Divisional Officer.
Fairchild, C. E. L., District Officer.
De Uphaugh, F. E. B., District Officer.
Best, F. C., District Officer.
Cadman, W. A., District Officer.
Robbie, T. A., District Officer.

Division 3 (*Beacon House, Queen's Road, Bristol*).

Scott, Frank, Divisional Officer.
Broadwood, R. G., District Officer, Higher Grade.
Cowell-Smith, R., District Officer.
Backhouse, G. W., District Officer.
Haldane, W. D., District Officer.

Division 4 (*Grand Buildings, Trafalgar Square, London*).

Felton, A. L., Divisional Officer.
Lowe, George, District Officer, Higher Grade.
Stileman, D. F., District Officer.
Muir, W. A., District Officer.
Barrington, C. A. J., District Officer.

Division 5 (*Llandaff Chambers, Regent Street, Cambridge*).

Macdonald, J., Acting Divisional Officer.
Connell, C. A., District Officer.
Ross, J. M., District Officer.
Rouse, G. D., District Officer.
Morrish, C. G., 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.
Currie, J. H., District Officer.
Yarr, W. J., Assistant to Deputy Surveyor.

Division 7 (*Whitemead Park, Parkend, Lydney, Glos*).

Long, A. P., Deputy Surveyor.
Forster Brown, W., Deputy Gaveller (Mines).
Wylie, N. A., District Officer.
Williamson, J. Q., District Officer.
Roper, John, Survey Clerk.

Division 8 (26, *Lowther Street, Carlisle*).

Ross, A. H. H., Acting Divisional Officer.

Division 9 (*Graham Buildings, Newport Road, Cardiff*).

Ryle, G. B., Acting Divisional Officer.

School for Forest Apprentices.

Russell, W. D., District Officer (Instructor).—Parkend, Lydney, Glos.

SCOTLAND.

Assistant Commissioner's Office (25, *Drumsheugh Gardens, Edinburgh*).

Murray, J. M., Assistant Commissioner.
Cameron, John, Land Agent.
Mackie Whyte, J.P., District Officer (Acquisitions).
Beresford-Peirse, H. C., District Officer (Acquisitions).
Webster, John, District Officer.
Mackay, J. W., District Officer.

Northern Division (51, *Church Street, Inverness*).

Fraser, James, Divisional Officer.
Oliver, F. W. A., District Officer.
Spraggan, D. S., District Officer.
Gibson, W. N., District Officer.

North-Eastern Division (12, *North Silver Street, Aberdeen*).

Steven, H. M., Divisional Officer.
Newton, L. A., District Officer, Higher Grade.
Bird, D. H., District Officer, Higher Grade.
Warren, A., District Officer.
Watt, A., District Officer.

South-Eastern and Western Division (53, *Bothwell Street, Glasgow*).

Sangar, O. J., Divisional Officer.
Whellens, W. H., District Officer.
Gosling, A. H., District Officer.
Macdonald, J. Maxwell, District Officer.
James, J. E., District Officer.
Chard, J. S. R., District Officer.

School for Forest Apprentices.

Watson, Harry, District Officer (Instructor).—Benmore, Argyll.

FORESTERS.

England and Wales.

Name.	*Grade.*	*Name.*	*Grade.*
Division I.			
Anderson, T. E.	Head	Everitt, F. W.	II
Weir, A. B.	I	Liddell, Joseph	II
Simpson, G. A.	I	Frank, Harold	II
Bewick, W. J.	II	Massey, J. K.	II
Anderson, J. T.	II	Rowell, James	II
McNab, Colin	II	Scott, J. F.	II
Gough, W. R.	II	Shaw, J. W.	II
Hodgson, William	II	Smith, W. T.	II
Division 2.			
Butter, Robert	Head	Edwards, D. T.	II
Shaw, J. L.	Head	Jones, David	II
Jones, H. W.	I	Jones, Alfred	II
Anderson, J. W.	I	Evans, J. E.	II
Fraser, Robert	I	Reese, W. H.	II
Roberts, W. G.	I	Watkins, Stanley	II
Cowe, J. F.	I	Wilkinson, W. E.	II
Harris, W. A.	II	Tucker, E. J.	II
Harrison, Percy	II	Pye, W. E.	II
Brown, G. H.	II	Williams, H.	II
Small, J. R.	II	Yapp, P.	II
Lomas, John	II		

England and Wales—continued.

Name.	*Grade.*	*Name.*	*Grade.*
Division 3.			
Williams, John	I	Edwards, L. T.	II
Squires, C. V.	I	Wellington, C. R.	II
Hollis, G. W.	I	Carnell, Reginald	II
Wallington, H. J.	I	Jones, W. E.	II
Pallett, R. E.	I	Lewis, T. H.	II
Harrison, Phillip	I	Young, H. C.	II
Laney, Horace	II	Richards, G. H.	II
Pritchard, Roderick	II	West, S. J. C.	II
Jones, A. H.	II	Gunter, A. T. G.	II
Caddy, Thomas	II		
Division 4.			
Dyer, H. C.	I	Phelps, S. E.	II
Nelmes, F. J.	I	McKenzie, Colin	II
Wallington, A. W.	I	Kirkup, J. T.	II
Cottenham, W. C.	II	Hyett, Samuel	II
Gulliver, G. H.	II	Halsey, H. R.	II
Gillmore, D. W.	II	Reid, Duncan	II
Craft, J. H.	II	Wild, P. R. S.	II
Lingwood, N. J.	II	Maund, J. E.	II
Aston, T. H.	II		
Division 5.			
McGlashan, John	I	Parry, A. A.	II
Tribe, William	I	Smith, J. J.	II
Hendrie, T. F.	II	Wyatt, Lionel	II
Clark, J. S.	II	Jackson, W. V.	II
Bewick, Robert	II	Birkett, Albert	II
Johnson, Harry	II	Button, G. H.	II
Gilson, R. B.	II	Saunders, H. J.	II
Price, Alfred	II	Mitchell, A. L.	II
Beasley, F. G.	II	Redford, C. W.	II
Davies, D. J.	II		
Division 6.			
Forgan, William	Head	Kennedy, J. B.	I
Aston, O. R. T.	I	Adams, J. H.	II
Hale, W. J.	I	Parker, F. H.	II
Colwill, S. W.	I		
Division 7.			
Smith, Frank	Head	Adams, Isaac	II
Humphries, W. J.	I	Watson, Frank	II
Lewis, Tom	I	Lees, George	II
Williams, D. N. (School)	I	Morgan, T. R.	II
Walker, A. E.	I	Roberts, E. James	II
Christie, W. L.	II	Davies, J.	II
Taylor, G. J.	II	Little, T. E.	II

Scotland.

N. Division.

Name.	*Grade.*	*Name.*	*Grade.*
Anderson, William	Head	Stewart, P. C.	II
McEwan, James	I	Mackenzie, John	II
Murray, William	I	Mackintosh, Alexander	II
Mason, William	I	Gordon, James	II
McClymont, William	I	Munro, George	II
Mackay, Kenneth	I	Mackenzie, George	II
Macintosh, William	I	Mackie, A.	II
Macdonald, Donald	II	Murray, Robert	II
Drysdale, Alexander	II	Mackay, William	II
Gunn, John	II	Mackenzie, Alex.	II
Cameron, Roderick	II	Campbell, Robert W.	II

N.E. Division.

Shaw, Robert	Head	Mackay, William	II
Lamb, J. A.	I	Kennedy, J. A. M.	II
Edwards, Johnston	I	Robbie, James D.	II
Robbie, John D.	I	Scott, John	II
Mitchell, F. M.	II	Ross, W. L.	II
McConnell, James	II	Ritchie, M. A.	II
Corbett, John	II	Milne, W. G.	II
Allan, James	II	Urquhart, D. J.	II
Ross, Allan	II	Ross, Archibald	II
Allan, Thomas	II	Reid, J.	II
Kennedy, J. M.	II	McDowall, C.	II
Murray, G. J. A. M.	II		

S.E. and W. Division.

Paterson, S. H. A.	I	Sinclair, Laurence	II
Simpson, A. N.	I	Graham, J. McK.	II
Macintyre, J. F.	I	Steele, R. P.	II
Cameron, Hugh	I	Munro, Duncan	II
Reid, J. M.	I	Macrae, A. D.	II
Fraser, A. M.	I	Stoddart, W. F.	II
Graham, Alexander	I	Brown, Peter	II
Donald, R. R.	I	Mackay, Angus	II
Calder, J. M.	II	Ferguson, J. M.	II
Cameron, Alistair	II	Mackenzie, Ian H.	II
Macmillan, Hugh	II	Peddie, A. S.	II
Macrae, Murdo	II	Maclean, J. D.	II
McDonald, J. D.	II	Kennedy, John	II
Watson, James	II		

Scotland—continued.

Research and Experiment.

Oxford.

Gray, W. G. I
Nimmo, M. II

Edinburgh.

Grant, A. II
Farquhar, James II
Dewar, J. D. II

Headquarters.

Mackenzie, A. M. .. .. I.

REGISTER OF IDENTIFICATION NUMBERS.

FOREST YEAR, 1936.

The order of arrangement is as follows :—

Serial numbers (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.

36/1 4 oz.; *Nothofagus menziesii;* 1935; New Zealand (Nelson Conservancy); gift from New Zealand Government.

36/2 ½ oz.; *Nothofagus fusca;* 1935; New Zealand (Nelson Conservancy); gift from New Zealand Government.

36/3 ½ oz.; *Nothofagus truncata;* 1935; New Zealand (Nelson Conservancy); gift from New Zealand Government.

36/4 ½ oz.; *Nothofagus solandri;* 1935; New Zealand (Nelson Conservancy); gift from New Zealand Government.

36/5 2,134 lb.; *Fagus sylvatica;* 1935; Germany (Mecklenburg); Schultze & Co.

36/6 275 lb.; *Pinus pinaster;* 1935; Portugal (Leiria); gift from Portuguese Government.

36/7 762 lb.; *Quercus rubra;* 1935; Holland (Wageningen-Dieren-Doesburg, Guelders); Nederlandsche Heidemaatschappij.

36/8 4,759 lb.; *Fagus sylvatica;* 1935; Holland (Wageningen-Dieren-Doesburg, Guelders); Nederlandsche Heidemaatschappij.

36/9 24 lb.; *Juglans regia;* 1935; Central France; Vilmorin-Andrieux.

36/10 10 lb.; *Juglans nigra;* 1935; France (Paris); Vilmorin-Andrieux.

36/11 2 lb.; *Platanus orientalis;* 1935; Southern France; Vilmorin-Andrieux.

36/12 302 lb.; *Larix europaea;* 1935; Austria (Inn Valley, Northern Tyrol; altitude 1,900–2,600 ft.); J. Jenewein; 83·6; 33.

36/13 630 lb.; *Picea excelsa;* 1935; Austria (Inn Valley, Northern Tyrol; altitude 1,900–2,600 ft.); J. Jenewein; 96·4; 89.

36/14 21 lb.; *Alnus incana;* 1935; Austria (Inn Valley, Northern Tyrol, altitude 1,900–2,600 ft.); J. Jenewein.

36/15 1,250 lb.; *Picea excelsa;* 1935; Germany (Black Forest; Freudenstadt-Horb-Nagold; altitude 1,470–2,300 ft.); J. Rafn and Son; 98·3; 89+1.

36/16 56 lb.; *Larix europaea;* 1935; French Alps; Vilmorin-Andrieux; 96·4; 47.

36/17 511 lb.; *Picea excelsa;* 1935; Central Alps; Vilmorin-Andrieux; 99·2; 96.

36/18 500 lb.; *Larix leptolepis;* 1935; Japan (Nagano); S. Ando; 96·9; 58+1.

36/19 129 lb.; *Picea excelsa;* 1935; Germany (Harz Mountains, Rübeland, altitude 1,500 ft.); Braunschweig Forstliche Versuchsanstalt; 96·7; 81.

36/20 98 lb.; *Pseudotsuga douglasii;* 1935; Canada (New Westminster; British Columbia, altitude 25–200 ft.); Canadian Government; 93·9; 76.

36/21 2¼ lb.; *Pseudotsuga douglasii;* 1935; Canada (Bella Coola, British Columbia, altitude 0–300 ft.); Canadian Government.

36/22 57 lb.; *Pinus contorta;* 1935; Canada (Prince George, British Columbia, altitude 1,875 ft.); Canadian Government; 98·8; 93.

36/23 2,310 lb.; *Picea sitchensis;* 1935; Canada (Queen Charlotte Islands, British Columbia, altitude 0–150 ft.); Canadian Government; 96·4; 85+3.

36/24 2½ lb.; *Picea sitchensis;* 1935; Canada (Alert Bay, British Columbia, altitude 0–150 ft.); Canadian Government.

36/25 1¼ lb.; *Picea sitchensis;* 1935; Canada (Campbell Lake, Oyster River, British Columbia, altitude 550 ft.); Canadian Government.

36/26 4 lb.; *Picea sitchensis;* 1935; Canada (Bella Coola, British Columbia, altitude 0–300 ft.); Canadian Government.

36/27 1¼ lb.; *Picea sitchensis;* 1935; Canada (Kitimat, British Columbia, altitude 0–300 ft.); Canadian Government.

36/28 79 lb.; *Tsuga heterophylla;* 1935; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government; 99·9; 77+8.

36/29 12½ lb.; *Tsuga heterophylla;* 1935; Canada (Queen Charlotte Islands, British Columbia, altitude 0–150 ft.); Canadian Government; 95·5; 73+9.

36/30 31 lb.; *Thuya plicata;* 1935; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government; 92·6; 65.

36/31 19 lb.; *Thuya plicata;* 1935; Canada (Queen Charlotte Islands, British Columbia, altitude 0–150 ft.); Canadian Government; 96·1; 66.

36/32 75 lb.; *Alnus oregona;* 1935; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government.

36/33 5¾ lb.; *Alnus oregona;* 1935; Canada (Queen Charlotte Islands, British Columbia, altitude 0–150 ft.); Canadian Government.

36/34 6 oz.; *Alnus sitchensis;* 1935; Canada (Vancouver, British Columbia, altitude 0–200 ft.); gift from Canadian Government.

36/35 195 lb.; *Abies grandis;* 1935; Canada (Campbell Lake, Oyster River, British Columbia, altitude 550 ft.); Canadian Government; 97; 27+13.

36/36 14 lb. (fruit); *Arbutus menziessii;* 1935; Canada (Point Atkinson, British Columbia); Canadian Government.

36/37 4 lb.; *Picea sitchensis;* 1935; Canada (Bella Coola, British Columbia); gift from Iver Fougner.

36/38 3 oz.; *Sequoia sempervirens;* 1935; U.S.A. (California); gift from J. Burtt Davy.

36/39 419 lb.; *Pinus laricio* var. *corsicana;* 1935; Corsica; O. J. Rossi; 97·6; 62.

36/40 10¼ lb.; *Pinus contorta;* 1935; Canada (Terrace, British Columbia, altitude 200 ft.); Canadian Government.

36/41 26 lb.; *Pinus contorta;* 1935; Canada (Smithers, British Columbia, altitude 2,000 ft.); Canadian Government; 96·7; 84+4.

36/42 2½ lb.; *Pinus contorta;* 1935; Canada (Queen Charlotte Islands, British Columbia, altitude 0–150 ft.); Canadian Government.

36/43 1 lb.; *Pinus contorta;* 1935; Canada (Hazelton, British Columbia, altitude 1,150 ft.); Canadian Government.

36/44 1¼ lb.; *Pinus contorta;* 1935; Canada (Vavenby, Chu Chua, Clearwater, British Columbia, altitude 1,500 ft.); Canadian Government.

36/45 98 lb.; *Larix europaea;* 1935; Scotland (North); D. Meldrum and Sons; 90·6; 35.

36/46 1 lb.; *Picea sitchensis;* 1935; U.S.A. (Olympic Peninsula, Western Washington); Manning Seed Co.

36/47 2 oz.; *Pinus contorta;* 1935; U.S.A. (60 miles inland); gift from Manning Seed Co.

36/48 2 oz.; *Pinus contorta;* 1933; U.S.A. (Coast); gift from Manning Seed Co.

36/49 3 lb.; *Acer macrophyllum;* 1935; U.S.A. (Western Washington); Manning Seed Co.

36/50 1,611 lb.; *Pinus laricio* var. *corsicana;* 1935; Corsica (Pascio, altitude 4,100 ft.); J. Grimaldi; 98·5; 21+2.

36/51 4 lb.; *Cryptomeria japonica;* 1935; France (South); Vilmorin-Andrieux; 90·6; 16.

36/52 30 lb.; *Robinia pseudacacia;* 1935; France (Central); Vilmorin-Andrieux.

36/53 3 lb.; *Pinus insignis;* 1935; U.S.A. (California); J. Rafn & Son.

36/54 2 lb.; *Cupressus macrocarpa;* 1935; U.S.A. (California); J. Rafn & Son; 99·8; 21.

36/55 2 lb.; *Quercus cerris;* 1935; Denmark; J. Rafn & Son.

36/56 10 lb.; *Picea sitchensis;* 1935; Scotland (Murthly, Perthshire); Col. Steuart-Fothringham; 86·7; 3.

36/57 21½ lb.; *Tsuga heterophylla;* 1935; Scotland (Murthly, Perthshire); Col. Steuart-Fothringham; 91·1; 13.

36/58 3¾ lb.; *Abies grandis;* 1935; Scotland (Murthly, Perthshire); Col. Steuart-Fothringham; 78·4; 14.

36/59 7¾ lb.; *Pinus montana* var. *uncinata;* 1935; French Alps; Vilmorin-Andrieux.

36/60 6 lb.; *Picea excelsa;* 1935; Rumania; gift from Rumanian Government.

36/61 2 lb.; *Cedrus deodara;* 1935; France (South); Vilmorin-Andrieux; 90·6; 55 + 7.

36/62 72 lb.; *Pinus pinaster;* 1935; Portugal (Leiria); gift from Portuguese Government.

36/63 4 oz.; *Nothofagus obliqua;* 1935; Argentina; gift from Argentine Government.

36/64 ¼ oz.; *Nothofagus procera;* 1935; Argentina; gift from Argentine Government.

36/65 2 oz.; *Nothofagus dombeyi;* 1935; Argentina; gift from Argentine Government.

36/66 2 oz.; *Nothofagus antarctica;* 1935; Argentina; gift from Argentine Government.

36/67 34 lb.; *Pinus sylvestris;* 1935; Glenmore, Inverness-shire; own collection.

36/68 1¼ lb.; *Pinus sylvestris;* 1934; Ballochbuie, Aberdeenshire; own collection.

36/69 26 lb.; *Pinus sylvestris;* 1935; Scotland (West); own collection.

36/70 460 lb.; *Pinus sylvestris;* 1935; Scotland (N.E.); own collection.

36/71 25 lb.; *Larix europaea;* 1935; Cawdor, Morayshire; D. Baillie.

36/72 436 lb.; *Larix europaea;* 1935; Kirkhill, Morayshire; own collection.

36/73 448 lb.; *Larix europaea;* 1935; Lethen, Morayshire; own collection.

36/74 106 lb.; *Larix europaea;* 1935; Seafield, Morayshire; own collection.

36/75 149 lb.; *Larix europaea;* 1935; Kinsteary, Morayshire; own collection.

36/76 88 lb.; *Larix europaea;* 1935; Carron, Morayshire; own collection.

36/77 42 lb.; *Larix europaea;* 1935; Auchlunkart, Morayshire; own collection.

36/78 54 lb.; *Larix europaea;* 1935; Drummuir, Morayshire; own collection.

36/79 1½ lb.; *Larix europaea;* 1935; Holme Rose, Nairnshire; own collection.

36/80 74 lb.; *Larix europaea;* 1935; Drummond Hill, Perthshire; own collection.

36/81 ½ lb.; *Larix leptolepis;* 1935; Inverliever, Argyllshire; own collection.

36/82 3½ lb.; *Picea excelsa;* 1935; Newcastleton, Roxburghshire; own collection.

36/83 2¾ lb.; *Picea sitchensis;* 1935; Benmore, Argyllshire; own collection.

36/84 2 oz.; *Pseudotsuga douglasii;* 1935; Benmore, Argyllshire; own collection.

36/85 2½ lb.; *Thuya plicata;* 1935; Monreith, Wigtownshire; Sir H. Maxwell.

36/86 5 lb.; *Thuya plicata;* 1935; Benmore, Argyllshire; own collection.

36/87 2 lb.; *Thuya plicata;* 1935; Knapdale, Argyllshire; own collection.

36/88 29 lb.; *Abies nobilis;* 1935; Benmore, Argyllshire; own collection.

36/89 4¾ lb.; *Chamaecyparis lawsoniana;* 1935; Benmore, Argyllshire; own collection.

36/90 1½ lb.; *Chamaecyparis lawsoniana;* 1935; South Laggan, Inverness-shire; own collection.

36/91 2 oz.; *Tsuga heterophylla;* 1934; Drummond Hill, Perthshire; own collection.

36/92 ¾ lb.; *Tsuga heterophylla;* 1935; Durris, Kincardineshire; own collection.

36/93 1 lb.; *Tsuga heterophylla;* 1935; Novar, Inverness-shire; own collection.

36/94 4 lb.; *Tsuga heterophylla;* 1935; Benmore, Argyllshire; own collection.

36/95 50 lb.; *Fraxinus excelsior;* 1935; Fleet, Kirkcudbrightshire; own collection.

36/96 5,768 lb.; *Quercus pedunculata;* 1935; Scotland (S.W.); own collection.

36/97 360 lb.; *Quercus pedunculata;* 1935; Scotland (West); own collection.

36/98 200 lb.; *Fagus sylvatica;* 1935; Fleet, Kirkcudbrightshire; own collection.

36/99 7 lb.; *Fagus sylvatica;* 1935; Glengarry, Inverness-shire; own collection.

36/100 100 lb.; *Acer pseudoplatanus;* 1935; Fleet, Kirkcudbrightshire; own collection.

36/101 10 lb.; *Acer pseudoplatanus;* 1935; Inverliever, Argyllshire; own collection.

36/102 2½ lb.; *Acer pseudoplatanus;* 1935; Glengarry, Inverness-shire; own collection.

36/103 36 lb.; *Acer pseudoplatanus;* 1935; Scotland (N.E.); own collection.

36/104 35 lb.; *Betula verrucosa;* 1935; Scotland (West); own collection.

36/105 1 bush.; *Alnus glutinosa;* 1935; South Strome, Ross and Cromarty; own colleltion.

36/106 13 lb.; *Pinus laricio* var. *corsicana;* 1935; England (East); own collection.

36/107 734 lb.; *Pinus sylvestris;* 1935; England (East); own collection; 98·4; 89.

36/108 4,392 lb.; *Fagus sylvatica;* 1935; Continental; English Forestry Association.

36/109 10 lb.; *Alnus incana;* 1935; England (North); own collection.

36/110 38 lb.; *Betula verrucosa;* England (North); own collection.

36/111 ½ lb.; *Chamaecyparis lawsoniana;* 1935; England (North); own collection.

36/112 10 lb.; *Fraxinus excelsior;* 1935; England (West); own collection.

36/113 697 lb.; *Fagus sylvatica;* 1935; England (West); own collection.
36/114 847 lb.; *Quercus pedunculata;* 1935; England (West); own collection.
36/115 358 lb.; *Quercus sessiliflora;* 1935; England (West); own collection.
36/116 28 lb.; *Acer platanoides;* 1935; England (West); own collection.
36/117 33 lb.; *Acer pseudoplatanus;* 1935; England (West); own collection.
36/118 3,868 lb.; *Fagus sylvatica;* 1935; England (S.W.); own collection.
36/119 76 lb.; *Fagus sylvatica;* 1935; Wales (South); own collection.
36/120 2 lb.; *Betula verrucosa;* 1935; Wales (South); own collection.
36/121 112 lb. cones; *Larix europaea;* 1935; Wales (South); own collection.
36/122 10 lb.; *Castanea sativa;* 1935; England (S.W.); own collection.
36/123 140 lb.; *Quercus pedunculata;* 1935; England (S.W.); own collection.
36/124 2 lb.; *Alnus glutinosa;* 1935; England (S.W.); own collection.
36/125 30 lb.; *Acer pseudoplatanus;* 1935; England (S.W.); own collection.
36/126 10 lb.; *Thuya plicata;* 1935; England (S.W.); own collection.
36/127 2 lb.; *Chamaecyparis lawsoniana;* 1935; England (S.W.); own collection.
36/128 13 oz.; *Larix leptolepis;* 1935; England (S.W.); own collection.
36/129 2 lb.; *Tsuga heterophylla;* 1935; England (S.W.); own collection.
36/130 3 lb.; *Abies nobilis;* 1935; England (S.W.); own collection.
36/131 1,539 lb.; *Quecus pedunculata;* 1935; England (Midlands); own collection.
36/132 33,725 lb.; *Quercus pedunculata;* 1935; England (South); own collection.
36/133 8,175 lb; *Fagus sylvatica;* 1935; England (South); own collection.
36/134 2,085 lb.; *Fagus sylvatica;* 1935; England (Midlands); own collection.
36/135 520 lb.; *Castanea sativa;* 1935; England (South); own collection.
36/136 30 lb.; *Acer pseudoplatanus;* 1935; England (South); own collection.
36/137 120 lb.; *Acer pseudoplatanus;* 1935; England (Midlands); own collection.
36/138 12 lb. cones; *Alnus incana;* 1935; England (South); own collection.
36/139 16 lb.; *Araucaria;* 1935; England (South); own collection.
36/140 21,157 lb.; *Quercus pedunculata;* 1935; England (East); own collection.

36/141 500 lb.; *Quercus sessiliflora ;* 1935; England (East); own collection.

36/142 1,754 lb.; *Fagus sylvatica ;* 1935; England (East); own collection.

36/143 25 lb.; *Betula verrucosa ;* 1935; England (East); own collection.

36/144 60 lb.; *Fraxinus excelsior ;* 1935; England (East); own collection.

36/145 24 lb. cones; *Alnus glutinosa ;* 1935; England (East); own collection.

36/146 50 lb.; *Quercus cerris ;* 1935; England (East); own collection.

36/147 330 lb.; *Fagus sylvatica ;* 1935; England (South); Paultons Estate, Hants.

36/148 336 lb.; *Fagus sylvatica ;* 1935; England (South); Norman Court Estate, Wilts.

36/149 70 lb.; *Castanea sativa ;* 1935; England (West); own collection.

36/150 50,000 1-yr. seedlings; *Fagus sylvatica ;* crop year unknown; origin unknown; Commissioners of Crown Lands.

36/151 25,000 transplants; *Fagus sylvatica ;* crop year unknown; origin unknown; Commissioners of Crown Lands.

36/152 15,000 transplants; *Betula verrucosa ;* crop year unkown; origin unknown; English Forestry Association.

36/153 48,700 1-yr. seedlings; *Fagus sylvatica ;* crop year unknown; origin unknown; D. Stewart & Son.

36/154 450,000 1-yr. seedlings; *Fagus sylvatica ;* crop year unknown; origin unknown; Horticultural Botanical Association.

36/155 13,400 transplants; *Fagus sylvatica ;* crop year unknown; origin unknown; Horticultural Botanical Association.

36/156 275,000 1-yr. & 2-yr. seedlings; *Fagus sylvatica ;* crop year unknown; origin unknown; English Forestry Association.

36/157 45,000 transplants; *Fagus sylvatica ;* crop year unknown; origin unknown; English Forestry Association.

36/158 5,000 2-yr. seedlings; *Fagus sylvatica ;* crop year unknown; origin unknown; Clinton Estates.

36/159 20,000 seedlings; *Betula verrucosa ;* crop year unknown; origin unknown; Trinity College Estate, Collingham, Newark.

36/160 30,000 seedlings; *Acer pseudoplatanus ;* crop year unknown; origin unknown; Carburton Woods, Clipstone.

36/161 8,000 transplants (2 + 2); *Picea sitchensis ;* crop year unknown; origin unknown; Clinton Estates.

36/162 3,000 transplants; *Picea sitchensis ;* crop year unknown; origin unknown; G. W. Pledge.

36/163 8,700 transplants; *Picea sitchensis ;* crop year unknown; origin unknown; Commissioners of Crown Lands.

36/164 164,000 transplants (1 + 3); *Picea sitchensis ;* crop year unknown; origin unknown; Plymouth Corporation.

36/165 9,697 lb.; *Quercus sessiliflora ;* 1935; England (South); own collection.

36/166 2 lb.; *Pinus sylvestris;* 1935; Germany (Crawinkel, Gotha, Thüringen, altitude 1,380–1,800 ft.); gift from German Government.

36/167 87 lb.; *Larix europaea;* 1935; Beauly, Inverness-shire; own collection.

36/168 6 lb.; *Nothofagus obliqua;* 1935; Chile; gift from Chilean Government.

36/169 1½ lb.; *Nothofagus procera;* 1935; Chile; gift from Chilean Government.

36/170 5 lb.; *Nothofagus dombeyi;* 1935; Chile; gift from Chilean Government.

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