JOURNAL

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No. 17: APRIL, 1938.

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EDITORIAL.

Many changes have taken place during the past year.

Commission Staff Changes.

Dr. H. M. Steven has resigned from the Commission, having been appointed to the Chair of Forestry in Aberdeen University. Originally Research Officer for Scotland, Dr. Steven became Research Officer for England and Wales, then Divisional Officer, No. 5 Division and latterly had charge of the North Eastern Division, Scotland. Regrets caused by his severance with the Commission are modified by the thought that his services are still available to British forestry. Dr. Steven's successor is Mr. Frank Scott.

Following the transfer of Mr. O. J. Sangar to Headquarters to take charge of the Census and Plans Branch, Messrs. F. W. A. Oliver and A. H. Gosling were appointed acting Divisional Officers, Southern Division, Dumfries, and Western Division, Glasgow, respectively.

Mr. H. Watson (Benmore School) has been promoted to a Higher Grade District Officer and Messrs. J. E. Maund (Census and Plans) and A. M. Fraser (N. Division) have been promoted to District Officer rank.

Mr. R. G. Broadwood has taken over the smaller Division 3 now at Exeter and Messrs. R. Cowell-Smith, G. W. Backhouse and W. D. Haldane have been transferred to Division 9. Other movements among District Officers have been as follows: Mr. J. W. Mackay and Mr. A. Watt to S. Division; Mr. J. R. Thom to Division 8; Mr. J. Q. Williamson to Division 5; Mr. T. A. Robbie to N. Division, and Mr. J. S. R. Chard to Census and Plans.

Mr. J. Maxwell Macdonald has resigned in order to become Land Agent to Buccleuch Estates, Ltd., and Mr. G. H. Good has left to take up an appointment with the Inland Revenue Department.

Six new District Officers have been appointed on probation *viz.*: Mr. L. G. T. Kenyon (Division 7), Mr. G. F. Ballance (Division 3), Mr. W. J. Stiles (Estate—Division 1), Mr. W. R. Short (Estate—25 Drumsheugh Gardens, Edinburgh), Mr. R. F. Wood (S. Division), and Mr. H. V. S. Dier (W. Division).

Contributors to the Journal.

The following Divisions have been selected as special contributors to next year's Journal: Division 4; the New Forest (Division 6); the Forest of Dean (Division 7); and Scotland, South and Western Divisions.

The special contributors to the present number of the Journal are Divisions 1, 3 and Scotland, Eastern.

PROGRESS REPORT ON RESEARCH: JANUARY, 1938.

By W. H. Guillebaud.

1.—Nursery Experimental Work.

A repetition of the experiment carried out in 1936 on the stratification of seed of *Pinus contorta* (one year stored) gave almost equally favourable results. Stratification resulted in an increased yield of 1-year seedlings amounting to 88 per cent. compared with ordinary dry storage.

Early sowing, *i.e.* before the middle to end of April, continues to give the best results with such species as larch, spruce and Douglas fir. Scots pine can be sown later than the above species without hurt.

A satisfactory form of mechanical distributor has been devised by the Research Officer for Scotland with the assistance of other technical officers. The machine is a modification of a commercial type of manure distributor and works very well with coarse materials such as fine gravel or chippings but is less successful with sand. The machine has been adopted in a number of Scottish nurseries and appears to find general approval. At Kennington Nursery yields of 90,000 1-year Sitka spruce and 26,000 Japanese larch 1-year seedlings were obtained per pound of seed sown, using sand, applied by the machine, for covering.

The importance of using the right type of covering material was shown by some comparative experiments with sand and sandy gravel respectively. The sand was a form of so-called silver sand, containing no silt or clay at all, while the gravel was a coarser material but containing some finer particles.

The production in 1,000s of 1-year seedlings per pound of seed was:

	Nursery Soil.	*Sandy Gravel.*	*Silver Sand.*
Sitka spruce	26	61	112
Japanese larch	12	27	39
Lawson cypress	4	15	35

Although the sandy gravel has given much better results than the nursery soil the yields are still far below those obtained by the use of the silt-free silver sand.

The experiments on the addition of dried peat to nursery soil continue to give conflicting results. At Kennington there is no doubt whatever that the peat is beneficial, but in most of the other nurseries in England and Wales and in all those in Scotland the improvement in size and quality of seedling is so small as to be insignificant. It is possible that some of the nurseries where there has so far been no result may yet show a benefit when the peat becomes more completely incorporated with the mineral soil.

Wet weather sowings carried out in a number of nurseries in Scotland, using a coarse grit for covering the seed, again proved quite successful in most cases. This work is to be continued.

A trial was carried out in a number of nurseries on a method of manuring seedbeds by applying so-called liquid humate. This was prepared as follows :—a 50-gallon barrel was half-filled with litter and humus collected from beneath a forest stand. To the litter was then added 1 lb. of 20 per cent. ammonium sulphate, 1½ lb. of ammonium phosphate and 1½ lb. of potassium nitrate, and the barrel filled up with water, stirring vigorously meanwhile. After standing for several hours the mixture was again stirred to bring the finer humus particles into suspension, siphoned off into watering cans and applied at the rate of 3½ gallons per 50 sq. ft. of seedbed. Applications were made in most cases in the month of July and rather variable results were obtained. Spruces improved in colour and in some cases also in growth, though the growth difference was not as a rule very striking. Other species, *e.g.* ash, birch, beech, grey alder and larch showed little response. At Kennington birch responded well early in the growing season, but by the end of the growing season there was little difference between the treated and the untreated plots. At Altonside nursery in Scotland, where the humate was applied to Sitka spruce, European larch and Scots pine shortly after the seed germinated the treated seedlings are much the stronger; on the other hand the same solution of artificials applied without infusion with the humus gave equally satisfactory results and it is possible that the humus is unnecessary. On the whole the results of the treatment have not been very striking.

Preliminary trials have also been carried out with a preparation called Hortomone A, containing a growth-promoting substance. The species used included cuttings of aspen, poplar, golden privet and sundry conifers. A small number of the aspen rooted successfully and there was a decided stimulus to the rooting of privet. Poplar struck well both with and without the treatment. All the conifers failed. The work is being extended this year.

Ash responded well at Kennington to a complete manure consisting of lime and magnesium, in addition to potash, phosphate and nitrogen. At the end of two years the treated seedlings averaged 24 inches in height compared with 13 inches in the untreated controls.

Some remarkable 2-year walnut seedlings were raised at Kennington in well-manured soil; black walnut were up to 7 feet and common walnut up to nearly 5 feet in height. These will be lifted and re-lined at a wide spacing; a proportion of the plants will be stumped before re-lining.

The new poplar nursery at Mundford, near Thetford, is turning out well. Stumped one-year-old poplar cuttings lined out in P.36 now average from 9 to 13 feet in height, according to species.

Poplar cuttings lined-out at different spacings in the Fen Row nursery at Rendlesham showed the benefit of wider spacing. The plants grew

well, averaging 6 feet in height at the end of the first year. When graded on size and vigour the following data were obtained :—

Spacing. in. in.	*Grade I.*	*Grade II.*	*Grade III.*	*Culls.*	*Dead.*
	Percentage of Cuttings lined-out.				
3×12	32	27	18	17	6
6×12	50	31	14	5	—
9×12	50	29	17	4	—

Extending the spacing from 3 inches to 6 inches has appreciably increased the proportion of Grade I plants.

A repetition of the previous year's experiment on size of cutting indicated that 8 inches is the most suitable length for a poplar cutting. The best result is obtained when the cutting is buried in the soil so that the top only just shows above ground-level.

An experiment on the stumping and re-lining of some aspen transplants which were of very poor form and growth gave good results. Some of the cut-back plants made shoots of up to 6 feet in length.

2.—Plantation Experiments.

Peat Soils.—In spite of a number of severe gales during the past year *Pinus contorta* are standing up well on the deep peat at Inchnacardoch, Borgie and Beddgelert. Growth continues to be good. Hybrid and Japanese larch are the outstanding species on the shallow *Calluna-Scirpus* peats on the steeper slopes at Achnashellach and Inchnacardoch.

Upland Calluna Soils.—A survey has been made of those experiments in which mixtures of pines and spruces occur. Many of these are too young for the pines to have any influence and in some cases the pines have failed to develop owing to damage by blackgame or to unsuitable planting methods. Where the pines have grown satisfactorily and have reached a height of not less than 3 feet there is evidence of a definite improvement in the rate of growth of the spruces. Data from experiments at Teindland, Allerston, Inchnacardoch and North Tyne are summarised below.

A. *Teindland.* Experiment 16 P.27 and 23 P.28 on shallow ploughed, poor upland *Calluna* ground. The plots summarised in the table all received an application of basic slag, and the data represent in each case the mean of 6 plots.

Average heights in inches of plants after 12 and 11 growing seasons respectively :

	Norway Spruce mixed with			*P. contorta*	*P. montana*
	P. contorta.	*P. montana.*	*Pure.*	*in N.S. Plots.*	*in N.S. Plots.*
P. 27 ..	19	21	17	42	42
P. 28 ..	23	28	18	75	38
	Sitka Spruce mixed with			*P. contorta*	*P. montana*
	P. contorta.	*P. montana.*	*Pure.*	*in S.S. Plots.*	*in S.S. Plots.*
P. 27	38	35	29	41	41
P. 28	45	39	35	86	38

There are several interesting points in the above table. In the first place the spruces have benefited in every case by admixture with pines, but whereas Norway spruce appears to have done relatively better in mixture with mountain pine than with *Pinus contorta*, the reverse is the case with Sitka spruce. Secondly, three out of the four species (mountain pine is the only exception) have grown better in the P.28 experiment; the ground was all ploughed in P. 27 and possibly the delay of a year before planting has been beneficial; the difference is most marked in the case of *Pinus contorta*. Thirdly, Sitka spruce has grown nearly twice as fast as Norway spruce on this poor ground.

B. *Allerston*. Experiment 6. P.28 on shallow ploughed, poor upland *Calluna* soil. The plots summarised in the table were not slagged; the data represent in each case the mean of 18 plots.

	Sitka Spruce mixed with Scots Pine.	*Pure.*	*Scots Pine in S.S. Plots.*
	in.	in.	in.
Average height	28·5	24	57
Average leading shoot	4·0	1·5	

The effect of the pine mixture is less apparent in the mean heights of the Sitka spruce than in the current leading shoots. The difference in colour of the needles is very apparent on the ground and it is probable that the spruce in the spruce-pine mixtures will now grow rapidly ahead of those in the pure plots.

C. *Inchnacardoch*. Experiment 16. P.27. This experiment has already been written up by Mr. J. A. B. Macdonald in the Scottish Forestry Journal published in October, 1936. The experiment started in P.23 with a series of season of planting plots with Sitka spruce planted by direct notching. The ground was rather variable and three distinct soil types are now recognised. In P.27 alternate plots were interplanted with Scots pine and in 1935 an assessment was made of the relative growth of the spruces in the pure and the mixed plots on each of the three vegetation types. The spruces were then 13 years old and the pines 9 years old, from the date of planting.

Vegetation Type.		*Sitka Spruce mixed with Scots Pine.*	*Pure.*	*Scots Pine in S.S. Plots.*
Dry and exposed *Calluna / erica cinerea* slopes.	Height	2·9 ft.	1·7 ft.	9·3 ft.
	Shoot	7 in.	2 in.	20 in.
Sparse bracken, grass, and *Calluna*.	Height	8·8 ft.	4·2 ft.	13 ft.
	Shoot	20 in.	5 in.	25 in.
Strong dense bracken, grass, and *Calluna*.	Height	13·3 ft.	8·9 ft.	14·2 ft.
	Shoot	26 in.	19 in.	24 in.

In each type the pine admixture has improved the growth of the spruces in a very marked degree. This is a good pine site and

the pines started away without any check. The spruces in the mixed plot on the poorest ground put on an average shoot of 7 inches in 1935, which compares with only 2 inches in the control. It is also remarkable that the pine admixture should have had such a great effect on the development of the Sitka spruce on the good, dense bracken, type.

D. *North Tyne.* Experiment 6. P.27, planted on turfs on *Calluna, Molinia, Eriophorum* peat. Assessed in 1937, *i.e.* after 11 growing seasons. The data are given in inches and represent the means of two plots.

	Sitka Spruce mixed with Scots Pine.	*Pure.*	*Scots Pine in S.S. Plots.*
	in.	in.	in.
Average height	66	54	51
Average leading shoot	8·5	6·4	9

In this example also there is an indication of improved growth of the spruce in the mixed plots.

The exact part played by the pines in the mixed plots is not fully understood. The pines presumably have a sheltering effect in the earlier stages. Later on the more freely growing pines will bring about earlier suppression of the heather and other vegetation which must help the root development of the spruces. Ultimately, especially on upland *Calluna* soils in which the pan has been disturbed by ploughing, the deeper rooting pine will certainly tend to a more effective penetration of the soil besides contributing to the stability of the crop in the event of wind storms.

The Teindland plots in the experimental compartment at the top of the hill are making very satisfactory progress especially in the ploughed blocks. The ploughing was done by a horse plough and was relatively shallow, there is little doubt that the modern tractor ploughs would make a much better job of the work and probably better growth would result. The position at the moment is that it appears possible with the aid of ploughing to establish a satisfactory crop of either *Pinus contorta*, Scots pine or Japanese (and hybrid) larch. Basic slag gives an undoubted stimulus to growth but does not appear to be essential for the pines. Sitka spruce, with slag and in mixture with *Pinus contorta*, is distinctly promising and may prove the best species for the final crop. Norway spruce is much slower in becoming established than Sitka spruce and appears to have no advantage, except possibly in frost hollows. Considering the very unpromising type of ground, dwarf *Calluna* and *Erica tetralix*, with *Carex panicea*, and some *Scirpus*, bog asphodel, etc., growing on a soil consisting of a heavily leached layer some 9 to 12 inches in depth over a hard iron pan, the results obtained in the experimental work are distinctly encouraging and appear to justify the acquisition of further land of this type.

Another area of a very different type is represented by the higher ground at Clocaenog Forest in Division 2. This is typical *Calluna* moorland at an elevation of 1,400 to 1,500 feet. Apparent exposure is very considerable; there is a layer of 3 to 6 inches, sometimes more, of black peat over the soil, and the vegetation is dominant *Calluna* with a very little fine grass which, however, increases in amount on drainage or disturbance of the soil. The soil is a brown loam showing practically no evidence of leaching. The experimental work was started in P.32 and consists of the trial of such species as Sitka spruce, *Pinus contorta* and Japanese larch, effect of slag, intensity of drainage, heather burning, etc. All trees were planted on turfs. The effect of the experimental treatments is not very well marked on the whole and the main interest of the plots lies in the surprisingly good growth of the Sitka spruce and, as a rule, also of the Japanese larch. A prolonged check of spruce was anticipated on this high exposed ground but this has not occurred; the spruces are now mostly growing freely and it is evident that conditions are favourable for the growth of this species. Neither spruce nor larch show any appreciable signs of exposure. The net result is to include in the plantable area a large tract of otherwise very doubtful ground.

The French plant-roll machine, described on pages 15–19 of the 1937 Journal, has been tested at Allerston and at Clipstone Forests. The species used was Corsican pine (1-year seedlings), and rolled plants were planted alongside controls consisting of seedlings planted in the ordinary way. Thanks to an exceptionally favourable planting season the percentage of success in the controls was so high that there was virtually no room for improvement. The method will be tested on a larger scale during the current planting season.

Dorset Heaths.—The Lawson cypress plot at Wareham continues to make excellent growth. Some recent Danish work showed that this species can be planted with advantage in July or August and an experiment on season of planting is now in progress.

Corsican pine, direct sown in P.36 in patches treated with hop-waste compost, has grown phenomenally; at the end of the second year many of the seedlings were over a foot in height; germination was so good that the patches have had to be drastically thinned. A costing experiment, employing Dr. Rayner's compost method, is planned for the coming season.

Loam and Clay Soils.—The hoeing experiments at Tintern with ash and sycamore showed an interesting development at the end of the growing season. The unhoed controls began to make good growth in P.37 and the difference between the hoed and unhoed plots is much less striking. If the improvement in the unhoed plots continues it will be doubtful if hoeing can be economically justified, at least on ground that is really suitable for ash.

At Dymock half of each of the unweeded plots in the P.30 oak weeding experiment were completely cleared of coppice and other weed growth. Owing to the dense growth the work proved very expensive, costing nearly £7 per acre. Much of the coppice was over 10 feet in height and

it was a surprise to find how many of the oak seedlings had survived. In the fully weeded plots there was an average of 15 plants per 6 feet of row. This compares with 10 plants in the unweeded but now completely cleared plots. On paper a stocking of 5 plants per running yard, or one every 7 inches, is more than ample to produce a good crop. Actually the position is not so favourable, because the plants in the unweeded plots are very weakly owing to the prolonged competition with the weed growth. They fall in fact into two groups, one consisting of very small plants barely visible in the grass and of somewhat doubtful future; the other group consists of long whippy plants most of which cannot now stand erect but bend over in all directions, some lying right along the ground. How these weakly plants will respond to their freedom remains to be seen. In any case it is clear that oak seedlings cannot safely be left unweeded for eight years if the vegetation consists of vigorous coppice, gorse and broom. The remaining half of the unweeded plot will be allowed to grow on to see if any of the seedling oaks succeed in pushing their way through the weed growth.

An experiment on age and type of sycamore showed that 2-year seedlings are much less satisfactory as planting material than transplants. The data are as follows :—

Type of Plant.	*Height at Time of Planting.*	*Average Height after 6 growing Seasons.*
	in.	ft.
2 + 0	11 — 14	5·0
1 + 1	11 — 14	7·5
1 + 2	15 — 25	10·0
2 + 2	36 — 54	9·9

The tall 2 + 2 plants remained in check for the first 3–4 years but then began to grow fast. The smaller transplants grew well from the start, the sturdy 1 + 2 plants giving the best result.

3.—Pruning Investigations.

Relatively little new experimental work on the establishment of plantations is now contemplated in Scotland and the way is open for a more comprehensive attack on problems connected with pruning.

Although the last word has not been said on the question of tools there are more urgent problems to be tackled. The correct intensity of pruning at any given stage in the early life of a plantation is still largely unsolved. Assuming a total length of pruned stem of, say, 25 feet it is uncertain whether this can be achieved best in two, three or four operations. Another point of doubt relates to live pruning, particularly with regard to Norway and Sitka spruce. There is a mass of evidence on the Continent pointing strongly against any live pruning of Norway spruce owing to the risk of the pruning wounds becoming infected with rot-producing fungi. There is no information at all as regards Sitka spruce and it is urgent that this point should be settled as soon as possible.

The thinning treatment of pruned stands is another matter requiring investigation. The rate of occlusion of the cut surfaces left by artificial pruning depends largely upon the subsequent rate of diameter growth. This can be stimulated by giving more light to the pruned trees, but the thinning must not be too heavy or it will hinder the further suppression of the branches at the base of the crown and may upset the pruning schedule.

Pruning plots have been established in Douglas fir at Inverliever and Monaughty, Norway spruce at Inverliever and Drummond Hill, Sitka spruce at Inverliever and Scots pine at Edensmuir.

4.—Sample Plot Work.

The celebrated Sitka spruce plot, E.41, in the Long Combe, near Minehead, was re-measured during the year for the sixth time. In the 15 years since the plot was established the number of trees has been reduced from 1,650 to 420 per acre, the mean height has risen from 33 to 72 feet and the mean quarter-girth at breast height from $3\frac{1}{4}$ inches to 7 inches. The standing volume is now, at 28 years of age, 4,700 cu. ft. quarter-girth per acre, and a total of 2,300 cu. ft. has been removed in thinnings.

A number of Corsican pine plots were re-measured during the year on the Highclere, Dunster and other estates. These mostly consist of pairs of plots in which light and heavy thinning are contrasted. In each case the advantage as regards rate of volume production appears to be on the side of the heavy thinning. The Highclere plots 59 and 60, in particular, form a good comparison. These plots were 19 years old and 35 feet high in 1932 when they were established. They had then a stocking of about 1,800 stems per acre. In four thinnings the stocking has been reduced to 850 trees in the lightly thinned B grade plot and 280 trees per acre in the D grade plot. The dominant trees average 67 feet in both plots. Comparative data are tabulated below.

	Mean No. Stems per Acre.	*Quarter-girth at 4 ft. 3 in.*	*Crown.* per cent.	*Volume Quarter-girth per Acre.* cu. ft.	*Total Volume of Thinnings.* cu. ft.	*Periodic mean annual Increment.* cu. ft.
B. Grade ..	850	$5\frac{3}{4}$	33	4,420	340	230
D. Grade ..	280	8	42	3,360	1,600	285

The difference in crown per cent. in the two plots is quite marked and the volume increment is appreciably higher in the heavily thinned plot.

5.—Report on Smoke Areas.

Mr. W. R. Day and Mr. Sanzen Baker have completed a comprehensive report on the growth of trees in smoke areas, with special reference to the development of the plantations in Llanover and Llantrisant Forests in South Wales.

The general conclusion reached was that the unsatisfactory state of the plantations in those forests was not primarily due to smoke or fumes; all the evidence was against that theory. Soil conditions, incorrect choice of species, lack of weeding, and drought years, were the principal factors involved. The most successful species on the steep, dry slopes of Llanover are Scots pine, Corsican pine and Japanese larch. Sitka spruce does fairly well on peat ground, provided it is kept out of the valleys. The chief mistake made in the past was in planting so much European larch and Douglas fir on the slopes where the soil is too dry and possibly also too poor for these species. Another error was the planting of Sitka spruce in the valleys where it suffered very severely from frost, the damage being aggravated by recurrent attacks of spruce aphis.

6.—Research Work at Aberdeen University.

Dr. E. V. Laing has submitted a report on his recent investigations on European larch. The report stresses the difference in behaviour of larch, as regards root development, from that of other coniferous species such as pine and spruce. Whereas the roots of other species were found to be growing actively at the end of March, the European larch roots were dormant. The contrast is the greater when it is remembered that the larch flushes its short shoots much earlier than any of the other conifers. Root extension does not as a rule take place in larch until the long shoots begin to develop. Meanwhile the plant is dependent for its water supply upon the existing root system. In the case of a plant which has to be moved, special precautions are obviously necessary; the plant should be lifted and handled with great care to preserve as many of the small roots as possible, and good planting and careful firming are indicated in order to bring the small roots in as close contact as possible with the mineral soil. The observations on period of root growth provide a simple explanation of the losses often resulting when larch are planted late, after flushing has begun. It was found that when larch of two different seed origins were used (namely Scottish and Swiss from the Munsterthal), the roots of the Scottish plants began to grow much earlier than those of the foreign origin. On 16th May the Scottish larch were showing strong root extension when the Swiss larch were still inactive.

Dr. Laing found that the roots of seedlings begin to develop actively much earlier than those of transplants. The advantage held by the seedlings appears however to be more than counterbalanced by the smaller root system of the seedling and the fact that most of the secondary roots are near the root collar. In transplants there is a better distribution of the secondary roots over the lower part of the root system and this fact, combined with the more bushy root development, presumably accounts for the better results given as a rule by transplants when put out into the forest.

Although these observations and general experience alike point to the importance of early planting of larch, sometimes delay is unavoidable, and planting has to be done later than is desirable. Dr. Laing has carried out some interesting experiments on the treatment of plants after lifting.

He found that flushing could be delayed by burying the plants completely in soil for not longer than one month. The burying was done as follows :— a pit 12 ft. × 3 ft. × 15 in. in which the plants, after untying the bundles, were laid flat and covered with about 6 inches of soil. The soil was well-drained clay-loam. The plants were buried on 26th February and planted one month later, when the buds were found to be swelled, with the tips of the needles just showing. After planting, the plants quickly flushed and soon caught up those which had been planted in February; there were no losses and the plants grew well.

Another experiment of perhaps more general application was the heeling-in of the plants in the ordinary way and then covering them with a box with air spaces, tightly packed with straw, left between the boards for ventilation. The cover remained on until 11th May when the plants were found to be partially flushed. Growth started immediately on planting and soon overtook the February-planted controls. There were no losses among the plants which had been shaded, while in those which were lifted from ordinary lines and planted out on the same date in May the failures were very heavy. These experiments require repetition on a more extensive scale but they suggest that it may be possible by delaying flushing, to tide over the danger period between the flushing of the short shoots and the development of new roots.

A method of planting which Dr. Laing has found very successful on a dry site is to insert the young trees in the bottom of shallow continuous trenches somewhat resembling the turf drains prepared on peat soils. Such a method has its dangers as the collection of water in any local wet spots is fatal to the plants.

7.—Mycorrhiza Research.

Experiments on the sowing of seed of pines and other conifers on soil treated with compost prepared by Dr. M. C. Rayner from hop-waste have shown that there is a striking difference between the effect of the compost when applied to soil that has been under an agricultural regime and its effect on natural moorland or heath soil. For example the addition of compost to new nursery soil (formerly under grass) at Widehaugh Nursery near Hexham resulted in no improvement in the growth of Corsican pine. When Dr. Rayner examined the 1-year seedlings she found no mycorrhizas present in either the treated plants or the controls; both lots of plants showed the typical symptoms of uninoculated nursery soil. On the other hand seed of the same origin sown on moorland soil at Allerston, after treatment with the compost, developed into quite normal plants, with a profuse development of " balanced " mycorrhizas. Seed sown on the same soil without compost produced much poorer seedlings with only scanty mycorrhizas. It would appear that, in the moorland soil so far examined, mycorrhizal fungi are present but the plant has difficulty in forming normal mycorrhizas; there is some inhibiting condition present. Application of compost, or alternatively, but less satisfactorily, basic slag, removes the inhibiting

condition and permits normal mycorrhizal development. *Pari passu* with normal mycorrhizal development goes satisfactory growth of the plants.

Agricultural treatment of a soil, including permanent pasture, appears to destroy the mycorrhiza-forming fungi but experience has shown that these can be restored by lining-out a single crop of conifer seedlings from any established nursery. In this connection a verbal communication from Mr. Frank Scott is of interest. It seems that he has evidence that seedlings of Lawson cypress are an exception to the general rule in that they do not inoculate the soil as do the commoner species, such as pines, larches, spruces, etc.

Although an ordinary coniferous seedling crop does inoculate a grassland soil and enable seed to be sown successfully in future, Dr. Rayner has evidence that conditions are not the same as in a natural soil which has been improved by the application of compost. There is a lack of balance in the mycorrhizal structures of the plants of most of the common species, raised in an ordinary nursery. This is evidenced by the presence of intense intra-cellular infection by the fungus. In the normal mycorrhiza of such a species as Corsican pine there is a fungal mantle round the short roots and a hyphal network between the cells, but no invasion of the cells by the hyphae. On the other hand in the average nursery the hyphae are found invading the cortical cells of the roots and it is to this intra-cellular invasion that Dr. Rayner applies the term "unbalanced." To what extent this condition of the roots is injurious is not yet certain. Mycorrhizas are known to be annual structures and a single year in a new and favourable habitat may be sufficient for the plant to develop a normal type of mycorrhiza. There is, however, some evidence to show that seedlings raised on natural soils, and with balanced mycorrhizas, have a better constitution and are able to withstand adverse locality conditions better than the comparable, nursery-raised plant.

One further point that may be mentioned is that the addition of compost to an established nursery does not affect the root structure of the seedlings, proving that there is an essential difference between the nursery soil, which is almost invariably a product of an agricultural regime, and a natural soil such as heath or moorland. The evidence so far is in favour of the natural soil (modified, if necessary, by the application of compost) as a medium for raising coniferous seedlings.

8.—Soil Research (Macaulay Institute).

Dr. G. K. Fraser of Aberdeen University has been appointed to the Staff of the Macaulay Institute as from October, 1937. A report on his investigation of humus types of *Calluna* heath is in course of preparation.

Dr. A. Muir has completed a survey of the soils of the Clashindarroch and Bin Forests. An independent vegetation survey was carried out by Dr. Fraser and the work has now been collated and a joint report prepared. The report will be completed by Dr. H. M. Steven with a section describing the current choice of species on the main soil types which have been recognised.

Dr. A. B. Stewart has continued his analytical work on nursery soils, and is also collaborating with the Research Officers in planning and assessing nursery manuring experiments.

9.—Advisory Committee on Forest Research.

The Committee met in the New Forest in July and inspected experimental work there and at Wareham Forest.

10.—Entomology.

Chafer Grubs.—During the past year Mr. J. M. B. Brown carried out a fairly comprehensive survey of the more severely infested nurseries of the Commission. The object of the survey was partly to determine which species of chafer were present and partly to attempt to correlate local factors with the occurrence of the pest and the amount of damage done. The report will be found on page 75.

In addition to Mr. Brown's work, research on a parasite of the *Melolontha* larva is in progress at the Farnham House Laboratory. Dr. Walker, who is working on this problem, is in receipt of a grant from the Carnegie Trust. The parasite in question is a Tachinid named *Dexia rustica*. This lives in a funnel formed from the skin of the chafer grub. The funnel grows from the point at which the parasite enters the grub and is clearly visible through the skin as a small blackish orifice. A single chafer grub may contain up to 16 parasite larvae and as many as 5 or 6 parasites may issue. Little is known as yet as to the extent to which the grubs are parasitised in our nurseries. A parasitism of 5 per cent. was recorded from Fairoak Nursery at Tintern, while at Nagshead Nursery in the Forest of Dean an average figure of 23 per cent. was obtained. In certain sections at Nagshead the parasitism was as high as 50 per cent. It is hoped to obtain further data during the coming season.

Pine Beetle.—Mr. H. S. Hanson has been actively engaged during the past year on a survey of pine woods throughout the country. Thinning experiments have been carried out and a large series of billet and trap stems laid down. The later work has proved that the rough-barked billet with the bark intact is much superior to any of the other types of billet tried. In Scotland there was a heavy infestation of some of the trap stems by *Pissodes pini*, and this beetle may be of more importance in standing woods than has hitherto been suspected. The major experimental areas have been linked up by a series of nearly 100 sets of felled pine stems distributed throughout Great Britain. These are giving much useful information regarding the various species of bark beetles and their parasites and predators. Some species which have hitherto been considered very rare are found to be widely distributed and fairly common, while others have a very limited distribution.

Polygraphus on Norway Spruce.—An outbreak of the bark beetle *Polygraphus polygraphus* was discovered by Dr. Chrystal on large Norway spruce on an estate near Halesworth in Suffolk. Other attacks

were later reported from Holkham and from Melton Constable, both in Norfolk. The damage was very considerable, many trees having died and others evidently being much weakened. *Polygraphus* has not previously been recorded in this country but is well known in Germany where, however, it is regarded as a relatively minor pest. Mr. Hanson, who visited the Holkham and Melton Constable outbreaks at the end of January 1938, reported that the dominant spruce were recovering and that any new attack appeared to be confined to suppressed trees or to trees which had already been seriously weakened. On the whole there does not seem much cause for alarm.

Chermes cooleyi on Sitka Spruce.—There is still no definite record of the occurrence of *Chermes cooleyi* on Sitka spruce in England or Wales. There was a very heavy infestation of egg-laying females on Sitka spruce in Glenrigh Forest in the autumn of 1936 but a recent examination of the trees showed that few galls were produced and these only on the lower branches. There is again this year a considerable infestation on the Sitka but this is almost confined to the less vigorous trees. Healthy vigorous trees show no sign of infection, even where they are growing in close contact with Douglas fir. At present there is clearly no need for alarm about this pest.

Use of Hylarsol for the Control of Pine Weevil.—In recent years extensive use has been made in German forests of an arsenical preparation, called Hylarsol, as a means of preventing damage from pine weevil. Hylarsol is a powder which is made up with water into a liquid spray with which the plants are coated, using a special twin-nozzle spraying lance. The powder is made by Messrs. Schering, Ltd., of Berlin, and costs about 8*d.* per lb. From 8 to 12 lb. are required to spray one acre of new plantation, the cost including labour and materials ranging from 12*s.* to 18*s.* per acre. In the case of a severe infestation two sprayings are required during the first growing season, so that the total cost will be of the order of 25*s.* to 35*s.* per acre. Very intensive billet trapping may amount to about 30*s.* per acre but as a rule trapping costs are considerably below this figure.

German reports on the use of Hylarsol are almost uniformly favourable and the method is coming more and more into general use in State as well as private forests. In this country two provisional trials were carried out in 1936, but owing to delay in obtaining the material the spraying was not done at the optimum season. In 1937 more extensive experiments were arranged in Divisions 7 and N.E. Scotland. These are reported on below.

1. *Durris Forest.*

Location.—Mulloch Wood, Durris, planted 1873, Scots pine, felled 1935–36. One acre replanted with Scots pine 2 + 2 spring, 1937.

Arrangement of Experiment.—There were 42 lines each containing about 50 plants. The treatments were as follows :—

A.—Unsprayed.
B.—Sprayed with Hylarsol 13/5/37.
C.— „ „ „ 13/5/37 and 2/7/37.

Each series of 3 lines was repeated 14 times. The method of application was as set out in the memorandum sent with the Chief Research Officer's letter dated 15/6/36. From other trials it was found that approximately 10 lb. of Hylarsol are required per acre of Scots pine of, say, 2,100 plants per each spraying and the labour cost is *5s.*

Results.—In October, 1937, the plants in each row were classified as follows :—

1. Undamaged by weevil.
2. Damaged by weevil but not killed.
3. Damaged by weevil and killed.
4. Dead but not damaged by weevil.

The results are given in the following table :—

Treatment.	Average Percentages.			
	Undamaged by Weevil.	Damaged but not killed.	Damaged and killed.	Dead but not damaged by Weevil.
A. Unsprayed ..	12·5	15·5	55·5	16·5
B. Sprayed once ..	25·5	23·5	30·5	20·5
C. Sprayed twice ..	48·5	10·0	12·0	29·5

Conclusions.—(i) Spraying by Hylarsol once and, still more, twice has had a definite protective action. The difference between the percentages undamaged and damaged and killed are definitely significant. 58·5 per cent. of plants sprayed twice survived, of which only 10 per cent. were damaged by weevil, against a 28 per cent. survival unsprayed of which 15·5 per cent. were damaged.

(ii) There is evidence, however, that the Hylarsol had an adverse effect on the plants. Deaths not due to weevil were :—

	per cent.
(*a*) Unsprayed	16·5
(*b*) Sprayed once	20·5
(*c*) Sprayed twice	29·5

The last figure is probably significant.

(iii) The large resident weevil population made the trial a severe one. The results are not sufficiently good to enable replanting to follow after felling even apart from cost. A survival of 58·5 per cent. is not enough and spraying would have to continue for at least 4 years not only to protect the first season's survivals but subsequent beating-up plants. The experiment demonstrates that where the weevil population is high the only practical course so far found is to defer planting for 5 years after felling. Protection of margins from adjoining felled areas is probably best and cheapest done by the existing billet trap method, but this is worth further trial.

H. M. Steven.

2. *Newtyle Forest.*

A 2-acre marginal strip at Newtyle, adjoining an area where there was a considerable weevil plantation. The area of the sprayed strip was 2 acres. A count made at the end of the planting season gave the following information :—

1. Total number of Scots pine planted	4,250
2. Number of live plants	3,423
3. Dead plants most of which were damaged by weevil	757
4. Percentage loss	18

Of the 3,423 surviving plants 1,020, or nearly one-third, had sustained some weevil damage in spite of the protection afforded by the Hylarsol.

3. *Tintern Forest.*

An area of 9 acres was sprayed on the Beacon. This was part of a large block which was burned in 1933, since when there had been a severe infestation of weevils which did much damage to our plantings in 1935/36. Alongside was a control area of 10 acres which was trapped with billets, bundles of pine twigs and pine bark.

Both areas were inspected daily and any weevil found collected. The weevil avoided the sprayed area almost completely, only 11 weevils being collected over the whole 9 acres during the season.

In the control area over 6,000 weevils were collected (600 per acre) of which more than 90 per cent. were taken from the billets which proved much the most effective form of trap.

In contrast to the previous year the trees suffered virtually no damage on either the trapped block or on the area which was sprayed with Hylarsol.

The results are somewhat inconclusive. The Scottish experiments suggest that even two sprayings of Hylarsol may not be sufficient to prevent considerable damage where the weevil population is high. It is possible that the small scale of the experiments and the intensive system of replication mitigated to some extent against success. The avoidance by the weevils of the sprayed area at Tintern is a phenomenon which is frequently mentioned in reports on the use of Hylarsol in Germany and may possibly depend on the size of the area treated.

Two sprayings of Hylarsol cost about 30*s.* per acre which is approximately the cost of very intensive trapping.

11.—Research on Vole Disease.

A questionnaire has been issued to all Divisions to obtain data on the status of the voles during 1936.

In the course of the pathological work at Oxford an organism has been isolated from diseased voles which appears identical with that causing tuberculosis. This discovery has obvious importance in relation to public health.

12.—Mycology.

Elm Disease.—The disease continues to spread and each year some fresh centres of intense infection are discovered. In 1937 two local outbreaks were found in Bedfordshire. In one or two areas the progress of the disease has been followed up annually for a number of years by recording a limited number of trees. A group at Foulden, in Norfolk, is a case in point :—95 trees were examined in 1928 and all were free from disease. In the following year 4 trees were diseased. In 1930 two out of the four trees had recovered, *i.e.* did not show any fresh signs of die-back, but there were 13 new infections. At the end of 1937 six out of the 95 trees had died, 19 trees were diseased, 21 were " recoveries " and 49 were as yet unattacked. This is a good illustration of the relatively slow progress of the disease in many localities.

Plants obtained from a resistant elm seedling raised in Holland were heavily inoculated at Oxford with the fungus (now known as *Ophiostoma ulmi*). Only two of the plants showed any external symptoms, and in

those the slight initial wilting disappeared completely after a few weeks. It is hoped soon to have a good stock of plants of this elm.

Inoculation tests carried out by the American pathologist, Dr. Walter, point to the relative immunity of *Ulmus stricta Wheatleyi*, and there is also some field evidence to the same effect. This elm has been planted fairly extensively in England, and if it proves resistant the ravages of the disease will be less serious than is sometimes feared.

Butt Rot of Conifers.—The survey carried out by Mr. Peace showed that the only fungus of major importance concerned was *Fomes annosus*. The principal species affected are the larches and spruces, pines being resistant except when past maturity. The disease is definitely worse on land previously under trees, but is also liable to be severe on old arable land. It is not as a rule bad on land which was previously moorland, or under grass. Larch is more liable to rot on light land than on heavy, and there is also more rot in areas of low rainfall.

Stereum sanguinolentum.—Some small Scots pine pitprops which failed unexpectedly in a mine in Scotland were sent to the Forest Products Research Laboratory for examination and proved to be infected by *Stereum*. This fungus is common as a saprophyte but under certain conditions seems capable of spreading from the decaying side branches into the stem. Evidence of rot caused by *Stereum* has also been found in Norway spruce cut for telegraph poles and in a small number of larch, This is not an easy fungus to detect as the amount of staining is usually slight and is often confined to the upper part of the stem.

Poplar Canker.—A few years ago a number of poplars were sent from Oxford to be planted among heavily cankered *Populus trichocarpa* on Hayling Island. Of these only *P. nigra italica*, *P. regenerata* and *P. serotina* have remained free from canker. *P. robusta*, *P. generosa*, *P. marilandica* and *P. candicans* have all been attacked. *P. robusta* and *P. marilandica* are usually resistant.

Disease of Norway Spruce at Comlongan.—A disease attacking 30-year-old Norway spruce at Comlongan, near Dumfries, was investigated. Many of the trees are dying back from the tops; but examination showed that the roots are quite healthy. Two fungi, *Hormonema dematoides* and *Phoma acuum*, have been isolated from dying needles, and a third, *Phomopsis Pseudotsugae*, from dying shoots. Inoculation experiments are to be carried out.

Die-back of Douglas Fir in the New Forest and at Dovey.—A curious case of the sudden death of a group of large Douglas fir in the New Forest and other cases of die-back of young Douglas fir in Dovey Forest have been investigated. Material from both areas yielded, on culturing, the same fungus, *Phomopsis occulta*. In this country, *P. occulta* has only been recorded as a saprophyte, but in the United States it is said to be parasitic on conifers.

Frost.—Scots pine plants of various seed origins were used in a series of refrigerator experiments in the spring of 1937. It was found that

plants raised from Scottish seed were, on the whole, hardier than those from seed collected in England.

Frost-lift.—In refrigerator experiments the best materials for covering seedbeds to prevent frost-lift have been moss, peat moss litter, and Sorbex peat. Granite chips and grit, which have given good results in nurseries in Scotland, were not satisfactory in these experiments.

13.—Utilisation.

The creosoted telephone poles of Norway spruce and Sitka spruce which were not accepted by the Post Office for service trials are now being erected at Kershope Forest. The poles will be kept under observation and it is hoped that the trial will prove successful. Spruce poles are used in various parts of the Continent for carrying telegraph or telephone wires and there appears no reason why they should not be used for that purpose in this country, at any rate in case of emergency.

PLOUGHING OPERATIONS.

The scale of our ploughing with caterpillar outfits is extending every year. Considerable experience has been obtained by those officers who have been longest at the work and I feel that it would be useful to pool knowledge.

It seems to be generally agreed that the tractors themselves are adequate for the work, though there may be some difference of opinion as to the desirability of using the larger or the smaller caterpillar.

On the other hand, the ploughs have been less satisfactory, especially where there are boulders or other obstructions in the soil. It is doubtful, in fact, whether ploughs designed on traditional lines are the right implements. They might for example be replaced by modifications of subsoilers such as the Killefer.

I do not wish to put Divisional Officers to an inordinate amount of trouble in preparing statements, but I would be glad if they would commit their main conclusions to paper. In order to help in correlating views the statements should be prepared under the following heads :—

I.—*The Caterpillars :* general adequacy for their work, limitations with reference to the difference types of ploughs.

II.—*The Ploughs :* types considered in relation to the work they have been given to do.

Weak points; modifications which have been found useful.

III.—*The Killefer :* as for ploughs.

IV.—*Remarks and suggestions* on the mechanical aspects.

V.—A general note on the silvicultural results obtained by ploughing.

A limited amount of work has also been done by the Gyrotillers. A note on this would be useful.

R.L.R.
1.10.37.

MEMORANDUM BY ASSISTANT COMMISSIONER, E. AND W.

Mr. Brockett, the agricultural expert of Messrs. Olding & Co., Ltd., the Tractor Agents, was given the opportunity of perusing the reports by Divisional Officers with a view to comment on the contents thereof, so far as affects the tractors and ploughs. His views are:—

(1) Caterpillar tractors are normally expected to do most of their work in second gear and no bad results should be experienced on this account. The use of top gear is inclined to wear out tracks rather quickly. In many cases the need of bottom gear work arises from the presence of stones and the consequent danger of travelling at too great a pace. He considered the use of a plough and a Killefer Sub-soiler tandem imposed too great a load on our tractors and this would account for the fact that Divisional Officer 1 refers to the necessity for bottom gear work.

(2) For deep ploughing, the wheel should run in the bottom of a furrow. In our case of strip ploughing, the plough has to work with the wheel on the surface. It is therefore working at an unnatural angle and the angle of the breast is inclined to be flattened. This fact may have bearing on the frequent complaint that the furrow slice falls back.

(3) Instead of deep ploughing, we might adopt shallow ploughing and then sub-soil. Mr. Brockett was not able to say if this point would be of general application.

(4) There appears to be a general opinion that wide-gauge tractors and wider tracks are advisable. The extra cost of a wide-gauge 22 tractor is a matter of £25 only as compared with that of the standard model. The substitution of wider tracks than standard would cost possibly £10 in each case.

(5) Single-furrow ploughs with sub-soilers attached as part of the framework can be purchased (Ransomes), also 2–3 furrow types, but the latter necessitate substantial power in the tractor.

With regard to the various points raised by the Divisional Officers—

(*a*) The caterpillar can climb a gradient for any length of time without damage to the tractor, as the engine is pressure lubricated and has an additional oil pump which functions when necessary.

(*b*) Mr. Brockett was very doubtful if any soil is actually compacted by the ploughshare, *i.e.* there could be no appreciable " pan " from a single ploughing.

(*c*) Tree stumps can be removed in some cases by the pull of the tractor itself, but if necessary a winch can be attached.

(*d*) The risk of water freezing can be overcome by the introduction of anti-freezing solution.

(*e*) For the effective treatment of fire-rides, it is suggested that they should be harrowed with a cover crop disc harrow. Disc harrows are, however, awkward and expensive things to move from forest to forest.

(*f*) A front pull hook can be fitted to tractors if required.

(*g*) For treatment of molinia, etc., areas, Mr. Brockett considers that a single-furrow plough with a bar point share is the only implement likely to succeed and that if this is found unsuccessful he still considers that the only possible alternative is the employment of a heavy disc plough.

(*h*) As a further remedy for the falling back of ridges, an experiment might be made with the extension to perhaps three times their normal length of the mould board tail pieces where ploughs with these are used.

(*i*) With regard to Divisional Officer No. 9's suggestion, Mr. Brockett considered that it would be necessary to mount the knives *from above* on a tool bar frame fixed to the tractor. The plough would then follow behind but he considered that a double-furrow plough drawn in this way might prove too much for the lower powered caterpillars.

Mr. Brockett said that he would like to consider whether it would not be possible to modify the standard tool bar frame, which is 7 ft. 6 in. in width and carried behind the tractor, being fixed by strong arms to the tractor frame; this normally carries tines or ridging bottoms. His idea is to reduce the length and to mount thereon stalks which would carry plough bottoms. The space between the plough bottoms would be adjustable and the tool bar frame operated by a power lift. If this idea is successful, the need for a separate plough as now used would disappear and there would be the great advantage that the ploughshares are carried in their proper position. He proposes to discuss this with the manufacturer of the tool bar frames, which are made in this country by a small firm who are, therefore, quite likely to be interested in the making of a small number of frames. Mr. Brockett stressed that the idea was one which had only recently occurred to him and that it had not been tested. He thought that in view of the fact that all Divisions considered the standard ploughs unsuitable, it was necessary to think of some completely new implement or method of mounting.

A regular quarterly inspection of tractors, etc., by a service engineer and the submission of a report on each caterpillar tractor in Scotland as well as in England and Wales can be arranged. No charge will be made for this service unless it is found necessary to execute some work in consequence of the inspection. This arrangement will be useful to the Forestry Commission, inasmuch as no tractor should ever get into a really bad state and the visits of the service engineers will prove of assistance to the drivers who have not, so far as Mr. Brockett has seen, the qualifications necessary to effect any except the most minor repairs. In this connection, Messrs. Olding & Co. would service tractors in the territory covered by Messrs. Leverton, the caterpillar agents for the North of England.

Division I.

Caterpillars.

Two caterpillar tractors have been employed in this Division, namely a 20 h.p. and a 25 h.p., and of the two the 25 h.p. has given the most satisfactory service. The extra power developed by the latter is undoubtedly required for efficient work, particularly when the tractor is drawing both the Killefer subsoiler and the plough. Even the 25 h.p. tractor is not sufficiently powerful to draw the Killefer and a *double* furrow plough under the conditions met with in this Division. It would appear to be an open question as to whether a more powerful tractor might not be more efficient.

Drawing a subsoiler and plough, the tractor is continually working in bottom gear, and it is suggested that part of the heavy cost of upkeep of the tractors is due to this. If a more powerful tractor were capable of doing this work in second gear, the number of engine revolutions per hour would be greatly reduced which should lead to much less wear on such parts as the crank shaft, pistons, big end and small end bearings,

cylinder walls, valves, etc. Consideration might be given to, say, a 40 h.p. Diesel tractor which might prove more efficient.

There would appear to be some scope for improvement in the servicing of the caterpillars. The service given latterly by tractor traders in the supply of spare parts, etc., left much to be desired. Messrs. Leverton, who now service No. 4 tractor working in this Division, have been considerably more helpful. It must be realised that the only person who knows the tractor properly is the driver. Tractors pass from forest to forest and neither District Officers nor Foresters know much about them, and of necessity a great deal of reliance must be placed on the driver with regard to the condition of the tractor, necessity of repairs, etc.

It is suggested that one firm of agents might be given the work of supervising and servicing all the Commission's tractors and that regular periodical inspections should be made by an experienced man, who would report on the condition of the machine, repairs required, driver's skill, probable economic life of older tractors, etc. It is very essential that the agents should hold an adequate stock of spare parts, as otherwise costly delays may ensue, and that every Forester should know exactly to whom he has to 'phone or wire for the necessary replacements. It is also essential that drivers should have the necessary books of instructions, lists of spare parts, etc., so that no error in ordering should occur.

Unless it can be arranged that the driver takes his leave when the tractor is at the agents for overhaul, which is not always possible, it is suggested that arrangements should be made with the agents that the driver goes to them and assists in the overhaul work, and that the Commission is credited with, at any rate, a portion of his wages. This should prove very helpful to the drivers in acquiring a fuller knowledge of the tractor. The present alternative is to put the driver on to ordinary forest work, which is uneconomical.

Ploughs.

Experience leads to the conclusion that the ploughs are the weakest part of the outfit. They do not appear to be designed for the work to which they are put and consequently do not give satisfactory results. They are not strong enough and as a result are continually requiring spare parts fitted. They do not get down deep enough into stony soil.

It is sometimes, particularly in certain types of grass vegetation, very difficult to get the furrow slice to lie over in position; it has a tendency to fall back again into the furrow. Under conditions where they work best—sandy soils—they are fairly efficient, but doubtless a more useful plough could be designed. It would appear that a deeper and longer mould board is required, so shaped that it will press the furrow slice well back and prevent it falling again into the furrow. The ploughs in this Division have sundry home-made attachments on them to try and give effect to this.

Normally in this Division the Killefer is drawn in front of the plough and gets in considerably deeper than the plough, and probably reduces the wear and tear on the plough by coming against the rocks and stones first, and generally loosening the soil.

The Killefer.

The Killefer subsoiler stands up well to its work and the larger one has given excellent service. The smaller one, which has recently been purchased, has so far proved satisfactory, and the larger one, which was considerably damaged after long service, has now been repaired and strengthened and will probably give useful service for some time to come.

The subsoiling is probably as important in this Division as the ploughing, but neither operation would be complete without the other. The loosening of the soil at the foot of the furrow gives an excellent place in which to plant pines and probably materially increases the drainage.

It is just as necessary to have a spare Killefer in case of breakages as it is to have a spare plough, as the necessity to use both Killefer and plough is agreed by all who have been concerned.

Remarks on Mechanical Aspects.

The function of the ploughing and subsoiling is two-fold : firstly, to turn over the top layer of the soil, if possible including the pan, to allow of the weathering and aeration of the soil, and secondly, to stir up the subsoil to permit better drainage, deeper aeration, easier penetration of roots and better planting conditions (pines).

The question immediately arises as to whether an implement could be designed which would do both the work of the subsoiler and the plough and do it as efficiently if not more so.

Such an implement must be capable of two functions—stirring up the soil and turning the top over. It would seem impracticable, even if it were desirable, to get a plough that would go to the depth reached by the Killefer, so it would seem that the implement would have to have the equivalent of the subsoiler " Mole " as well as the ploughing effect. An implement with double mould board ploughshares fitted to the cutting portion of the subsoiler might produce the desired results. This would throw out two furrow slices and stir up the soil in between. It would have to stand a very considerable strain and in consequence would need to be of great strength. Even so, it should not put a greater load on the tractor than the present outfit.

Silvicultural Results.

There can be no doubt whatsoever of the beneficial effect of ploughing and subsoiling on tree growth in the hard compact calluna areas. The evidence is particularly marked on pines at Slaley and Allerston, and although the initial effect on spruces is less apparent and plants may go

into check on ploughed ground, the probability is that they will get away in time, whereas on unploughed ground of a similar nature they would nearly all die.

It is quite impossible with even a heavy expenditure to produce such results by manual cultivation of individual holes in preparation of planting.

Trenching such as has been done by the Ministry of Labour trainees approaches in efficiency the ploughing, but is so costly in labour as to be impracticable on a large scale.

A. D. H.

Division 2.

The experience of tractor ploughing outfits in this Division has so far been limited to Clocaenog.

Caterpillars.

Only one caterpillar tractor has been in use, a 28 h.p. model. It can tackle gradients up to about 1 in 4 ploughing uphill provided more level ground is available for turning. It would not be safe to attempt long stretches so steep. The caterpillar is able to run on rougher ground than can be ploughed, but the limiting factor is wet ground. I am sure some deep peat areas could easily be ploughed with great benefit if a tractor capable of running on wetter ground could be found. It is suggested that a much wider track could be fitted to the existing caterpillar.

Ploughs.

The double-furrow Oliver plough without any special parts has been found the most satisfactory, but it is necessary to have the right breasts, coulters and steel shears. These are all standard parts and their pattern numbers are on the actual plough.

Ground successfully dealt with is as follows: grass, gorse, heather, bracken, *nardus-juncus squarrosus*, but all dense vegetation must be burnt beforehand with the exception of bracken which can be ploughed equally effectively summer or winter. Heather, gorse, or dense, matted grass foul the plough and prevent it cutting into the ground properly and also prevent the furrow turning over and lying as it should. Boulders up to 18 in. diameter are not an insuperable difficulty but lead to (1) loss of time, (2) wear and risk of breakage and (3) shallow ploughing, as every time the plough comes out of the ground it takes several yards to cut in again to full depth. Broken rock and rocky subsoil of extreme hardness lead to shallow ploughing.

The compacting of the ground under the shears may hinder root penetration, though I do not consider this likely.

A safety release coupling is essential and frequently functions on boulder-covered ground.

Except possibly on ground free of boulders, rock and all dense vegetation, a man behind the plough is essential (1) to push the furrow over when the plough fails to cut into the ground owing to rocks or vegetation

and when the furrow tends to spring back, due to too much unburnt vegetation, (2) to fix the safety release coupling when it becomes unhitched.

Tree stumps are an insuperable difficulty.

The Killefer.

No observations, as the implement has not been tried here.

Remarks on Mechanical Aspects.

An extra coulter to facilitate turning the first furrow has been tried but tends to prevent deep ploughing. It is important to get the right parts for the plough or breakages and bad results follow. The tractor gives little trouble but in cold weather a cabin is needed for the driver, and some means of preventing the water freezing when not in use.

In semi-moist ground where the hair-moss (*Polytrichum*) is dense, the plough generally fails to function. It simply drags the whole of the vegetation along with it, as at present the coulters fail to cut completely through into the firmer soil. I feel that a much larger coulter shaft is required for this type of ground, but there is difficulty in getting this as the makers do not seem to have them in stock.

Silvicultural Results.

So far, deaths have been negligible and weeding vastly reduced; growth promises great improvement over surface-planting and over turf-planting, and the cost is much less than turf-planting (including overhead charges). The dangers of frost-lift have not been fully tested owing to late planting.

Fire-ride ploughing is temporarily very effective but afterwards cultivation of some sort requires considering. Harrowing seems to be the best treatment.

The most profitable time for bracken ploughing would seem to be the spring, just as the bracken is becoming active. It checks the growth of the bracken, and if the following summer be dry many of the rhizomes are killed. Boulders, uneven ground, etc., can also then be seen and avoided. If bracken ploughing be done when the bracken is dormant a thick stumpy growth comes up, making weeding necessary.

The actual site for the transplants to be used in planting can be more readily consolidated if the ploughing is done some considerable time ahead of planting.

Where some subsidiary drainage is required it seems less costly to "lift" the plough over the probable line of the drain, which is subsequently cut by man-power.

Gyrotillers.

There has not been any work done by the Gyrotiller machine in this Division, but from a demonstration I saw some time ago I should not think that it would be of much use compared with the caterpillar plough. The result of a Gyrotiller is to churn up the whole surface for a depth of

20 inches or more, leaving a very rough track behind it. Before this could be used for planting it would have to be allowed to consolidate a certain amount and as the top soil is not necessarily turned under, free growth of vegetation would follow with subsequent weeding.

The only type of ground in which I think a Gyrotiller might be of use is a deeply compacted soil with deep pan.

A. H. P.

Division 3.

Caterpillars.

The following caterpillar tractors have been in use in this division :— No. 6 (28 h.p.), No. 7 (22 h.p.) and No. 10 (30 h.p.); Nos. 7 and 10 are at present at work here.

No. 6 (28). This tractor did good work under all conditions in which it was employed. In the few instances in which it became " bogged," too great a risk was taken. Old agricultural land, peaty moorland and scrubby woodland (Penllergaer) were successfully ploughed. There was no lack of power and grip was good.

No. 7 (22). This machine has only 10 in. tracks and this is the main reason why its use has not been so successful, though on heavy land such as at Halwill its power is not sufficient for the most satisfactory working. In uphill ground and on clogging vegetation the engine has boiled and has had to be stopped to cool. On rising ground first gear has to be used and second on flat or downhill.

The great drawback to the use of this tractor is its liability to become bogged in wet peaty soils. It was also found at Margam that where molinia on shallow peat had been turned, the tracks would slip and churn the surface when the peat became wetted. This was also the experience in attempts to plough fire-lines with a peaty surface. When starting uphill or on soft ground, there is a certain amount of track spin. At Halwill under similar conditions of soil and vegetation it is estimated that this plough performed only 74 per cent. of the work of No. 6.

No. 10 (30). This tractor has only been at work a few weeks, but results are most satisfactory. The ploughing has so far been on old arable land only. Ploughing is carried out normally on second gear. The tractor has ample power to travel in top gear, but at the speed attained, the first plough ridge is apt to " spin " and roll into the next furrow; normally therefore the plough is worked on second gear.

General. The quality of the ploughing is much the same with all tractors, provided a moderate rate of speed is maintained. The lighter tractor is not suitable for peaty soils when wet and has not sufficient power for steady working in heavy or steep land. It is also very readily bogged.

Ploughs.

For strip ploughing for planting, a double-furrow plough has proved to be the best. It is difficult to draw comparisons between the Ransome

and the Oliver ploughs for the reason that the latter have been new ploughs or ploughs in a good serviceable condition while the Ransome ploughs have seen much wear.

The new Oliver Plough 218 BXX double furrow is a very satisfactory plough for most conditions where ploughing is required. Though fall back occurs to a less extent than in the Ransome, the Oliver is not entirely free from this defect. Comparisons made by various observers between the Oliver and the Ransome ploughs are summarised below.

Ransome.—Better penetration by share in tough surface. Blocks less on soft ground and with loose molinia. Wheels of too light construction and give more trouble. A guard protects the front edge of the breast.

Oliver. Lifting mechanism has given less trouble. Lighter plough, but wheels seem more in keeping, additional weight would be an advantage, say up to 15 or 16 cwt. No guard on front edge of breast—not a very important point.

General. My impression is that the Ransome ploughs penetrated rough turfy surfaces better than the Oliver ploughs now in use. At Margam, ploughing of burnt molinia ground was practicable up till about the middle of July, by which time the new growth had become strong. In this condition it was found impossible, even with the added weight of three men, to obtain penetration or to keep the plough in the ground after entry had been secured. This was not due to a very great extent to the riding of the disc coulter on the vegetation, but to the flat entry over a large surface of the shares. The effect was almost similar on rough rushy ground at Halwill and there it was necessary to do a certain amount of mowing at the ends in order to obtain satisfactory entry of the shares.

Weak Points. No double-furrow plough has yet given satisfactory results in ploughing heavy molinia and tussocky vegetation. Under winter conditions, when molinia is dead and breaking off, this gathers badly between the coulter and breast in the Oliver plough and blocks it completely at about every 20 yards of ploughing. In summer the Oliver will not penetrate in strong molinia and even if an opening is prepared the plough will not stay in the ground under these conditions. A heavy single-furrow Ransome plough did passable work at Margam some years ago in this type of condition. There was, however, much falling back of the ridges, but penetration presented little difficulty. It is probable that no double-furrow plough at present on the market will work satisfactorily in this type of vegetation. Messrs. Ransomes have offered to give a demonstration with a special single-furrow plough on strong molinia and this will be made under suitable conditions this winter.

The Killefer.

No experience.

Remarks on Mechanical Aspects.

Safety Hitch. For the first time a safety hitch which really functions has been supplied by the Oliver Company and reports from both Halwill and Brechfa are satisfactory.

Modifications tried. A third disc coulter for cutting both sides of the first ridge was tried at Wilsey Down. This worked effectively for only a short time. When the disc became blunt it rode the surface and lifted the plough out of the ground. It was not a success under stony conditions, but might prove useful on peaty land and on land free from stones.

Dangerous Features. The raising gear—crank and lever—of the Oliver plough comes into contact with the end of the tractor at the headlands when turning and also in crossing banks. In one case the crank handle has been shortened and this has proved satisfactory, but any adjustment of the lever will be more difficult.

Fire-line Ploughing. For fire-line work on tough ground the effect does not last for long, as grass grows quickly from the upper edges of the ridges. Some additional form of cultivation is necessary to permit of the lines being refreshed periodically by harrowing. A short disc harrow of heavy type would appear to be most suitable, but no trial has so far been made with this.

Suggestions. 1. Longer coulter shanks for greater depth adjustment would be an advantage in tough peat.

2. To remedy the falling back of ridges a suggestion made by Mr. Broadwood seems worthy of consideration. As by cutting the plough ridge and treading it the falling back is stopped, it is suggested that, by hingeing a small roller or a curved plate at about two feet behind the second plough breast, and fitting a lever to it, pressure could be applied to the ridge by a man following in the furrow. This it is thought would sufficiently settle the ridge to obviate the falling back.

3. Drivers have as a rule a fair knowledge of the working of the tractor itself. The ploughing is not so well understood. It is thought therefore that apprentice drivers should follow the plough for a time as part of their training.

Silvicultural Results.

Strip ploughing has to a large extent solved the problem of planting in tight moorland soils. The drainage and general aeration effect is much superior to that secured by turf drainage.

There are, however, shallow peat conditions with impervious sub-soil, usually associated with a calluna condition of vegetation, in which check in the growth of spruces is still being experienced. This occurs both in the case of hard sub-soils and stiff clay. The area of such types is as a rule small, and they would probably improve if left to weather for a year or two, or alternatively slagging might effect a remedy.

Interline ploughing on poor pine areas, *e.g.* at Haldon, has led to some improvement in growth.

As a result of the improved aeration, etc., produced by ploughing there is generally an increase in the growth of grass, especially in the second year after ploughing. Seedlings planted under these conditions may require up to three weedings in the first season, but otherwise the results with seedlings on ploughed ground are good.

F. S.

DIVISION 4.

In this Division a tractor plough has only been used at Bramshill. Except for the ploughing of approximately 6 acres all work carried out was on fire-rides.

The soil dealt with was sand, brash coming in in places. The vegetation varied from light heather to dense molinia.

Caterpillars.

The old type of 20 h.p. Fordson was used. This stood up to the work well, but at times difficulty was experienced in very wet places. No steep gradients had to be tackled.

Ploughs.

The double-furrow Oliver plough proved satisfactory. When, however, very dense grass was dealt with at times there was a difficulty in turning the furrow over satisfactorily. On the barer areas or where the grass had been burnt the plough was efficient. Some difficulty in the fire lines was experienced by old Scots pine stumps and roots. Although the trees had been felled for 15 years the plough was unable to cut through or tear up the main roots. A Ransome plough was tried but did not stand up to the work.

The Killefer.

I have had no experience of this.

Remarks on Mechanical Aspects.

Some modification to allow of the furrow being properly turned back in dense grass would add greatly to the efficiency of the plough. With my limited experience I regret I have no constructive suggestion to put forward on this point.

To get good results an efficient driver is one of the essential points.

Silvicultural Results.

The silvicultural results from the ploughing at Bramshill are not clearly marked by the results, but the area on which it was tried was not of a bad type. The Scots pine have done well but have not got away appreciably quicker than on the surrounding area. I am, however, of the opinion that had it been possible to plough parts of the area where there is a thin pan, definite beneficial results would have been obtained both by aeration and allowing the surface water to percolate through instead of standing in wet weather on the surface.

A. L. F.

Division 5.

Caterpillars.

Caterpillar tractors have been used in this Division principally in the East Midlands on several types of land, of which the most important are the calluna moorland at Clipstone and the heavy clay soils at Bourne. Areas of heavy tussocky *Aira* and the gravel of the Bunter have also been dealt with. The 40 h.p. tractors which have been used have not met with any difficulty in dealing with these types of land or in drawing any of the ploughs or subsoilers.

The work has consisted of ploughing for planting in single and double furrows, complete ploughing of fire-rides and ploughing and subsoiling. This caterpillar has proved extremely useful for work of these types. The track is admirably suited to forest work and passes over wet patches of moorland and wet heavy clays where wheels would not go. It can also get over areas of loose sand—an important advantage. It requires little room in which to turn, and ploughing can be carried quite close to a fence or other boundary. A lower powered model would be less suitable for forest work generally and would be insufficient, for example, for subsoiling.

Generally a medium powered machine is preferable to smaller sizes in that a higher gear ratio can be used with a reduction in engine wear. Larger machines are much more stable than the smaller sizes and can deal with slopes and ridges on which it would not be safe for a small model to venture.

The caterpillar is economical on fuel and oil consumption and the most frequent source of expense seems to be the track plates which need frequent renewal.

The Fordson. Work on the light East Anglian soils is carried out by the Fordson tractor which is efficient and cheap to run. It is used for ploughing, for planting and for complete ploughing of fire-rides and traces; for these operations the power is ample.

The Fordson does not have the power for dealing with heavy soils or for pulling a subsoiling outfit in light soils. It is unsuitable for dragging large logs in timber extraction if the ground is rough and full of stumps and the power is inadequate for uprooting stumps and thorn bushes. For hauling produce from thinning areas and for haulage on highways it is satisfactory.

Giant pneumatic tyres should be fitted.

Ploughs.

There are four types of plough in the Division.

(*a*) *Single-furrow Oliver Plough.* This is used for ploughing of new fire traces and for ploughing for planting in heavy vegetation. It is satisfactory so far as strength and rigidity are concerned and is suitable for the work. It can be drawn by the Fordson.

(*b*) *Three-furrow Oliver Plough.* This is generally employed, with one share detached, as a 2-furrow plough and is used in East Anglia with the Fordson for ploughing for planting on light soils. It is also used for fire trace ploughing on the easier sites. With a caterpillar it can be used for complete ploughing and for 2-furrow ploughing on more difficult land. No modification is required.

(*c*) *Two-furrow spaced Plough.* This was purchased from Clegg of Bressingham in East Anglia and is an adapatation of a cultivator frame. As purchased it was not altogether satisfactory, being too weak to withstand contact with small stumps or large stones. The frame is too wide and the plough has always to be moved by lorry as the track is unsuitable for road haulage by the Fordson. This machine has been strengthened with triangulated tie-bars but these often become twisted and require re-setting. In addition they impede progress in that they collect turf, etc., and have to be cleared periodically, the plough having to be specially stopped for this purpose.

(*d*) *Three-furrow Ransome Plough.* This is strongly built and is good on strong ground or on land which is full of rotting stumps. It is too heavy for the Fordson and requires a caterpillar to haul it.

Subsoilers.

Subsoilers have been used on the Clipstone moorland soils, on the heavy clay land at Bourne and on sandy land with a chalk subsoil in East Anglia. Subsoiling seems to be effective in breaking up beds of pebbles in the Bunter soils, in aerating and breaking up a plough pan on derelict clay arable soils and it is probable that it will prove useful in East Anglia in preparing ground for hardwood planting.

For a subsoiling apparatus considerable strength is needed for breaking through old roots and layers of stone, flint or gravel, without damage to the machine.

One difficulty with the subsoiler is to keep it at a constant depth in the soil, and most types of subsoiler require some kind of tackle to take the pull in a horizontal direction irrespective of the bumping of the tractor on the surface. It appears also to be essential to have the variable depth snout-bar sufficiently strong and rigid to prevent deviation from the vertical when obstructions are encountered. This is one of the most frequent causes of digging in which can bring the outfit to a standstill and of lifting which varies the depth at which the mole tunnel is formed.

For combined ploughing and subsoiling the incorporation in the framework of the plough of the actual subsoiler seems to be necessary. In the machine used at Clipstone, the plough and the subsoiler were separate units, the subsoiler being slung between two large wheels and having a direct attachment to the tractor for use without the plough. Ploughing being necessary on account of the vegetation on the site at Clipstone, operations were begun with the subsoiler unit coupled direct to the tractor and followed by the plough. The result was that the

plough often threw the turf on top of the subsoiled track and buried it. To prevent this, a rigid bar of iron was fitted to the back of the plough and the subsoiler was then fitted to follow the plough in the furrow. One disadvantage of this arrangement was that one wheel of the subsoiler travelled on top of the turf thrown by the plough and raised the subsoiler with a resulting loss of depth of cultivation.

At Bourne, on the other hand, the subsoiler was incorporated in the frame of the plough and being set in line with the coulter ahead, worked in the middle of the furrow. It thus gave greater depth and left a distinct central track on which subsequent notching was an easy operation.

Remarks on Mechanical Aspects.

Conditions in this Division are not exceptionally difficult and the mechanised ploughing is, generally speaking, carried on in a satisfactory way at costs which are not excessive.

There is room for a good, light but rigid plough set to plough two furrows at 4 ft. 6 in. spacing.

All ploughs used for work on thick turf or springy heather should have extra long mould boards and sharp, long-shafted discs capable of being set to sever completely the outside edge of the slice from the undisturbed ground. Otherwise in actual ploughing the slice tends to fall back into the furrow.

Silvicultural Results.

(*a*) *East Anglia.*

Single-furrow Ploughing. In East Anglia there seems to be no doubt that the principal danger to newly planted stock is drought with frost as the next important adverse factor. Drought danger comes from a low rainfall and the intense competition of grasses, etc., for the available supply of water in the upper layers of the soil, and this is to a certain extent reduced by the ploughing which gives temporary relief from this competition. Shallow furrows are ploughed in order to keep as much of the top soil as possible.

Complete Ploughing. This has been tried experimentally with a variety of species. Complete ploughing, it was felt, by removing (temporarily) the vegetation, would reduce the risk both of drought and frost damage, but very little difference actually has been observed; nor has there been any better growth on the full ploughing when compared with the standard single furrow.

Subsoiling. This has been used—without ploughing—at the King's Forest in the establishment of Queen Mary's Avenue and of the hardwood belts. Examination of the roots of planted beech and birch has shown that root activity goes on principally along the line of the subsoiler. There is no evidence that subsoiling has had any beneficial effect on the growth. The general response has been quite good, but good plants were put in with more than the usual care and the plantation has had the benefit of two exceptionally good seasons.

(*b*) *East Midlands : Moorland Soils.*

Single-furrow Ploughing. On the calluna ground at Clipstone where a thin layer of heath peat overlies a poor sandy soil, shallow single furrows after the Thetford manner are little good and have given results no better than direct notching. Plants went into check on the worst vegetation types when put in the furrow in exactly the same way as they did on the natural surface.

On two areas at Clipstone single-furrow ploughing to a depth of 10–12 inches was carried out. On one of these areas the plants were notched into the furrow direct and have made none too satisfactory growth although better than in the shallow furrow. In the other section the soil in the furrow was thoroughly churned up with the spade before planting and this gave better results.

Complete Ploughing. A considerable area of deep, complete ploughing was carried out at Bilsthorpe, Clipstone, a few years ago. The work was badly done and the turfs did not settle at all well. With this and the dry seasons which followed, there were many losses among the plants, but the survivors and the beat-ups have grown sufficiently well to show that deep disturbance of the soil is necessary on this type of land. This is confirmed by the good growth which has been obtained on the Clipstone main block where plants have been put in on the deeply disturbed soil round the old trenches.

The actual planting in deeply ploughed furrows, though it gives better results, is more costly than in the shallow ploughed as sites have to be levelled and prepared for the plants. It is possible that shallow ploughing with subsoiling might prove as effective (this is by no means certain) and it would be easier and cheaper to plant.

Lincolnshire : Clay Soils. Work has been done at Bourne on old grassland on heavy clay. On ordinary single-furrow shallow ploughing the death rate with oak in 1935 was 10 times as great as that on ploughed and subsoiled areas and planting costs were 50 per cent. higher. Subsequent growth has been better on the subsoiled areas.

Ploughing without the subsoiler left the soil stiff and compact in the furrow and on the turf and generally unfavourable for root development. Subsoiled furrows were loose and pliable, benefited from a short weathering period before planting and generally gave an excellent medium. The subsoiler further permits the use of shallow furrows so that the loss of good top soil is reduced to a minimum.

Gyrotillers.

The first work done by Gyrotiller in this Division was carried out last year on the Warsop section of Clipstone. This area carried a remarkable crop of very heavily tussocked *Aira flexuosa* so strong as to make ordinary ploughing methods ineffective. Had it been possible to burn the grass off before ploughing, operations would have been simplified and ploughing would have been feasible, but this was not possible owing to the danger to surrounding plantations.

An 80 h.p. Gyrotiller running on oil fuel was hired at a contract price of 30*s.* 0*d.* per acre (33*s.* 0*d.* per acre, less 3*s.* 0*d.* for payment within a month). The work was unfamiliar to the men in charge who were used to arable land only, but they dealt with it successfully. The machine took a strip 8 ft. wide and churned the soil up very thoroughly to a depth of two feet, except where beds of pebbles were struck. The tine tended to ride over these and not to break them up. The heavy grass was partly buried and partly thrown on the surface, where it withered and died, while an area of tall bracken was successfully broken up. The soil was left in a fine and open state of cultivation. It was difficult to walk over and a stick could be pushed in without effort to a depth of about 2 feet.

The disadvantages of the Gyrotiller from the silvicultural point of view are, first, that it leaves the soil in such an open condition that it cannot easily be planted for some time. This applies of course only to light soils as at Clipstone; on a heavy clay conditions no doubt would be better. In any case, drought might be a serious factor on gyrotilled soil in the first two years after cultivation.

Another disadvantage is that gyrotilled land in periods of hard frost might well freeze down to a depth of 18 inches or more and thus impede forest operations very seriously. A further disadvantage is that it will not work on land where there are large boulders.

As a method of soil preparation for planting I believe gyrotilling would be good for hardwoods, but I have as yet no proof of this. For conifers I doubt whether it would give very much better initial results than deep ploughing, although the final result might be better. It is worth a trial on boulder-free calluna moorland.

A larger Gyrotiller (180 h.p.) has been used in East Anglia very successfully to clear overgrown rides. For this purpose the machine is excellent, as it uproots gorse, broom, seedling pine and elder bushes rapidly and leaves the soil in a fit state for subsequent ploughing. The Gyrotiller had no difficulty at Swaffham in uprooting bushes and small trees up to 15 ft. in height.

J. M.

Division 6.

Caterpillars.

We have had a very limited experience in this Division of the tractors now in use. Tractor No. 7 came here when new and was found fully up to the work on the light soils of Wareham and Ringwood. Compared with the old type of tractor, which works very satisfactorily, the present type is at a slight disadvantage in respect of its narrower base. The older one was less liable to topple over on slopes with its broader base.

Ploughs.

After experimenting in the early days with different methods of ploughing, *e.g.*, complete ploughing, strip ploughing and single and

double furrow, our opinion quickly settled down to the double-furrow ridge method as being the best for the planting of pines on the Dorset heaths. For this work a Ransome double plough was used and I have no complaint against it. It is essential, however, to use a proper safety coupling as supplied by the makers of the plough.

The Killefer.

No experience.

Remarks on Mechanical Aspects.

We are always up against one mechanical difficulty in ploughing strong heather ground : the plough with a broad enough breast to overcome the springiness of the long heather has not been invented and the turfs spring back. The heather has to be burned or cut beforehand. Burning is often risky and the motor scythe should be very useful in this respect.

Silvicultural Results.

So far as our Wareham and Ringwood soils are concerned it is mainly a matter of aeration. The soils there pack tight and develop in algal growth on the surface which holds up the water in the winter and prevents any air getting to the soil. The result is that any plants in the soil in its virgin condition can only develop roots in the summer when the algal coat has cracked and the sinking of the water table has drawn in a modicum of air. In the autumn the algal coat re-forms, the water table rises and the roots die back in a practically airless soil. The open condition resulting from ploughing not only increases the air content but permits showers and convection currents to keep up an interchange. The result is to induce root development and better growth.

There probably is much more to it than that—the increased air content favours microfaunal and floral development and breaks down the organic compounds in the soil, some of which have been proved to be toxic. How far this latter effect will be lasting remains to be seen, but it is evident that it will be more lasting with the double ridge ploughing than with the " complete " ploughing. This method moreover helps in keeping the winter water table low in relation to the tree roots.

The effect on tree growth is conspicuous. Large areas of these difficult soils are showing normal and often exceptionally good growth, though on the wetter portions it remains slow.

D. W. Y.

DIVISION 7.

My experience of ploughing in Division 2 was limited to a small area ploughed by a contractor at Cannock and one year's work (plus the commencement of the second year's) at Clocaenog.

Caterpillars.

The contractor's tractor was a new Fordson, which was adequate for a single-furrow plough working up to 11 inches in depth in a pebbly sand which had lain undisturbed for a long period and was consolidated into a hard mass. The same tractor made a trial trip at Clocaenog and had adequate power for the same plough under those conditions.

The Departmental tractor at Clocaenog was a caterpillar of ample power for double-furrow work. Owing to the presence of boulders it was necessary to run on second gear for most of the work; this leads to heavy oil and plug consumption and may shorten the life of a tractor.

Ploughs.

The contractor used an Oliver plough, which stood up to the work well. Difficulty was always being experienced with the shoe owing to excessive wear and even turning at times.

At Clocaenog much trouble was experienced with ploughs. To the best of my recollection the Ransome ploughs were not efficient and we got better results out of an old Oliver plough, although it was not in good repair. Just before I left a new Oliver was supplied, but this had not been put into commission.

Without details I am unable to comment upon modifications.

The Killefer.

No experience.

Remarks on Mechanical Aspects.

All ploughs to date have failed properly to turn out the furrow slices when the vegetation contained anything wiry, such as heather, gorse, etc. As a result the ploughing on such land left much to be desired. Messrs. Olivers were consulted, and an additional coulter was suggested and provided, but had not been tried before I left.

The contractor ploughed single track only and went over his work again to give a second furrow. In the hands of a skilful man the result appeared to be as good as double-furrow ploughing, but unless the driver is really expert double-furrow ploughing is the more efficient.

A safety device is absolutely essential in our work for the preservation of the plough. Wooden plugs are not a satisfactory solution and the numbers used at Clocaenog before a spring was supplied made for considerable expense and loss of time.

Silvicultural Results.

Part of the Cannock ploughed area was planted the same year as ploughed and my impression is that the results were not inferior to those on the ground left a year to settle. In sandy soils a year for settling does not appear to be essential.

At Clocaenog there were indications that clayey soils benefit from settling or weathering, but owing to the nature of the turf artificial

consolidation was always necessary whether ploughing took place shortly, or some time, before ploughing; otherwise hollowness persisted.

Results at Cannock during the first year or two after ploughing were no better than in unploughed areas.

At Clocaenog the spruces kept their colour particularly well and suffered fewer losses on ploughed land. The small trial area was planted in May with cull plants with much better results than in any other type of planting; root development in particular was exceptionally good.

Gyrotiller.

This implement has only been seen at work on agricultural land and a small strip carrying boulders and small tree stumps. On the former there was complete upheaval of the soil down to about 18 inches. On the latter small boulders and small tree stumps were all turned over by the implement: the owner of the land said that it appears not to be troubled by boulders up to half a ton.

A. P. L.

Division 9.

Caterpillars.

The "Caterpillar 20" and the more powerful type of Tractor Traders Limited both seem to be as well adapted to the work as may be expected. The class of work done, often under extremely bad climatic conditions, necessarily involves rapid deterioration, but this would be unavoidable with any type of machine.

It is a pity that the caterpillar is not fitted with a hitch at the front end as this would often facilitate haulage of the machine or the ploughs out of deep bogs.

Ploughs.

Single and double-furrow ploughs of Ransome's and Oliver's manufacture have been in use and while either of these are effective in ridge ploughing or mineral or burned-over hard peats of the calluna type, they are far from satisfactory either for fire-lines (*i.e.* complete ploughing) or for molinia types. In both these cases it is impossible to achieve a complete and clean turning over of the ridges. Breakages are also too frequent on boulder-strewn ground.

For molinia ground it is felt that we require a plough which will cleanly cut both sides of the furrow before turning the ridge out, and that the length and twist of the breast should be adequate to place the ridge an inch or two away from the furrow in a completely inverted position. The trouble is that any type of disc coulter is incapable of cutting *down* through the tough molinia herbage, while a knife coulter perpetually becomes clogged up with loose grass. Two curved knives designed to cut the sides of the furrow *from beneath* upwards were used with success on a locally made plough at Margam.

For fire-line work it would seem that after a preliminary ploughing, which in most cases must leave the ground in a very rough condition, a further breaking up of the ground will be necessary, and for this purpose a special narrow gauge, but heavy, inclined disc cultivator would be worthy of experiment. This might be followed by a heavy chain harrow or wheel roller, according to the nature of the ground. Disc cultivators and rollers should not be more than about 6 feet wide in order that they may take irregularities in the ground and to facilitate manœuvring on the turns and corners.

The use of scoops rigidly attached to the front of the tractor of the type frequently used for levelling made-up ground would be of very limited use on hilly and peaty ground.

The Killefer.

I have no experience of subsoilers or Killefers.

Remarks on Mechanical Aspects.

As engineering jobs the tractors are vastly superior in construction to the tackle which they have to pull. For forest work it is very strongly felt that the agricultural types of ploughs which we have used are inadequate in strength, and the trouble involved in constant repairs and provision of spare parts leads to much loss of effective time.

Silvicultural Results.

Ploughing simply as opposed to manual turfing of molinia types is both cheaper and superior. The better and larger contact which the plough ridge makes with the surface of the ground entirely prevents losses from drought. If carefully laid out the ploughing gives the effect of immeasurably superior drainage. Actual planting on plough ridges is only a trifle slower than planting on individual turfs.

G. B. R.

DIVISION N.

The experience gained is limited to that obtained in the ploughing of about 140 acres of fairly level moor ground which is free from stumps.

Caterpillars.

The " Caterpillar 22 " has proved itself quite equal to the work. The first work was done with petrol as fuel; for the past three weeks it has been running on paraffin and the running has been very satisfactory. The tractor has given no trouble.

Ploughs.

The Ransome double-furrow plough was used at the beginning of the work. This plough gave a depth of furrow of 7 inches at the most; in working of the plough it was found impossible to avoid stones, and breakage of the shear pins was common. This made the work slow.

The Uni-trac Major No. 2 single-furrow plough is in use at present and is a much more satisfactory tool. It gives a furrow of 12 in.—15 in. depth. Furrows are made about 4 ft. 6 in. apart and the general appearance of the finished job is that it looks almost like solid ploughing. We are running the plough with the two wheels on the undisturbed surface; the plough is designed for agricultural work where one wheel would run in the furrow after the first furrow had been made. Consequently there are strains on the plough for which provision is not made in construction. The malleable steel castings which form the adjusting gear of the plough are not strong enough for our work.

The faults of the plough for our work are :—

(1) Weakness pointed out above.

(2) The plough tends to run on its nose and to draw to one side. When the locating ring and draw bar are set to get the plough running as level as possible, the draw bar wears at the point where it passes through the locating ring and the locating ring itself catches the stones which project above the surface of the ground and gets bent.

Less important faults are :—

(3) The subsoiling attachment is useless; it does not get into the soil and it is made of cast metal.

(4) the tail press has not sufficient adjustment to allow it to throw the soil clean up on the unploughed strip.

Ransome's man adjusted the plough to correct fault (2) as far as possible but did not eliminate it. An arrangement has been made with K. Mackenzie, Evanton, to set the point of attachment of the draw bar farther back on one of the ploughs and to crank the draw bar farther forward on the plough. This may give a more level running of the plough and prevent wear on the draw bar. Mackenzie has also undertaken to make a tail press that will give more adjustment and this, it is hoped, will throw the soil up more effectively.

A coulter has been fitted in front of the share and this addition seems to have improved the throwing up of the soil by cutting the top layer better.

Using a small wheel (binder wheel) in place of the big wheel on the plough did not give improved workings.

K. Mackenzie also undertook to supply a spring release attachment to replace the shear pin arrangement. The spring hitch, ordered from Ransome's weeks ago, has not yet arrived.

The Killefer.

I have no experience of the tool. Our local expert on ploughs, K. Mackenzie, whom we had on the ground, gave his opinion that it was an unsuitable tool on account of the boulders in the soil.

Mechanical Aspects.

Remarks are given above.

Silvicultural Results.

I have no experience yet of the results.

General.

I believe that K. Mackenzie, Evanton, who has had a large experience in all ploughing gear, will be able to give us a tool that will do our jobs, including the stump pulling job. He has the confidence of Ransomes and if we are allowed to spend a relatively small amount of money in experimental gear, Ransomes could put the improved plough on the market at a fair price.

Two lines might be worth investigation :—

(1) A plough made on the lines of a drill plough to give a throw up on each side. This plough would be provided with a coulter.

(2) A plough made on the lines of Killefer, but provided also with a share that could turn over the top skin of turf. The turning of the turf is an advantage.

J.F.

DIVISION N.E.

My observations relate to Tractor No. 5 outfit, which has operated in the N.E. Division for two years, but comparisons are made with the first outfits tried out at Allerston in 1929 when I was Research Officer and with work done at Clipstone and elsewhere in Division 5 in 1932-33.

Caterpillars.

Tractor No. 5 is a 28 h.p. petrol-paraffin caterpillar, delivered in September, 1935. It has operated under very difficult conditions as regards stones and slope at Clashindarroch and Scootmore and also for short spells at Culbin and Roseisle, and it has stood up to all the work. The only major replacement is a new radiator; this was necessary, due to a crack in a tube, possibly due to frost damage. The engine is in as good running order now as when delivered. It is not considered that a lower-powered machine would have been able to do the work required. It has been run on petrol, as I am advised that at the low speeds possible on the hill work paraffin would probably damage the engine. It is intended, however, to use paraffin on low ground ploughing at Lossie this winter.

Ploughs.

Two ploughs have been used :—

(*a*) Ransome's No. 2 " Unitrac " Major deep-digging plough with subsoil tines.

Practically all the ploughing for planting has been done with this plough. It has successfully ploughed more stony ground than I have previously seen tackled. Minor breakages have been frequent, particularly shares, but the main frame and fitments have stood up to the work, and a small stock of spares enables it to work continuously. This plough is a great advance on Ransome's earlier ploughs.

(*b*) Ransome's No. 3 "Junotrac" two-furrow plough with subsoil tines.

As deeper and more suitable work for planting on is done by the Unitrac, this plough is only used to plough fire-lines and as a stand-by.

One defect of all ploughs seen to date is that under some conditions, *e.g.* abundance of lichen, they do not keep in the ground. The heavier the plough the less does this happen. In this respect the Junotrac, having a heavier frame, is better than the Unitrac. A still heavier-framed Unitrac would be an improvement.

The only modification made in the Unitrac is an extra cutting disc to the right of the original one.

The Killefer.

No observations.

Remarks on Mechanical Aspects.

Tractor. The 28 h.p. caterpillar has met all demands made on it From the point of view of economy a Diesel-engined unit will be advisable as soon as reliable lower-powered Diesels are available.

An increase in the width of axle would enable the tractor to operate on steeper slopes.

Ploughs. A still heavier-framed single-furrow plough will be an improvement.

Silvicultural Results.

Only one year's planting on ploughed ground has been done in this Division. The results are good.

Danish foresters have told me that simple ploughing such as we do gives poorer results in subsequent growth of the trees than cultivation methods which ensure the intimate mixture of peaty layers and soil. This is to be expected on theoretical grounds and if it is the case the Gyrotiller should give better results ultimately. A trial of the new 30 h.p. Gyrotiller arranged provisionally with Messrs. Fowler for last spring had to be postponed as a machine was not available to send north.

H. M. S.

DIVISION S.W.

Ploughing Operations.

My experience of tractor work in my own Division has been limited to the Bristol Tractor, and of ploughing has been limited to the work done by the Bristol at Fleet, Carron Valley and Dundeugh Forests. Any other information I have was obtained simply by observing the work which was being carried out in other Divisions some years ago and regarding which full and up-to-date information will doubtless be provided by the Divisional Officers directly concerned.

As affecting my personal experience in this Division with the Bristol Tractor, my observations are as follows :—

Caterpillars.

The Bristol is an example of a relatively cheap machine, purchased because of its cheapness and small size for a definite experiment in the extraction of thinnings at Inverliever. It has to be realised that it is not a powerful or complicated machine requiring skilled attention and having high maintenance, depreciation and running costs. As such it is extremely satisfactory mechanically and for a low outlay has satisfied me as to the practicability of extracting produce with tracked tractors and trailers even under very adverse circumstances without incurring heavy expenditure on the preparation or the maintenance of rides. It is, however, under-powered for the work it has had to do; this results in track slip (with consequent damage to rides) on up grades and means continual over-straining of the engine. Similarly, the engine has been over-stressed on the ploughing done in the forests, and I am definitely of the opinion that the Bristol Tractor is not sufficiently powerful for extraction work in hilly country or for deep ploughing in the forest; even deep ploughing (8 in. deep) at Tulliallan Nursery to bury a very heavy greencrop (20–25 tons per acre) taxed the machine to the limit. I should like to add that, following a breakdown at Tulliallan which has been traced to a misreading of the lubrication instructions, the machine was sent back to the makers for general overhaul, and despite the way it had been over-worked the makers found no need for any extensive repairs except those directly due to the lubrication mistake, and even including these the overhaul is costing less than £30; the tracks needed virtually no attention.

In view of its cheapness and ease with which it can be handled and driven, *i.e.* not requiring a specially skilled driver, I recommend the Bristol for serious consideration as a standard tool for use in large nurseries where (as at Tulliallan) the annual programme of ploughing work alone aggregates over 100 acres per annum. This consists of ploughing prior to greencropping, ploughing-in greencrop and ploughing before preparation of lines and seedbeds; to this work, of course, must be added also the cultivation of summer fallow and other miscellaneous jobs.

Ploughs.

The plough used with the Bristol is the Lister-Cockshutt No. 6 Self-Lift Two-furrow Tractor Plough. For ploughing in the forest we use it as a single-furrow plough with No. 27 bottoms, combined discs and skims. The same bottoms would be suitable for double-furrow ploughing in the nursery, but for deep nursery ploughing when turning in a greencrop we do single-furrow work with a " Full Digger " bottom.

This plough has proved eminently satisfactory except that one of the beams was slightly distorted when we hit a rock at Carron Valley, and this indicates that it would not be strong enough for use with a more powerful

tractor. Apart from this the design of the plough is excellent, particularly in respect of the wide range of height-adjustment of the off-side wheel.

We find it essential to use solid steel shares as supplied by Messrs. Cruikshank, of Denny; the ordinary pattern break and wear almost at once when ploughing on stony ground.

The Killefer.

I have no experience of this.

Remarks on Mechanical Aspects.

Apart from what has been said above I have little direct evidence, but I should like to take this opportunity of emphasising the difference between tractors with a differential, such as the Bristol and the Roadless Fordson, and those with no differential, such as the Caterpillar 22. Steering with the former type involves braking one side which, through the differential, has the effect of increasing the speed and reducing the mechanical advantage of the other track; this tends to cause track slip, destruction of the surface of the ground and ultimately "digging-in." This is the sole reason why I have not previously pressed my suggestion that we purchase for trial a Roadless Fordson, having regard to its cheapness, ease of maintenance and well-tried power unit. I still submit that the purchase of one for ploughing operations is well worth consideration, but I am doubtful whether (owing to the steering difficulty mentioned above) it would be suitable for extraction of produce, where all too frequently the need for steering arises at just those points (on an up grade) where the maximum tractive effort is required.

Silvicultural Results.

I have little personal experience of those aspects of this work to which I believe the Chairman refers. The ploughing at Fleet is purely on good grassland for the planting of 1-year oak seedlings, and I can only say that it has been entirely successful, with great ease of weeding and remarkable growth of oak when planted on the furrow.

The ploughing at Dundeugh and Carron Valley was on hard ground and the results in this first season have been in every way satisfactory and such as to encourage the further use of seedlings for planting, particularly at Carron Valley.

General.

I should like to draw attention to some further points :—

(*a*) A tractor for use in the extraction of produce should be fitted with a winch; this conforms with the practice of all good timber merchants who use this sort of traction. The winch may also be extremely useful and save much time and strain on the tractor when the latter is being used for ploughing and gets into difficulties.

(*b*) In view of the great mileage of extraction routes which will be needed within the next few years for the removal of thinnings, I submit that the purchase of a tractor which can use a Grader or Angledozer should be considered. At places such as the Forest of Ae, grades suitable for laying a light railway or (more especially) suitable for the operation of track-laying vehicles could be rapidly and cheaply formed and these grades would in the meantime serve as cycle tracks.

(*c*) I understand existing tractors have got into difficulties when trying to plough on peaty ground, but the ploughing of areas such as the molinia types, with up to 9 in. of peat, should be a great deal cheaper than turf-draining. If the existing equipment cannot undertake this work, then a trial of caterpillars with wider shoes seems justified, or possibly (as suggested) the trial of some different type of track-laying tractor, such as the Roadless Fordson or the Fordson with the MacDowell Crawler Equipment as marketed by the MacDowell Equipment Company, Emerson Park Works, Wingletye Lane, Hornchurch, Essex.

(*d*) I have omitted any reference to English-made machines other than the Fordson in consideration of their high initial cost.

O. J. S.

VISIT TO NORTH GERMANY.

By W. H. GUILLEBAUD.

The writer visited North Germany in October, 1937, to meet his colleagues on the Permanent Committee of the International Union of Forest Research Organisations. This Committee meets once a year to discuss the work of the International Union and to prepare for the next Congress, which is to be held in Finland in 1940 or 1941.

In addition to the indoor work of the Committee a tour of a number of forests was arranged. After the tour a Conference was held in Berlin to study questions of tree races, seed regulations, etc. The report below summarises the salient points arising firstly out of the tour and secondly out of the conference on seed problems.

I. The Tour.

Visits were paid to the private forests of Lieberose, Hohenlübbichow and Bärenthoren. These are all situated in the province of Brandenburg, on light sandy soil, with a rainfall of from 12 to 15 inches per annum.

These three forests have many points in common; they represent the trend of modern German silviculture to break away from the old tradition of pure even-aged high forest regenerated by clear felling and replanting or resowing, and to adopt instead a system of mixed uneven-aged forest. An essential element in this new system is the so-called " Einzelstammwirtschaft " which may be roughly translated as the system of management by selected stems. The underlying principle is that in the ordinary management of even-aged stands, where a definite rotation is fixed, felling the entire crop results in the sacrifice of good individual trees which are in full vigour and could carry on profitably for many years to come. At the same time the stand contains weakly individuals which should have been removed long ago, as they are not putting on enough increment, but are retained to maintain the canopy. Management by selected stems implies the abandonment of a fixed rotation; so long as a tree is growing well and putting on increment it is allowed to carry on. A good tree is only felled when it is to the advantage of a better neighbour.

In 1934 a law was passed prohibiting clear felling throughout the whole of Prussia. This law does not apply to the other States, such as Saxony, Bavaria, Baden, etc. At about the same time another law was passed, which applies to the whole of the managed forests in Germany, increasing the annual cut by 50 per cent. of the normal prescribed in the working plans. The effect of the two laws in Prussia is that an annual yield of 50 per cent. above normal has to be obtained solely by means of thinning.

The impetus to the law against clear felling was derived in part at least from the success obtained in two of the forests visited, namely Bärenthoren and Hohenlübbichow. These are both private forests, of 2,200 and 3,500 acres area respectively, and have been under continuous management for 50 years in the first case, and 35 years in the second. In both forests the principal aim has been to avoid clear felling so far as possible and gradually

to introduce hardwoods into what were originally pure even-aged forests of Scots pine. At Bärenthoren an essential part of the method has been to leave all branchwood on the ground. At first this decayed slowly, but gradually as the moisture conditions in the soil began to improve as a result of the layer of branches the micro-organisms were able to function better and decay is now extremely rapid, branches 2 to 3 inches in diameter rotting away completely in 3—4 years. Under the decayed branchwood a layer of hypnum moss forms, and with sufficient interruption of the canopy, regeneration of pine quickly appears. Hardwoods—beech, sessile oak, etc.—have to be brought in by planting or sowing in enclosures fenced in against deer. Up to the present time, owing to the cost of such work, very little hardwood has actually been introduced at Bärenthoren.

Another characteristic feature of the Bärenthoren system is the thinning. This is apparently carried out annually over the entire area of the Forest. Thinning is conservative during the first 50 to 60 years of the life of even-aged Scots pine stands, but as soon as a length of 40 feet of stem has been obtained the canopy is gradually broken, resulting in an open stand under which regeneration soon appears. Virtually no regard is paid to this regeneration during the later stages of the crop, thriving trees are never removed in order to favour the young growth, and much of it was obviously suffering from insufficient light. It was observed however that in the larger gaps one or more of the younger trees were shooting up to utilise the light and that such trees were of excellent type and growth.

There are several difficulties inherent in the Bärenthoren method; one is the lack of order resulting from felling continuously over the whole forest each year. This would only be possible in a small forest with a highly trained staff, and even then must increase the cost of extracting the timber. Secondly, there is the difficulty of regulating the annual cut so as not to remove more than the increment. Thirdly, there is the danger that the final stems may be kept too long and may be defective owing to heart rot when they come to be felled.

Von Keudell's Forest of Hohenlübbichow contained much of interest. In an introductory address he stressed the point that the cheapest plantation is not usually the cheapest or best in the long run, but that it is the one which will yield the cheapest crop of timber. In the past cheap methods of establishments of pure conifers had led to very expensive forests, owing to the ravages of insect pests and cost of the necessary protection against them, loss of increment due to felling of immature crops, etc. Von Keudell certainly put his own precepts into practice, because his plantations were nothing if not expensive. His general procedure was to remove all stumps, completely plough the ground, sow pine in lines, and interplant beech, oak and other hardwoods at from 1 to 2 feet apart among the Scots pine rows. Various mixtures seen were—(1) Scots pine, sycamore, robinia and Norway spruce; (2) Douglas fir, oak, beech under a thin crop of old Scots pine; (3) Black Italian poplar cuttings 4 feet apart filled in with Douglas fir and Norway spruce to form a 4 ft. by 1 ft. plantation; (4) Birch, with some poplar and willow cuttings, Scots pine, acacia, Douglas fir and Norway spruce. Except where poplars are

planted the normal procedure is to cultivate between the rows of plants annually for three years after planting. Von Keudell stressed the importance of complete ploughing and subsequent cultivation as being much superior to the more usual strip cultivation. The young plantations were certainly very successful and even spruce put on good shoots on the moister soils. On the other hand, the quantity of plants used appeared unnecessarily extravagant, while the mixtures are bound to land the management in difficulties later on. Von Keudell has succeeded in greatly extending the proportion of hardwoods in his 3,500 acre forest. In 1891 99 per cent. of the forest consisted of pure Scots pine, but by 1931 the proportion of hardwood had risen to 17½ per cent. (It should be observed that Hohenlübbichow differs from Bärenthoren in that Scots pine regenerates only with difficulty, while at Bärenthoren seedlings spring up as soon as the canopy is broken.)

In 1926 there were nearly 800 acres of Scots pine of bad type of growth, believed to have originated from seed brought in from outside Prussia (probably of French or South German origin). Of this area 450 acres have been felled and replanted with native pine and hardwood mixtures and another 100 acres are to be felled. We were not shown any of these " foreign race " stands.

Von Keudell is a firm believer in pruning. Selected stems (about 200 per acre) of all species except beech are pruned as soon as the stems reach a diameter of about 3 inches at breast height.

Much importance was attached to the raising of conifers, pine, Douglas fir, etc., under the partial shade of the old pines. The young trees are much finer branched as a result of the shade and will produce cleaner timber. The fineness of the branching of the young pines growing up under the shade of the old trees was very evident, both at Bärenthoren and Hohenlübbichow.

Von Keudell believes in thinning every two years; a maximum interval of 3 years is now generally obligatory in the State Forests in Prussia.

The importance of the fast-growing softwoods was stressed, in particular poplar. Considerable hopes seem to be placed in the work now going on near Berlin on the breeding of new fast-growing and rust-resistant poplar hybrids. We saw some astonishingly fast growth of poplar at Hohenlübbichow, and it remains a mystery how such growth can be obtained on a sandy soil with a rainfall of only 15 inches. Unrooted cuttings were used and a shoot of 4 feet was made in the first year. It is perhaps significant that much importance is attached to the type of cutting. Only one-year-old wood from strong four-year-old shoots is considered satisfactory.

In the early thinnings of Scots pine the general procedure is to cut out as many as possible of the predominant stems, leaving the less heavily branched but slightly slower growing co-dominants to form the final crop. Von Keudell declared that it was a waste of good Scots pine to use these for telegraph poles; spruce is quite good enough for this purpose and should be used all over Germany, as it is now in East Prussia.

Poplar on the better soils and birch and aspen on the poorer soils are being used as advance growth to shelter oak against late frost.

Parts of von Keudell's forest reminded me vividly of Major Coke's wood at Weasenham, the combination of a thin crop of old pine with a lower storey of an uneven-aged mixture of hardwoods and conifers results in a very similar type of woodland in the two areas.

The third forest, Lieberose, was not quite so interesting as the other two. The rainfall is lower, only 12 inches, and the soil poorer. Great importance is attached to leaving the pine branchwood and twigs on the ground. Investigations have shown that the action of the brushwood is not manurial but that it improves the water-retaining capacity of the soil. There are some curious so-called "Siberia" areas at Lieberose. Here the pines at 70 to 80 years of age are only 20 feet in height and very crooked. It has been shown that the chief factor is the soil, which is a coarse sand containing practically no fine particles; water is the limiting factor. *Pinus rigida* has been tried on a small scale and appears promising.

Lieberose is a large forest of 28,000 acres of practically pure Scots pine. The forest has suffered, and is still suffering greatly, from every sort of insect pest and fungus disease afflicting the Scots pine. Aeroplane dusting has had to be employed with the aid of State grants, and apart from this great sums have had to be spent on protection. The present owner of the property, Oberforstmeister Graf von der Schulenburg, draws the same conclusion as von Keudell at Hohenlübbichow, namely that extensive even-aged forests of Scots pine are unnatural and bring their own revenge in excessively high losses owing to disease, fire, etc. The remedy is to stop clear felling, encourage natural regeneration and the development of an uneven-aged type of forest, and introduce hardwoods.

The Lieberose Forest is also considered to have suffered considerably from the introduction of foreign races of Scots pine owing to the purchase of cheap seed from Darmstadt.

One point of interest at Lieberose was the planting of mixtures in pure groups, each group being about 21 ft. by 21 ft. in size. The object is to obtain one final crop tree out of each group.

The remaining forests visited during the first half of my tour belong to the State. Freienwalde is one of the forests attached to the Forest School at Eberswalde and is a very fine mixed forest of oak and beech. There is a good deal of 300-year-old oak for the best of which a price of 1,000 marks per cubic metre (£2 15*s.* 0*d.* per cu. ft.) is obtained. Regeneration is by the shelterwood compartment system, tending towards a group system. Beech outgrows the oak in early youth and has to be cut back repeatedly to favour the oak. At the first cleanings, when the trees are about 15 feet high, the larger *dominant* oak and beech are removed gradually. Here, as in the pine forests, it is the intention to obtain a final crop from among the co-dominants. The trees removed in these cleanings are often topped to a height of 6 feet above the ground to help to stiffen the crop against snow. Subsequent thinnings remove the weaker trees and a spacing of about 2 feet by 2 feet is arrived at when the trees are 20–25 feet high.

The other two forests visited were Kupferhütte and Lonau in the Harz Mountains. The former is a beech forest with some spruce. Here I saw the worst case of deer damage I had come across: a stand of mature spruce in which every tree had been badly damaged between 3 and 5 feet above ground by red deer stripping the bark off with their teeth. Every wound on the stem of a spruce results apparently in attack by rot-producing fungi and I was informed that the first 15-foot length of each tree would be worthless. The actual damage done by the deer is not the end of the story. Of equal importance is the cost of protecting young plantations from the game. Some of the German foresters with whom I discussed the problem admitted that their silviculture was hopelessly handicapped by the present game stocks. Every young plantation has to be enclosed by a 6-feet-high fence to keep out the deer. Some of these enclosures were absurdly small, less than ¼ acre, and the cost must be quite out of proportion to the value of the crop.

The Forest of Lonau was of interest chiefly on account of the comparatively large area, nearly 200 acres, of Douglas fir of all ages up to 55 years. The 55-year-old stand was a very fine crop, averaging 110 feet in height, and carrying a volume of nearly 8,000 cubic feet quarter-girth per acre. There was no raw humus in spite of the dense crop. The younger plantations were not nearly so good, the branching was heavy and few of the stems straight. The Forstmeister disclaimed any knowledge of *Chermes cooleyi*, but we found it on some of the trees though not at present doing any harm. I heard a good deal about the Adelopus disease of Douglas fir which is severe in the south of Germany and is spreading steadily northwards. Apparently this leaf-cast disease started in Switzerland. No pruning had been tried as yet at Lonau, though the general opinion was that it would be impossible to get clean Douglas fir timber without pruning.

Lonau is predominantly a spruce forest and the Forstmeister strongly criticised the law prohibiting clear felling. He said that experience had proved that in his area spruce was unable to tolerate even the lightest shade. The result of the new regulation would be a heavy reduction in the growing stock of the older age-classes and no regeneration below.

II. Work of the Committee on Tree Races, Seed Regulations, etc.

The Conference included a number of German foresters who were not members of the Committee but who were interested in the problem. Among these were Professors Schenck and Dengler and Oberforstmeisters Eberts, Lass, and Seitz. Professor Schmidt, Chairman of the Committee was in the chair. Professors Pavari and Delevoy, M. Sven Petrini and myself were present as members of the Permanent Committee.

There was a long discussion on the definition of the term " Tree Race " and after some opposition from Professors Dengler and Schott a definition was finally agreed. The basis of this is that the term race shall only be applied in those cases where there is definite evidence of the presence of hereditary characters. In all other cases we are to speak of " provenance " or " type," which will leave the question of heredity open.

Regulations governing the collection and sale of forest tree seeds were then discussed. Professor Schmidt and a number of the other Germans explained the very drastic regulations which are now, or shortly will be, in force in Germany. It appears that some 2½ million acres of forest in Germany have now been registered for seed collection. Three-quarters of this area is composed of Scots pine stands. In course of time it is proposed to classify these stands according to region and to prohibit the sowing of any seed, except from registered stands growing in the particular locality which is officially prescribed for use in any given district. For example, a forester wishing to raise Scots pine for planting in East Prussia will be compelled to use only seed from registered stands in East Prussia; he may not use even registered seed from another part of Germany. The State will gradually take over the whole business of collection and distribution of tree seeds. The German delegates present in the Conference were unanimous as to the need for such regulations, and they gave some interesting information as to the extent to which unsuitable Scots pine seed had been introduced into Germany. Records showed that during the middle and end of last century 130 wagon loads of pine cones and 60,000 pounds of seed were exported annually from southern France into Germany. The result is that in every part of Germany inferior quality stands raised from this seed are to be found and it is regarded as essential to prevent the collection of seed from these stands. In many forests, as at Lieberose, there are documentary records as to the importation of seed from Darmstadt, which was the clearing house for the French seed. For 20 years (from 1890–1910) only imported seed was used in Lieberose and the stands are said to be easily distinguishable from those established before and after this period. The imported seed yields plants which grow faster than the native pine during the first ten years and then slow down, while the form of the stems is invariably bad. It is not only the pine of definitely French origin which is condemned, that from the Rhine-Pfalz, *e.g.* Darmstadt neighbourhood, is considered equally undesirable for use in other parts of Germany, and a great deal of this seed has been distributed throughout the Reich.

I saw at Chorin near Eberswalde 30-year-old race plots grown from seed obtained from different sources by Schwappach. The same races were planted simultaneously in a number of countries and it is hoped soon to bring out a combined report on the whole of these plots. The races include (1) French pine from the Haute Loire, these were very much smaller than most of the other plots but were fairly straight; (2) Belgian pine, almost the best and straightest of the whole series; (3) East Prussia, the best race for rate of growth, straightness and uniformity; (4) the local Brandenburg pine, straight and clean but not so tall as the East Prussian or Belgian; (5) Rhine-Pfalz, very crooked, hardly a straight stem in the plot; (6) Scotland, inferior to (2), (3) and (4) but better than the French or Rhine Pfalz; (7) Perm, Russia, almost a complete failure. This is a very striking series of plots and it is difficult to resist the conclusion that the race question is important in Scots pine. Nevertheless, Professor Fabricius, who unfortunately did not

take part in the conference on tree races, or visit the Chorin plots remarked on several occasions that the agitation about races of Scots pine was grossly overdone. He maintained that although every case of bad and crooked growth was ascribed without more ado to incorrect origin of seed, very often the explanation should be sought elsewhere, in locality factors, bad extraction methods, insect or deer injury, faulty thinning, etc. In his opinion there were very few cases in which there was any real proof that origin of seed was the true factor.

Dr. Schmidt of Eberswalde has developed a new technique for examining tree races which appears really promising. He has discovered that pine seedlings of a few days old react to exposure to light coming from one side, the hypocotyls bending towards the light. He finds that the races which are least sensitive, *i.e.*, show the smallest amount of curvature, are those producing the straightest trees. Maximum curvature is shown by the pine from the Rhine-Pfalz and least curvature by the pine from East Prussia. By examining the light reactions of seedlings grown from seed from the race plots at Chorin it is possible to identify each origin without reference to the labels.

Other points of interest which deserve mention are :—

(i) *Activity in Tree Breeding.*—Many of the German foresters believe that there is a great future for the breeding of pure lines of forest trees, fast-growing hybrids of poplar and willow and even of conifers. The new hormone discoveries (hortamone, etc.) are considered to be of potential importance in this connection, because even conifers can be propagated in quantity vegetatively. On the other hand, critics are not wanting who decry tree breeding as foolish except for such genera as *Populus* and *Salix*.

(ii) *Seed Extraction.*—Dr. Schmidt has a very fine seed extraction plant at Eberswalde. The outstanding points are speed of extraction and low air temperature. Quick extraction at a low temperature was said to yield seed of much higher quality than can be obtained by the older type of kilns. Seed which comes out at the end of the first 4 hours has a germinative capacity of 98 per cent. (Scots pine).

The heat, etc. is supplied by generator gas obtained from the combustion of the cones plus some briquettes of brown coal. Most of the energy is used to work blowers which blow a strong current of air at 50° C. (122° F.) through the cones which are kept in a series of shelves one above the other forming a sort of tower. The bottoms of the shelves consist of fine gauze frames which let through the air current but retain the seed. After the kiln has been running for 3–4 hours the lowest partition is removed, the seed extracted collected and the cones put aside for further treatment, the cones from the next shelf above go into the bottom shelf, again after removing any seed which has come out and so on. The entire process is complete in from 8–10 hours by which time the cones in the top shelf have reached the bottom and are completely opened and are ready for the big revolving shakers which extract the last of the seed. The plant can deal with 55 bushels of cones in a single 10-hour shift. The method is very cheap, the combustion of the cones providing

practically the whole of the energy, and the whole plant seems quite simple to run.

(iii) *Germinative Capacity.*—Dr. Eidmann has developed a quick method of determining the germinative capacity of tree seeds.

Three or four parallel samples of 100 seeds each are counted out and the seed coat of each seed removed either partially or entirely. The seeds are then soaked for 24 hours in water and transferred to beakers containing a solution of acid sodium selenite ($Na.H.Se.O_3$) for 48 hours. The embryo is then dissected out of each seed and the embryos classified into three groups by the colour developed. The deep red embryos are the viable seeds, the colour being produced by the reduction of the selmium salt by the living protoplasm of the seed cells. The second group contains the lightly-pink-tinged seeds and the mottled seed partly deep red and partly pink or white. These are the feebly viable seeds which count in an ordinary germinative test but do not survive in the nursery. The third group contains the colourless seeds; these are dead. Extensive nursery tests have proved that the percentage of dark red uniformly coloured seeds gives an accurate measure of the plant per cent. of any batch of seed, and thus is a much better guide to the value of the seed than the standard Jacobsen or Hearson Tests besides being complete in 3–4 days instead of the same number of weeks.

(iv) *Nursery Manuring.*—I was told that in Prussia it was the standard practice to manure all Scots pine seedbeds heavily with horse manure, the manure being applied each time the seedlings were lifted. (Very few transplants are raised; most planting is done with 1-year seedlings). This manuring practice results in very fine seedlings averaging from 3–4 inches in height at the end of the first season.

(v) *Reactions of Roots.*—Dr. Eidmann is also doing interesting physiological research on the reaction of the roots of different tree species to shortage of oxygen and to high concentration of carbon dioxide. There is evidence to show that trees vary greatly in their characters and the work seems likely to throw light on the silvicultural peculiarities of different species.

Summary.

The outstanding points are :—

(i) The new silvicultural trend apparent in Germany. Pure even-aged coniferous forests worked on an area basis are now regarded as both uneconomic and ecologically unsound. They are to be replaced by uneven-aged mixed conifer and hardwood forests and the maximum uses to be made of natural regeneration. Clear felling is prohibited in Prussia and the entire yield has to be met from thinnings or improvement fellings. One consequence of the new policy will be the adoption of a much heavier grade of thinning in the older woods. In Germany as a whole, and especially in the north the standard thinning has been the B grade, or light low thinning. In future the thinning grade will have to approximate to C or even D (very heavy low thinning) gradually passing, at maturity,

into an isolation (Lichtung) felling. The shortening of the thinning rotation to 3 years is a sound silvicultural move if it can be carried out in practice.

So far as the general condemnation of pure coniferous woods is concerned I think this has only an indirect bearing on our afforestation work in this country. Our soils are in general more fertile than the German forest soils and so there is less risk of soil deterioration under pure conifer, at any rate in the first rotation. Also, with a forest in being, it is a relatively simple matter to introduce broad-leaved trees into the new crop, while on bare ground, not previously under trees, the difficulties are made more serious, as we know to our cost. Pure coniferous forests are thus a more or less unavoidable evil under our conditions but anything that can be done to modify the evil by means of hardwood belts, retention of some of the coppice in coppice areas, etc., is likely to prove a wise precaution.

(ii) The theory of the selected stem as a basis of management, discarding any notion of a rotation. The rule that no tree should be felled as long as it is growing satisfactorily and not interfering with a better neighbour will result in a more or less selection type of forest in the future. Obvious difficulties are the increased risk from storm damage, the spreading of fellings over a much larger area of ground, necessity of volume control involving frequent assessments of the growing stock, damage to regeneration resulting from the felling and extraction of the mature trees, the risk that heart rot may attack the élite trees, etc., etc. Whether these difficulties are outweighed by the theoretical advantages of the selection system appears rather doubtful.

(iii) The importance attached to the question of the race of Scots pine, European larch, oak, etc. Stands raised from seed believed to be of "foreign" origin are to be cleared out as far as possible during the next few years.

Seed collection and supply are strictly controlled and every precaution taken to ensure the use of the correct race for any given locality. Already 2½ million acres of forest have been registered as suitable for seed collection and soon collection will be restricted to these stands. Dr. Schmidt's work on the phototropic reactions of pine seedling is believed to provide a new and quick method of identifying the different pine races.

(iv) The extent and importance of damage by game. The stock of deer is maintained at far too high a level in many forests but the general attitude is that deer interests must take precedence of economic forestry. The game problem is the most serious obstacle in the way of the new silvicultural reforms because practically all young plantations have to be fenced in at great cost. The position is not likely to improve as long as General Göring remains Reichsforstmeister.

(v) The seed extraction plant at Eberswalde appeared very efficient. Scots pine can be extracted in 10 hours working and seed of very high quality obtained. The method of extraction depends on forcing warm

air through the cones by means of powerful blowers. The plant is run by producer gas obtained from the cones with a small admixture of brown coal.

(vi) The Selenium method of seed testing seems promising and may eventually supersede existing methods. The colour change is believed to be due to the reducing action of the protoplasm of the seed embryo, the depth of colour being proportional to the vitality of the seed. The test takes only a few days to complete and yields a plant per cent. which corresponds closely to the yield obtained in a good nursery under optimum conditions. Further tests of the method are desirable, but if it is confirmed it will be particularly useful for the testing of stored seed.

TRIAL SURVEY OF WOODLANDS, 1937.

General.

In view of the proposal to undertake at an early date a complete resurvey of the woodlands of Great Britain it was decided to carry out a trial survey during September, 1937. The chief objects of the trial were :—

(1) to work out the best methods of carrying out a survey;
(2) to obtain data as to speed of working, cost, etc.

The trial survey was carried out by the Sample Plot Party under the direct supervision of Grade I Forester A. M. Mackenzie. The instructions, forms, etc., were drawn up by Mr. Story and myself in collaboration, and visits were also paid to the party in the field.

The districts and areas surveyed were as follows :—

District.	*Ordnance Sheet Nos.*	*Total Area of Woodland surveyed.* Acres.	*Period of Work.*
Banchory	Kincardine 9, N.W.	1,460	Sept. 6–12
Ecclefechan..	Dumfries 57, N.E., S.E., S.W.	1,464	Sept. 14–20
Much Wenlock	Shropshire 50, N.E., S.E. 51, N.W.	1,044	Sept. 23–29
Beaulieu	Hants 80, S.E. 81, N.W., S.W.	2,482	Oct. 1–9

The Chairman decided that while the basis of the Survey was to consist of the classification of the woodlands into the same categories as were employed in the 1924 Census, an attempt should be made to determine the timber volume in the respective categories. This was to be done by the measurement of plots of 1/10 acre each spaced so as to give approximately a ½ per cent. sample by area of the woodland on any one 6-in. sheet.

After consulting Mr. F. Yates, Statistician to the Rothamsted Experimental Station, a set of instructions was drawn up. Mr. Yates, who has been extremely helpful throughout the Survey, visited the party twice in the field and gave useful advice on many of the problems which arose. It was found necessary to modify the instructions and field forms in the course of the Survey.

The party engaged on the Survey comprised four men in addition to Mr. A. M. Mackenzie. One of the four men, Mr. G. E. Godwin, was appointed temporarily to assist in the work of the Survey and to free Mackenzie for independent classification work.

The method of working, which gradually evolved as the Survey proceeded, was for the men to work in two parties of two men, each party working on a separate Ordnance Sheet. The men visited all

the woods in which sample points fell, measured the plots (provided there was measurable timber present) and mapped in the approximate boundaries between the categories encountered. This left a residue of small woods in which no sample points fell and which lay off any of the routes taken by the party. The small woods (over 2 acres) were visited and classified by Mackenzie who ran a small car.

At first the work was very slow, the number of plots measured per party *per diem* varying from 6 to 12, averaging about 10. By the end of the month when the party was working in a fairly densely wooded district composed mostly of old hardwoods, the rate of working rose to 20 plots *per diem*. In terms of area of woodland this signifies approximately 400 acres *per diem* at the faster rate of working and 200 acres *per diem* at the initial slow rate. With a total area of woodland of 3 million acres in Great Britain the faster rate of working is equivalent to 7,500 days for one party, or 500 days for 15 parties of two men. Assuming 200 working days in a year, the survey would occupy $2\frac{1}{2}$ years with 15 parties or $4\frac{1}{2}$ to 5 years with 8 parties.

The cost both in time and money of a survey on these lines seemed prohibitive and less intensive methods had to be devised.

Results of Trial Survey.

The major results of the trial survey are set out in Tables I to IV, one form relating to each of the districts examined. The forms show, for each category of woodland, the corresponding area in acres, the number of plots examined, the average volume of each species per acre, as determined from the sample plots, and the total volume of conifers and hardwoods in each category. The volumes are given in cubic feet true volume over bark and must be reduced by about one quarter to bring them to cubic feet quarter-girth over bark.

It is important to point out that where there are less than 20 plots in any given category the average volumes are quite unreliable. It requires 25 plots to give a mean accurate to within $\pm$ 20 per cent. With a small number, such as 4 plots, the mean is not accurate to within less than $\pm$ 50 per cent. at the very best.

(1) *Kincardine Area.*

The total area of woodland (over 2 acres) on the one 6-in. Ordnance Sheet examined is 1,460 acres. Of this area Categories D and E, conifers 41–80, and over 80, absorb 476 acres, or roughly one third. A comparatively large area, 367 acres, was felled or devastated. The area allocated to scrub was only 67 acres, but 138 acres which were entered in the new survey as hardwoods 11–12 (M) and consisted mainly of young birch would certainly have been included in the previous Census as scrub.

The most important category was D, conifers 41–80, which, on the basis of 23 samples, carried 5,820 cu. ft. of conifer and 36 cu. ft. of hardwoods per acre. Of the conifer 80 per cent. consisted of Scots pine, and 20 per cent. of European larch and Norway spruce. In the over 80 conifer class (E) there were only $4\frac{1}{2}$ samples (the half sample was a

half plot taken on the edge of a wood) and the average volume found was much lower than in the D category. This result is no doubt partly due to inadequate sampling but partly also to windfall in the oldest age-class.

The average volume per acre over the whole area was 2,200 cu. ft. (equivalent to about 1,700 cu. ft. quarter-girth over bark).

Comparison with previous Classification.—In the following table the areas allocated to the different categories in the 1924 Census are compared with the new allocation :—

		Acres.	
		1924.	1937.
Conifers	A—E	930·0	599·5
Mixed	F—K	181·0	59·0
Hardwoods	L—P	2·0	354·0
Coppice	Q	—	14·5
Scrub	R	73·0	66·5
Felled	S	303·0	366·5
Amenity, etc.	T	117·0	—

There is an apparent reduction in 1937 in the area under conifers and mixed, and an increase of the area under hardwoods. In part this is due to faulty classification in 1924, but on the whole the 1924 survey was fairly correct.

(2) *Dumfriesshire.*

The woodlands in this area were much more scattered than those round Banchory. A total area of 1,464 acres, distributed over three Ordnance Sheets, was examined. Pure or mixed conifers accounted for 624 acres, or nearly half the total area. As in Kincardine, the best represented category was D, conifers 41–80, of which there were 237 acres. The average volume per acre, based on 18 sample plots was 3,900 cu. ft. Of this volume 39 per cent. was Scots pine, 46 per cent. Norway spruce, and 15 per cent. European larch and sundry hardwoods. The next most important category was J, mixed conifers and hardwoods 41–80, of which there were nearly 190 acres carrying a volume of 3,350 cu. ft. per acre. Felled or devastated accounted for nearly 25 per cent. of the total area. The average volume per acre of woodlands over the three Ordnance Sheets was 1,640 cu. ft. (1,300 cu. ft. quarter-girth over bark).

Comparison with previous Classification.—

		Acres.	
		1924.	1937.
Conifers	A—E	359·4	623·9
Mixed	F—K	226·9	215·3
Hardwoods	L—P	181·1	238·3
Coppice	Q	20·8	26·3
Scrub	R	6·0	12·4
Felled	S	508·0	347·5
Amenity, etc.	T	129·6	—

The agreement between the two surveys is quite good, having regard to the lapse of time. Most of the woodlands classified as Amenity in 1924 belong to the conifer categories and have been classified as such in 1937.

(3) *Shropshire.*

The work extended over three Ordnance Sheets and covered a total area of 1,044 acres. The principal categories were O and P, hardwoods 41–80 and over 80 respectively, and Q, coppice with standards. The stocking of the 41–80 hardwoods was very low, the average volume, based on 10 plots, being less than 1,000 cu. ft. per acre. The over 80 class, with 20½ counts gave an average volume of 2,270 cu. ft. per acre of which about half consisted of oak.

The average volume per acre over the whole area was 1,400 cu. ft. (1,100 cu. ft. quarter-girth over bark).

Comparison with previous Classification.—

		Acres.	
		1924.	1937.
Conifers	A—E	38·5	67·5
Mixed	F—K	233·3	67·0
Hardwoods	L—P	431·9	583·4
Coppice	Q	—	318·5
Scrub	R	91·2	5·0
Felled	S	149·1	3·0
Amenity, etc.	T	—	—
?	U	8·4	—

The 1924 classification was not good in detail, a considerable part of the land classified as scrub and felled evidently should not have gone into these categories.

(4) *Hampshire.*

Three Ordnance Sheets were examined. The total area of woodland was 2,482 acres, a considerably larger area than was covered in any of the other three districts. The woods were distributed over almost the whole range of categories, but predominantly in the one category P, hardwoods over 80. A total of 91½ sample plots was measured, so in this case the volume data can be accepted as fairly accurate. The table shows that the 1,644 acres of hardwoods over 80 carry on the average only 1,100 cu. ft. of timber, of which nearly 80 per cent. is oak. The proportion of scrub and felled or devastated was small, only 2½ per cent.

The average volume per acre over the 2,482 acres surveyed is 1,090 cu. ft. (860 cu. ft. quarter-girth over bark).

Comparison with previous Classification.—

		Acres. 1924.	1937.
Conifers	A—E	40·0	108·0
Mixed	F—K	139·5	224·0
Hardwoods	L—P	332·3	1,822·8
Coppice	Q	14·6	71·0
Scrub	R	1,352·7	15·0
Felled	S	229·6	80·5
Amenity, etc.	T	49·5	—
?	U	18·0	—

The previous classification was grossly inaccurate. Practically the whole of the 1,600 acres classified as scrub or felled in 1924 consisted in fact of moderately well-stocked oak woodland, over 80 years of age.

Summary.

A total area of 6,450 acres has been classified during the course of the recent trial survey.

The results may be summarised in the table below.

	Area. Acres.	Per cent.	*Volume. Quarter-girth over Bark.* 1,000's of cu. ft.
Conifers, hardwoods and mixed, 1–40 ..	1,212	19	756
Conifers, hardwoods and mixed, over 40	3,906	60	6,831
Scrub, and felled or devastated ..	902	14	105
Coppice	430	7	7
Total ..	6,450		7,699

On the basis of the last survey the four areas sampled in the trial survey are not very representative. This is apparent from the table below.

Composition of Woodlands.

	Census of Woodlands, Great Britain. 1924. per cent.	*Trial Survey.* 1937. per cent.
Total high forest	48	79
Coppice and coppice with standards	18	7
Scrub, felled or devastated ..	27	14
Uneconomic	7	nil

The proportion of high forest found in the trial survey was much higher than given in the 1924 Census, but some allowance must be made for inaccuracies in that Census, which classified some undoubted hardwood areas as scrub. This was notably the case in Hampshire. On the other hand, it is probable that the proportion of coppice area found in the trial survey is considerably lower than it is in the country as a whole.

The average quarter-girth volume per acre found in the trial survey was slightly under 1,200 cu. ft. This compares with the estimates of 870 cu. ft. per acre for the country as a whole given in the 1924 report, but as explained above a much larger area was then designated as scrub.

TABLE I.

Kincardine.

Summary.

Category and No. of Samples.	Total Area.	Average Volume per Acre based on Sample Plots. (True Vol. O.B.).											Total Volume of Category.		
		S.P.	E.L.	N.S.	D.F.	Total Conifers.	Oak.	Beech.	Ash.	Syc.	Birch.	Other.	Total Hard-woods.	Conifers.	Hard-woods.	Total.
	Acres.															
A (1)	27·0					—							—			—
B	3·0					—							—			—
C (5·5)	93·5	3,159·8	182·5	197·5		3,539·8		130·9			26·9		157·8	331,000	14,800	345,800
D (23)	375·5	4,708·7	530	579·6		5,818·3	5·2	10·4			20		35·6	2,184,800	13,400	2,198,200
E (4·5)	100·5	877·8	134·9	913·3	17·8	1,943·8	72·7				321·3		394	195,400	39,600	235,000
H (2)	23·0	1,285				1,285					520		520	29,600	12,000	41,600
J (2)	14·5	635	470	885		1,990	375				265		640	28,900	9,300	38,200
K (2·5)	44·5		816	1,668	232	2,716	1,207·2	288		204	172	229·2	2,100·4	120,900	93,500	214,400
L	20·0					—							—			—
M (3)	137·5					—					13·3		13·3		1,800	1,800
N (4·5)	42·5		52·9			52·9			12·2		491·1	146	649·3	2,200	27,600	29,800
O (2)	9·5					—	200	490		7		486·5	1,183·5		11,200	11,200
P (6)	121·5			199		199	520·5	112·3			132·8		765·7	24,200	93,000	117,200
Q_2 (1)	14·5					—							—			—
R (4)	66·5					—		21·7		95	22		138·7		9,200	9,200
S	366·5					—							—			—
TOTAL	1,460·0													2,917,000	325,400	3,242,400

Key to Category Letters.

	Age Classes. 1–10.	11–20.	21–40.	41–80.	*over* 80.
Conifers	A	B	C	D	E
Mixed conifers and hardwoods ..	F	G	H	J	K
Hardwoods	L	M	N	O	P

Coppice with standards	Q_1
Coppice	Q_2
Coppice under conversion to high forest ..	Q_3
Scrub	R.
Felled, and/or devastated, Uneconomic ..	S and T.

TABLE II.

Dumfries.

Summary.

Category and No. of Samples.	Total Area.	Average Volume per Acre based on Sample Plots. (True Vol. O.B.).													Total Volume of Category.		
		S.P.	E.L.	N.S.	S.S.	D.F.	Other	Total Conifers	Oak.	Beech.	Ash.	Syc.	Birch.	Other	Total Hard-woods.	Conifers.	Hard-woods.	Total.
	Acres.																	
A (7)	147·7							—							—			—
B (5)	105·2							—							—			—
C (5·5)	134·3	1,164·4	189·5	110·7	440·5			1,905·1			5·3		396	2	403·3	255,800	54,200	310,000
D (18)	236·7	1,513·3	188·2	1,781·8		55	20·3	3,558·6	70		14·7	37·6	167·2	11·8	301·3	842,300	71,300	913,600
H (2·5)	23·8	333·2	144·4	721·6				1,199·2	104			285·6	126	562·8	1,078·4	28,500	25,700	54,200
J (12)	186·5	993·9	33·1	1,073·7		3·1	56·5	2,160·3	289·1	25·3	107·6	273·2	61·3	451·4	1,207·8	402,900	225,300	628,200
K (1)	5·0			236		780		1,016	16			298		888	1,202	5,100	6,000	11,100
M (1)	28·0							—					330		330		9,200	9,200
N (1·5)	5·3							—				26·6		606·6	633·3		3,400	3,400
O (4)	117·9							—	1,750·5	132·7			22·5		1,905·7		224,700	224,700
P (6)	87·1			13·3				13·3	1,012·3	955·2	28·7	262·3		579·8	2,838·3	1,200	247,200	248,400
Q_2 (3)	26·3							—					3·3		3·3		100	100
R (3)	12·4							—							—			—
S	347·5							—							—			—
TOTAL	1,463·7															1,535,800	867,100	2,402,900

Category and No. of Samples.	Total Area.	Average Volume per Acre based on Sample Plots (True Vol. O.B.).												Total Volume of Category.		
		S.P.	C.P.	E.L.	N.S.	D.F.	Total Conifers	Oak.	Beech.	Ash.	Syc.	Birch.	Other.	Total Hard-woods.	Conifers.	Hard-woods.	Total.
	Acres.																
B	3·0						—							—			—
C (2)	33·5		85	405·5	6	81·5	578	40·5	39·5			29		109	19,400	3,700	23,100
D (3)	31·0		384·6	1,622·3		68·6	2,075·5	14			260·3	124·6	1,084	1,483	64,300	46,000	110,300
H (1)	18·0	815		240		247	1,302	34		438				472	23,400	8,500	31,900
J (3)	26·0	224·3	648·3	513·3	164·3		1,550·3	299·3		510	80		10·6	900	40,300	23,400	63,700
K (1)	23·0	1,180			1,530		2,710	1,547						1,547	62,300	35,600	97,900
L	5·5						—							—			—
M	4·5						—							—			—
N (5)	58·5						—	27·4			36·8	305·2	194	563·4		33,000	33,000
O (10)	143·5						—	480	1·2	127·6	20·1	87·7	234·4	951		136,500	136,500
P (20·5)	371·4						—	1,090·1	119·7	118·5	25·7	5·8	913·5	2,273·3		844,300	844,300
Q_1 (9)	141·0						—	148·7		10·7	10·4	42·1	93·1	305		43,000	43,000
Q_2 (6·5)	92·0						—	151·7				11·1	54·6	217·4		20,000	20,000
Q_3 (1·5)	85·5						—	182				218	85·3	485·3		41,500	41,500
R (1)	5·0						—							—			—
S	3·0						—							—			—
TOTAL	1,044·4														209,700	1,235,500	1,445,200

Table IV.

Hampshire.

Summary.

Category and No. of Samples.	Total Area.	Average Volume per Acre based on Sample Plots. (True Vol. O.B.).												Total Volume of Category.		
		S.P.	E.L.	N.S.	Other.	Total Conifers	Oak.	Beech.	Ash.	Syc.	Birch.	Other.	Total Hard-woods.	Conifers.	Hard-woods.	Total.
	Acres.															
A (2)	38·5	60				60					22		22	2,300	800	3,100
B (5)	89·5	30·6				30·6					3·2		3·2	2,700	300	3,000
C (1·5)	27·0	524·7				524·7							—	14,200		14,200
D (1)	20·0			2,760		2,760	370						370	55,200	7,400	62,600
E (3)	43·0	5,796·6				5,796·6	211				21·6		232·6	249,300	10,000	259,300
H (2)	35·0	95				95	101					9·5	110·5	3,300	3,900	7,200
J (2·5)	94·5	470·8	236			706·8	630			160·4	180·4	37·6	1,008·4	66,800	95,300	162,100
K (6)	94·5	1,017·8			135·5	1,153·3	866		12		29	39	946	109,000	89,400	198,400
L	16·0					—							—			—
M (2)	23·0					—	315·5				16	9·5	341		7,900	7,900
N (8·5)	69·3					—	277·3	252·9	12·5		64·7	3·2	610·6		42,300	42,300
O (4)	115·0					—	1019·2		24		26·7		1,069·9		123,000	123,000
P (91·5)	1,644·0	84		2·6	0·8	87·4	826·8	36·2	27·7	0·6	34·9	80·3	1,006·5	143,700	1,654,700	1,798,400
Q_1 (5)	31·5					—	498·2	58·8	4		23	26·6	610·6		19,200	19,200
Q_2 (5)	28·0					—	7·2					129·8	137		3,800	3,800
Q_3 (2)	11·5					—	599·5		8·5				608		7,000	7,000
R (1)	15·0					—							—			—
S (1)	86·5					—							—			—
Total.	2,481·8													646,500	2,065,000	2,711,500

Key to Category Letters.

Age Classes.

1–10.	11–20.	21–40.	41–80.	*over* 80.
A	B	C	D	E

Coppice with standards .. .. .. Q_1
Coppice .. .. Q_2
Coppice under conversion to high forest .. Q_3
Scrub .. .. R
Bare .. .. S

Addendum to Report.

The above report was written in November, 1937. Since then there have been rapid developments. Mr. G. E. Godwin, who took part in the trial census earlier in the year, was given part of the County of Surrey to survey. In this survey he had to classify the woods and to make an ocular estimate of the volume per acre in each stand. The work was duly carried out and an area of over 15,000 acres of woodland was classified. After completion of the work the corresponding maps covered during the 1924 Census were examined and the information extracted and summarised. The table below gives the comparative data for the two surveys. (Some of the categories have been grouped to facilitate comparison.)

Surrey.

Map References on which Data are based.

XXXII N.W. XXXIII N.W. XXXVIII N.W. XXXIX N.W.
„ N.E. „ S.W. „ N.E.
„ S.W. „ S.W.
„ S.E. „ S.E.
XL N.W.
„ S.W. & Sussex II (pt. of).
„ S.E. & LVII N.E. & Sussex (West) II & III.

	Category.	1924 Acres.	1937 Acres.	*Difference** Acres.
Young plantations with little or no pitwood.	A—B	340	1,940	+ 1,600
	F—G	140	510	+ 370
	L—M	—	280	+ 280
Total		480	2,730	+ 2,250
Conifer & mixed pitwood	C	160	750	+ 590
	H	150	140	— 10
Total		310	890	+ 580
Hardwood pitwood	N	50	230	+ 180
Conifer & mixed timber	D—E	920	790	— 130
	J—K	700	990	+ 290
Total		1,620	1,780	+ 160
Hardwood timber	O—P	1,240	4,600	+ 3,360
Coppice plus coppice with stds.	Q	360	3,760*	+ 3,400
Scrub	R	4,080	1,290	— 2,790
Felled and/or devastated	S	1,210	280	— 930
Uneconomic	T & U	1,800	—	— 1,800
Total		7,450	5,330	— 2,120
Grand Total		11,150	15,560	+ 4,410

* Includes 1,470 acres coppice with standards (Q_1).

The result is remarkable in that the new Census discloses an apparent increase in woodland areas of nearly 40 per cent. If non-effective woodland (coppice, scrub, felled and economic) be disregarded in both surveys the apparent increase is much greater, *viz.* from 4,000 acres in 1924 to 11,700 acres in 1937. Part of the difference may be accounted for in the largely increased area found under young conifer, mainly natural regeneration of Scots pine, but the greater part must be ascribed to incomplete and inaccurate description in the 1924 Census. The new survey shows the need for a systematic Census carried out under the direct supervision of the Commission's technical staff. As stated elsewhere in the Journal this is now being carried out by the Census and Plans Branch under the charge of Mr. Sangar. The methods finally adopted are briefly as follows :—

Every wood of 5 acres and over will be inspected and classified according to category or type. An ocular estimate of the volume of the timber will be made in each stand, by species and girth classes, and also of the amount of pitwood. As an objective check on the ocular estimates a certain proportion of the Ordnance Sheets covered will also be sampled by the sample plot method as employed during the first trial survey. The plots will also pick up any of the small plantations, below 5 acres, encountered.

A start has been made, and there are several surveyors already at work in the County of Nottingham which is serving as a training ground for the purpose of the new Census.

W. H. G.

ROYAL SCOTTISH FORESTRY SOCIETY.

1937 Meeting.

By J. L. Shaw.

I had the pleasure of visiting the Thuringia Forest with the Royal Scottish Forestry Society and spent a most interesting and instructive week under the guidance of Herr Forstmeister Hans de Marées who is in charge of the Forest. Thuringia is a mountain forest State of over 4,000 square miles, at an average altitude of 2,460 ft., with an annual rainfall of about 26 in. The headquarters of the party were at Bad Berka, a pleasant spa 5 miles south of Weimar, a town famous for its association with the poets Goethe and Schiller.

Some of the forests of Thuringia have had detailed working plans for 200 years, so that the forest officials have not only the past history of the forest but the actual results of the work done during that time to guide them.

To British foresters some of the most striking features are the density of the crop or closeness of the stems at 120 years, the almost complete absence of animals, the forest sense of the population, and the firm attitude of the authorities against possible infringement of the forest laws. The chief species seen were Scots pine, spruce and beech, with attempts here and there to introduce birch, maple and oak for shelter, and also to avoid loss of soil fertility. All the older forest areas are worked on a rotation of 120 years, and the chief aim of the forester is quality in the final crop. The trees are of great height, from 90–130 ft., but owing to the density of the crop there are few individual trees of really large dimensions, the stems being long and clean with very little taper and remarkably small crowns.

On the first day we visited woods close to Bad Berka, the first being one where Norway spruce were planted about 20 years ago and Scots pine coming in naturally, the pine eventually to be the final crop. Continuing, we inspected an area planted in 1936, 2-year Scots pine being planted in prepared strips (from which the humus had been removed) at 4 ft. 2 in. × 12 in., with seed of Norway spruce, Jap. larch and birch sown among the plants. The pine looked well, birch seed having germinated last, with the larch looking rather weak. We passed several compartments of Scots pine varying from 110 to 125 years, cubic contents averaging from 5,600 to 7,300 cu. ft. per acre. Passing on to an area planted in spring 1937, Scots pine seed had been sown, having been previously mixed with soil brought from the origin of the seed, Herr de Marées stressing the importance of selecting seed very carefully.

Natural regeneration of Norway spruce was looking very well, the final clearance of seed trees being made, causing little or no damage to groups of young trees. Natural regeneration is assisted in final stages by clearing humus in patches to enable seed to germinate better. We were also shown an experiment where 2-year Douglas fir were planted

in the middle of a group of Norway spruce seedlings; the Douglas looked well but had not been there long enough to be put properly to the test. In anticipation of 1938 being a good seed year, cultivation of the soil was being carried on rather extensively. A large gap made by lightning had been filled in with hardwoods, the Forstmeister explaining that he was introducing hardwoods wherever practicable to avoid loss of soil fertility.

Natural regeneration is practised in different ways according to the personal opinions of the foresters; some prefer the group system, others the strip system. The narrow strips seem to make extraction of timber rather difficult.

The question of natural regeneration and introducing of hardwoods is the main occupation of the Forstmeister at present, the working plan being followed very closely, but one can well imagine the cautious forester watching for a seed year before fellings are undertaken. These fellings commence by preliminary cuttings, which allow a certain disturbance to take place in the humus before the " seeding cutting " which takes place when a good seed year is certain. Further fellings take place from time to time, according to the demand for light, but great care must be exercised to avoid heavy weed growth springing up.

A final cutting is made when the groups of young seedlings have joined up. Great care is taken by the foresters, who mark the trees in such a manner that the timber fellers get the trees down without too much damage. We saw the men doing this work and they showed remarkable skill in felling, peeling and finally hauling the trees out to the roadway. Herr de Marées remarked that one of the advantages of natural regeneration was less risk of heart-rot, also for natural regeneration to keep the mosses as long as possible. Proceeding we passed a severance cut which had been made and planted with Norway spruce to act as shelter when the final cutting of that section was made.

On the following days we saw more wonderful forests of Scots pine and Norway spruce, also Silver fir from 90 to 110 years which had been badly frosted in 1929. Always the same dense crop of stems, not too large but beautifully clean, and only broken at intervals by clear fellings or thinnings.

We examined an area which had been sown in 1926. Pine had been planted and sown with birch, oak, larch and spruce, but the birch had grown too well and looked like smothering everything else unless weeded out soon.

Some of the areas here reminded us of home, the spruce tending to check on the *Calluna* area, having been planted in 1930, but they always had a good Scots pine natural regeneration to fall back on, although Herr de Marées said conditions were unsuitable for natural regeneration, the soil being too wet. He was trying mixtures. The introduction of hardwoods is done by artificial sowing or planting mainly of beech, birch and oak. The young trees are protected from deer by fixing a piece of paper to the stem of the tree, the paper having been impregnated with a strong-smelling chemical substance.

Attacks of *Hylobius* were being combated by spraying with "Hylarsol." For this operation the workman carries the sprayer on his back and the nozzle is shaped loop fashion, having perforations all around the loop, which is placed over the tree, allowing the spray to get to all branches and stems.

The Forstmeister had pits dug which showed a section of the soil, exposing the roots of Norway spruce, silver fir and beech to a depth of 4 to 5 ft. He explained how the stem of the tree being swayed by the wind caused the flat-rooted spruce continually to press the sandy soil down to hard pan. The silver fir with its slightly deeper roots showed an improvement, and the beech with its deep root system did good work by loosening the subsoil. We visited a different section of the forest, under the charge of Dr. Jahn, the forest control being very similar to that in Bad Berka, but natural regeneration of spruce was carried out on the zone system, which is done in strips instead of in groups. In one of the compartments we were shown Wagner's strip system in three cuttings which had failed on account of scarce seed years failing to stock the ground, and the area is now being worked under the Bavarian group system.

The only nurseries we saw were rather small, there being very little use for them on account of so much natural regeneration. Douglas fir and tsuga were the chief species in the nurseries, soil being sandy and dry; wooden slabs were laid between the lines in an effort to conserve the moisture. Lupins had been sown as a soiling crop.

Resin marks could be seen on many of the trees where they had been tapped for resin during the war, the scars being from 5 to 6 ft. in length. Most of the timber and pitprops are peeled when felled. Props are stacked on the ride side for seasoning and the timber and bark cleared away to allow replanting to take place.

Although most of our time was spent in conifer areas we were given the opportunity of visiting a very fine beech forest which was being naturally regenerated under the group system; this was in an advanced stage, the height of the young trees varying from 1 to 25 ft.; all of them looked very healthy.

Among the practical demonstrations seen were women planting seedlings; using a light type of mattock, they scraped the humus away from the surface, then one of the women made an oblique cut in the soil whilst the other inserted the seedling; the plant is left in this oblique position and we were informed that during the last two seasons much of the planting had been done in this manner. Pruning of Douglas fir was also demonstrated, the workmen using an extending pole saw (frame pattern) and, working from the ground, pruned selected trees to a height of 16 ft.

One of the most interesting demonstrations was given by a firm, for the destruction of geometer caterpillars which were threatening to destroy a nice wood of Scots pine. The machine, which is a powerful motor mounted on a horse-drawn truck, can only be operated on a calm day, and we attended this demonstration at 3.0 a.m. The motor blasts a powerful

spray of poisonous powder into the tree tops, and on this still morning the cloud of dust could be seen hanging among the tree tops for an hour afterwards. Aeroplanes have also been used for spraying the powder, but have not been very successful on account of the danger to pilots who have to fly extremely low.

Nearly all the woods seen were State-owned and, as already mentioned, have records and working plans covering two centuries. The forest officers still have problems to contend with, but all the time they are becoming more confident and able to guard against the mistakes which must arise from inexperience.

We visited woods on one of our trips which were owned privately by farmers who had worked individually, with the result that when one farmer decided to fell an area adjoining his neighbours the wind got in and blew down his neighbours' woods. These are now worked on a co-operative system under the control of the local Forstmeister. For the most part these woods are similar to our own coppice and standards and the plan is to thin out the better hardwoods, filling up with conifers, and where the coppice is too poor for this treatment they are clear felled and planted with spruce, larch, etc., the ultimate aim being to have a mixture of hardwoods and conifers.

Wherever we went we were impressed by the friendliness and hospitality of everyone and they did their utmost to make us welcome. The forest officers and their assistants did everything they possibly could to interest us and answered our many questions.

Climatic and other conditions are not the same as ours and the lessons learnt cannot be applied altogether, but in forestry our aims and ideas are identical and we cannot fail to benefit from a closer association with our "Comrades of the Green Cloth."

In conclusion I wish to thank the Forestry Commissioners for the opportunity afforded me of visiting the German Forests.

SURVEY OF CHAFERS IN FOREST NURSERIES, 1937.

By J. M. B. Brown.

During the past twelve months, visits have been paid to every nursery in Britain from which reports of serious damage have come in, and a few other large and important, although uninfected, nurseries have been included in the survey. No similarly comprehensive survey has been undertaken before which could have been used as a basis of comparison with the present, but there is little doubt that the damage caused by chafers in the past five years has exceeded that of any equal period in the past. The main objects of the survey were: (1) to identify with certainty the chafers responsible for the damage in the principal infested nurseries and (2) to correlate the incidence of damage by the several species with the conditions of climate, soil, local vegetation and nursery management. The first object has been attained, and considerable progress has been made towards the second. As regards the distribution of the different species of chafers as pests, a map has been prepared which unfortunately cannot be reproduced here.

(*a*) There is a large block in the south and the west Midlands, where the nurseries are very susceptible to damage by the cockchafer, *Melolontha*. Lying outside this region is Hamsterley nursery, Durham, where *Melolontha* damage was severe, though local, and to which reference will be made later; *Melolontha* was also found in most of the other nurseries, but never plentifully.

(*b*) *Rhizotrogus* is rare outside the eastern half of the country and is nowhere a serious pest at present.

(*c*) There is a tendency for *Phyllopertha* to be concentrated in Wales (Corris nursery and others) and the North-west of England (Delamere). *Phyllopertha* was, however, also found in nurseries elsewhere; e.g. Lynford and Weeting (Norfolk), Clipstone (Notts.) and Rhinefield (Hants.).

(*d*) There are irregularly distributed areas of damage by *Serica*. Considerable numbers of this chafer were found in the following nurseries: Fernworthy (Dartmoor), Gwydyr (Carnarvon), Hamsterley (Durham), Laughton (Lincs.), Hemsted (Kent), Rhinefield (Hants.), Coed-y-brenin (Merioneth).

In the reports of the Ministry of Agriculture Advisory Entomologists for 1937 there are about twenty references to damage by chafer larvae to agricultural crops. Let us take these and see how they confirm or modify the inferences already drawn.

(*a*) *Melolontha:* References to serious injury in Monmouthshire (several), Lincolnshire and Hampshire confirm the existence of a central and southern zone liable to cockchafer damage.

(*b*) *Rhizotrogus* appears as injurious in West Norfolk, Berkshire and Kent, *i.e.* in the Eastern and South-eastern counties.

(c) Reports of *Phyllopertha* injury to grassland in Westmorland, Cheshire, Central Wales and Somerset seem to indicate that *Phyllopertha* occurs plentifully in a belt running down the western side of the country. There are no references to *Serica* in these reports.

The only Scottish nursery where *Melolontha* was found was Fleet (Galloway). *Melolontha* was reported from Tulliallan (Clackmannan) about 1930, but has hardly been seen for some years. Otherwise, *Serica* was the only chafer found in the Scottish nurseries and it was plentiful only at Inchnacardoch (Inverness). The numbers found at Newton and Altonside (Moray) were trifling.

It must not be forgotten that these notes summarise the observations of one year only. In a few nurseries, records of past damage were available, but the identity of the chafer responsible and the date were usually in doubt. The writer has also some personal records, which, however, refer to a few nurseries only. It is certain, however, that in natural conditions, the numbers of each species fluctuate markedly from year to year, and in a cultivated nursery these fluctuations are likely to be accentuated. Instances are the decline of *Melolontha* in the Thetford nurseries and its increase in the Forest of Dean, and the variations in the numbers of *Phyllopertha* in the Delamere nurseries in the past 10 years, including first a big rise and then a fall. Further, the damage caused by *Melolontha* in any one year is determined by the relation of that year to the swarm year; the great damage caused in the Forest of Dean and other nurseries in 1936 followed the big swarm year, 1934. It is evident, therefore, that the abundance of chafers and still more the damage they cause will vary considerably from year to year, quite apart from direct measures to combat them.

The damage caused by other soil insects was, at least in the past year, unimportant. It will be sufficient for the purposes of the present report to list the main types and to note how they were distributed.

(i) First may be mentioned the Chafer, *Anomala aenea*, de Geer, considerable numbers of which were found in Rendlesham and Laughton nurseries. It was also noted in Weeting and Santon Downham nurseries, but not at all outside Division 5. It inhabits sandy places, mainly near the coast.

(ii) Cutworms (larvae of the noctuid moth, *Agrotis segetum*, Schiff., and related species) are generally the most important of these miscellaneous pests. They caused a good deal of damage in Ringwood nursery and were common in other nurseries with sandy soils (*e.g.* Lynford, Delamere, Stockley).

(iii) Swift Moth caterpillars were found in small numbers in different parts of the country. A severe outbreak at Buriton has just come to an end and Lyminge (Kent) has also suffered recently.

(iv) Wireworms (*Elaterid* larvae) occurred in small or moderate numbers in practically every nursery visited. Both *Agriotes* (probably *A. lineatus*, L.) and *Athous* (probably *haemorrhoidalis*, F.) were found. Wireworms are grassland insects with a long larval life and the conditions in a forest nursery do not suit them; but freshly broken-up grassland

is very liable to suffer from wireworm damage in the first few years. Such an attack was experienced in a freshly dug nursery at Halwill, Devon, and should also be looked out for at Tair Onen, Glamorgan.

(v) Leather-jackets were found here and there, but their numbers were quite insignificant; nursery soil is, in general, too dry and too frequently disturbed for their liking.

(vi) Several species of Carabid beetles occurred plentifully in most nurseries, but more in waste ground than in cultivated beds. Their status is problematical. It has been proved that some may attack the roots of plants, but most of the common species collected by the writer at Delamere and Inchnacardoch readily devoured the eggs and young larvae of both *Phyllopertha* and *Serica*, so that it is probable that they do more good than harm. The following species were plentiful: *Pterostichus vulgaris*, L., *Pterostichus madidus*, F., *Pseudophonus pubescens*, Mel., *Harpalus aeneus*, L., *Anisodactylus binotatus*, F., *Calathus fuscipes*, Goez. *and Amara aenea*, de Geer.

The factors which appear to affect the distribution of the chafers and the damage which they cause will now be briefly considered.

(1) *Climate.*—On the Continent, attempts have been made to relate the distribution of *Melolontha* as a pest with the mean annual temperature and/or the mean temperature from April to October. Where the mean from April to October exceeds 12·5° C., cockchafer damage may be expected. This region is approximately bounded by the July isotherm of 17° C. The July isotherm of 62° F. (16·7° C.) includes, roughly, Divisions 4, 6 and 7; of Divisions 2 and 3, the counties of Hereford, Worcester, Gloucester, Monmouth, Wiltshire, Somerset and East Devon; and, of Division 5, Cambridge, Ely and the south-east portions of Lincolnshire, Norfolk and Suffolk. That is to say, this isotherm embraces all the areas from which reports of serious *Melolontha* injury have come, with the exceptions of Hamsterley and Brechfa 1. Brechfa 1 is hardly excluded; furthermore, it is situated on a steep slope with a southerly aspect, so that it probably lies actually within the zone of higher summer temperatures. Hamsterley, though situated in a sheltered valley, lies a long distance north of the northern limit of the isotherm. The Forester at Hamsterley, as well as the Foresters at Fleet and a few other nurseries, have been asked to send specimens of the adults, as soon as they appear. *Melolontha hippocastani*, F., extends farther north on the Continent, and if this proves to be the species at Hamsterley, the abundance of larvae there in 1936 would be less surprising. According to Fidler, the distribution of *Rhizotrogus solstitialis* is similarly determined by temperature; it occurs plentifully only south of a line drawn from the Severn to the Wash. The scanty records collected this year bear this out, but suggest too that this species may also be limited by moisture conditions to the drier, eastern half of the country. There is not sufficient evidence to show whether some climatic factor causes *Phyllopertha* to be more plentiful in the west than in the Midlands and east—if, indeed, this is a constant feature of its distribution. *Serica*

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occurs in regions climatically as wide apart as Kent, Carnarvonshire and Inverness, and within the range of Britain, seems to be practically independent of temperature and rainfall.

(2) *Topography.*—The topography should be considered in its relation to the climate. *Melolontha* tends to fade out with increasing altitude, as well as with increasing latitude, but in hilly country the aspect is of considerable importance. The case of Brechfa has already been noted, and Coed-y-brenin is another nursery where the occurrence of *Melolontha* may be associated with the southern aspect. In hilly country, which it often affects, *Phyllopertha* is rare on northern slopes and *Serica* also appears to prefer nurseries with a southern aspect (*e.g.*, Fernworthy, Gwydyr, Inchnacardoch).

(3) *Soil.*—All the chafers breed most freely in light, deep, well-drained soils. *Melolontha* appears to be less closely dependent upon soil texture than the other three species and occurred in the Weald Clay at Chiddingfold, as well as in the loamy soil of Nagshead and the Bunter Sand at Delamere. However, it was notably scarce in the heaviest soil at Chiddingfold and—according to the 1937 reports—appears to be comparatively innocuous in the heavy soils of the Midlands. Shallow, stony soils are uncongenial, especially in localities of low winter temperatures, where the grubs hibernate about two feet beneath the surface. *Rhizotrogus*, *Phyllopertha* and *Serica* were plentiful only in light, well-drained soils and need not be feared on heavy loams, or clay-loams. With *Phyllopertha* and *Serica*, depth seems to be of less moment than with *Melolontha*, and *Serica*, at least, flourishes in shallow, gritty and stony soils (*e.g.*, Fernworthy, Gwydyr, Inchnacardoch and Hemsted, Section 1); the larvae pass the winter in the stony subsoil, if the top soil has insufficient depth. In certain nurseries there was evidence that the distribution of the chafers was associated with that of certain acidophil herbs, such as *Rumex* spp. Experiments, in which the reaction of the insects to soils of different acidity will be studied, have been planned for next season, and meanwhile information is being sought with regard to the amounts of lime (if any) used on some of the nurseries in recent years. The distribution of *Serica* within and without certain nurseries suggested that it might be attracted by humus; in particular, by leaf-mould; but the evidence so far obtained on this hypothesis hardly supports it.

(4) *Local Vegetation.*—This is evidently important, but its influence cannot be fully appraised without further ecological study of the chafers. The occurrence of certain species is often related to the presence of favourite food plants (*e.g.*, oak, horse chestnut, plum, cherry, beech, sycamore, willow, larch, for *Melolontha*; pine for *Rhizotrogus*; bracken, birch, rowan, broom, oak, robinia, etc., for *Phyllopertha;* birch, rumex, bracken, for *Serica*); but the importance of this factor cannot be determined, until it is known what the range of food plants is and whether feeding is obligatory for all the species before fertile eggs can be laid. In general, it may be said that *Melolontha* frequents open fields and

cultivated ground, in the immediate neighbourhood of deciduous woods; and that, on the contrary, *Rhizotrogus* is an inhabitant of open fields (arable and grass), with sparse trees (pine). *Phyllopertha* is a grassland insect, which sporadically colonises woodland nurseries and once there, is not easily expelled; Delamere and Corris, the two nurseries seriously infested by *Phyllopertha*, immediately adjoin grass fields. The ecology of *Serica* still presents a problem. It is generally, though sparingly, distributed through the rather open oak stands in the Forest of Dean and has been found in deciduous woods elsewhere; but it occurs also in forest nurseries remote from deciduous woods, *e.g.*, Inchnacardoch and on sand dunes near the sea; some common attribute of these three habitats may be usefully sought.

(5) *Nursery Lay-out and Treatment.*—Under this head, attention was given to such factors as :—

(*a*) Area of seedbeds.

(*b*) Species principally grown.

(*c*) Area and treatment of vacant ground; nature of green crop used (if any).

(*d*) Presence of grass paths and extent of any other waste ground where chafers may breed.

(*e*) Principal species of weeds and the condition of the beds as regard weeds at the date of the inspection.

(*f*) Recent manurial treatment.

(*g*) Special measures designed to reduce the chafer population.

(*h*) In nurseries infected with *Melolontha*, the stock map for the 1934 swarm year.

Other things being equal, it may be postulated that the population of chafers in a nursery will be proportional to the area which is suitable for egg-laying, so that the first step is to ascertain where the insects breed most readily. This question demands a great deal more study, but some tentative inferences have already been drawn. Grass paths do not appear to offer specially attractive breeding ground for *Melolontha*, particularly if the turf is well-trodden and firm. Waste ground, formerly cultivated and now with a liberal cover of weeds, is probably their favourite breeding site and old transplant beds, if spared the hoe during the flight period, are scarcely less congenial. One-year seedbeds and fallow ground may be invaded, but only very sparingly, if better sites are available. With *Phyllopertha*, on the other hand, grass paths are ideal, provided they are not too firmly trampled. Again with *Phyllopertha*, beds of transplants and waste ground attract many more beetles than 1-year seedbeds; but waste ground with a very heavy growth of grasses is, perhaps, less attractive. *Serica* seems to favour ground which has a good cover of vegetation, and which is undisturbed while the insects are on the wing; for instance, eggs may be laid plentifully in beds of plus 2, or plus 3, transplants or in unweeded alleys. In general, and in particular with 1-year seedlings, unweeded beds are more attractive than weeded.

We must next consider in what manner the actual damage is related to the occurrence and distribution of these breeding sites and to the other features of nursery management. In considering this, we must draw a distinction between *Phyllopertha*, with its 1-year cycle, and the other species, whose larvae exist for two or more seasons in the soil. With *Phyllopertha*, it is the condition of the beds in the current season that matters, whereas with *Serica* it is the condition in the previous year and, with *Melolontha*, probably the condition two or three years previously. Damage by *Phyllopertha* is determined by the proportion of beetles which lay their eggs in the susceptible beds (*i.e.*, principally 1-year beds of seedlings, and secondly 2-year seedbeds and 1 plus 1 beds of transplants). It is certain that these beds of small plants, especially if they are kept clean, attract far fewer beetles than the beds of older plants and the waste nursery space; but the number of larvae required to cause sensible damage is correspondingly smaller. In designing measures of control, we have the choice of either rendering the susceptible beds to the insects in as unattractive a condition as possible, or so reducing the general population in the nursery that the small percentage of beetles which lay their eggs in these beds will be of little account. The former measure demands the discovery, and if possible, elimination of every attractive feature, or the application of deterrent chemicals, or both. The latter, the eradication of all the feeding and breeding sites, in so far as they are not indispensable parts of the nursery vegetation. A combination of the two treatments should be effective.

With *Melolontha*, *Rhizotrogus* and *Serica*, the prevention of egg-laying on the susceptible beds is also very desirable, though less urgent, unless the crops are due to remain in the bed over the next season. It is probable that if effective preventive measures could be found for one species, they would, with modifications, be transferable to the other three. But with these three species, we are concerned not only with keeping the insect away from the susceptible plants, but also with keeping the susceptible plants away from the insect, *i.e.*, to avoid sowings, or lining-out small plants, in sections of the nursery which may have attracted the egg-laying beetles, and where the presence of chafer grubs may, therefore, be expected. In a nursery, where so many other demands must be satisfied, it is often difficult to arrange this; but, with a knowledge of the species of chafer present and of its life-history, an allowance of at least 20 per cent. of the nursery area fallow each year, and a little intelligent anticipation, it seems that much of the worst damage by *Melolontha*, *Rhizotrogus* and *Serica* could be obviated. In the particular case of *Melolontha*, the attack should be anticipated in the swarm year. If possible, a larger area than usual should be bare fallowed until the end of the flight; the 1-year beds, especially those due to stand over, should be kept scrupulously clean throughout the flight period; and the remaining sections of older plants, where the attack is likely to be most severe, should not be sown for three years, but should be taken in hand when their turn comes, and either bare

fallowed for a season, or else green-cropped and hand-picked when the grubs are near the surface.

These are the suggestions which a consideration of nursery practices in their relation to the chafer problem has prompted. Before they can be crystallised into definite recommendations, however, a much more thorough study of the ecology of the insects in the forest nursery habitat is required.

Conclusion.—As a result of the survey just completed, it is now possible to define approximately the areas where damage by the several species of chafers may be expected; but the full value of the survey will only be realised when the time comes to consider measures of control for particular species, and the nurseries likely to be affected by these measures can be at once found in the records. It is, therefore, desirable that the information should be kept up to date and provision should be made for short reports to be had each year from the principal nurseries and appended to the detailed records for 1937.

LINE-SURVEY METHOD OF ESTIMATING AREAS OF SPECIES IN MIXED COMPARTMENTS.

On the instructions of the Chairman a test of the line-survey method was carried out in the summer of 1937 at Glenloy Forest, by Mr. W. N. Gibson, District Officer in Division North.

The problem in this case was to determine the acreage under each species in a compartment containing many small blocks of different species. Ordinary methods of survey, involving the more or less accurate mapping of the areas under each species, are laborious and doubtfully worth the time required. The alternative method by line-survey consists of running a number of parallel lines, at a fixed distance apart, through the area to be surveyed. Each of these lines is chained up and the lengths occupied by each species recorded. When all the lines have been traversed the lengths under each species are totalled and expressed as a percentage of the total length of line. Given that the area of the compartment is known it is a simple matter to convert the percentages into acres under each species.

The accuracy of this form of line-survey naturally depends upon the distance between the lines, and the investigation described below was carried out to obtain information on this point.

The two compartments chosen had already been surveyed in detail, thus providing the necessary check.

Compartment A. Total Area 35·3 *Acres.*

Species.	Percentage found from detailed Survey.	Percentage obtained from Line-survey with Lines at the stated Distance apart.				
		1 Ch.	2 Ch.	3 Ch.	4 Ch.	5 Ch.
S.P.	2	2	2	3	3	4
S.P. & S.S.	1	2	2	3	3	4
J.L.	1	1	2	2	3	4
N.S.	31	29	31	22	27	28
S.S.	29	27	24	30	26	26
Blank	36	39	39	40	38	34

Converting the above percentages into acres gives the following results :—

Species.	Area found from detailed Survey.	Area obtained from Line-survey with Lines at the stated Distance apart.				
		1 Ch.	2 Ch.	3 Ch.	4 Ch.	5 Ch.
	Acres.					
S.P.	0·7	0·7	0·7	1·1	1·1	1·4
S.P. & S.S.	0·5	0·7	0·7	1·1	1·1	1·4
J.L.	0·4	0·4	0·7	0·7	1·1	1·4
N.S.	11·0	10·2	11·0	7·8	9·5	9·9
S.S.	10·0	9·5	8·4	10·6	9·1	9·2
Blank	12·7	13·8	13·8	14·0	13·4	12·0
Total	35·3					

Compartment B. Total Area 23·0 Acres.

This compartment was selected to provide a more severe test of the new method; there was a patchwork of species and most of the individual blocks were quite small. The procedure was the same as in Compartment A.

Species.	Percentage found from detailed Survey.	Percentage obtained from Line-survey with Lines at the stated Distance apart.				
		1 Ch.	2 Ch.	3 Ch.	4 Ch.	5 Ch.
S.P.	5	7	7	9	6	—
S.P. & E.L.	5	5	6	5	4	—
P.C.	6	6	8	5	13	14
C.P.	2	1	—	—	—	—
E.L.	15	14	15	15	15	26
J.L.	2	2	3	3	2	—
N.S.	50	49	45	44	47	34
S.S.	15	16	16	19	13	26

Converting the above percentages into acres gives the following results :—

Species.	Area found from detailed Survey.	Area obtained from Line-survey with Lines at the stated Distance apart.				
		1 Ch.	2 Ch.	3 Ch.	4 Ch.	5 Ch.
	Acres.					
S.P.	1·2	1·6	1·6	2·0	1·4	—
S.P. & E.L.	1·2	1·2	1·4	1·2	0·9	—
P.C.	1·3	1·3	1·8	1·2	3·0	3·2
C.P.	0·4	0·2	—	—	—	—
E.L.	3·4	3·2	3·4	3·4	3·4	6·0
J.L.	0·5	0·5	0·7	0·7	0·5	—
N.S.	11·6	11·3	10·4	10·1	10·8	7·8
S.S.	3·4	3·7	3·7	4·4	3·0	6·0
Total	23·0					

The test in Compartment A shows that a reasonably accurate result was obtained by the line-survey even with the lines 5 chains apart. The maximum difference of 1·1 acres compared with the complete survey cannot be regarded as serious. In Compartment B the 5-chain spacing was clearly too wide as it has led to the omission of no less than 4 species or categories, while the allocation to the remaining species is far from accurate. The 4-chain spacing on the other hand has given fairly accurate results and can be accepted as reasonably satisfactory.

The method of line-survey has obvious applications to other problems besides the one examined at Glenloy, for example, requirements for

beating-up, assessment of the proportion of plantation which is established, the percentage of plants likely to be set free by weeding and so on. It is hoped that officers will make use of the method whenever it can be applied satisfactorily.

W. H. G.

The following observations arising out of the above note have been received from Mr. J. Fraser and Mr. Gibson :—

(1) Is the proposed method sound mathematically? There is one obvious criticism that will come up when the matter is open for discussion. Men who like forms will say that such a survey should be quite unnecessary if a simple change is made in the method of keeping the R.I's, *viz* :—if the records were entered up so that the R.I. showed the number of each plant identification lot number that went into a compartment, such a survey should be unnecessary, except in cases where there were many scattered blanks or in cases in which B.U. made it necessary. The R.I's are kept by plantations and the instructions do not lay down keeping it by compartments : the compartments into which plant lots (Ident. No.) go are shown but the numbers of each Ident. lot going to a compartment are not shown. This is quite fair criticism but it leads back to records by compartments and thence to endless office work. The R.I. is a good and useful form within limits but it should not be overloaded.

Personally I would be very happy to have dead accurate compartment boundary maps and for a stock map should be content to have details sketched in with a very moderate degree of accuracy.

J. Fraser.

(2) The above method of survey has been shown to give fairly accurate results for species survey by taking strips as wide apart as 3–5 chs. and it is undoubtedly quicker than carrying out a detailed species survey, especially where many small blocks of different species occur. On the other hand, it requires a considerable amount of time to carry out even a line-survey and when this has been completed the data obtained are of no value in building up a forest stock map, which is an essential part of the Working Plan. Very little extra time would be required (except in the case of very broken-up compartments) to make a complete survey of a compartment or block of the forest. When this was done an accurate map could be prepared which would act as a permanent record during the length of the rotation of the forest. A species map should not require much alteration after its first preparation and any changes due to beating-up with a species different from the original can usually be made quite easily.

It would be an advantage if the preparation of the species map could be left until establishment of the crop was complete. (N.B.—Mr. J. Fraser does not agree with this suggestion.) Alternatively it could be prepared at the time of the first census report. In this way alterations to the map would largely be avoided and the survey would be more easily done as the

various species would be more easily distinguished than they are just after planting is completed.

The general introduction of the line-survey method would dispense with the species map entirely, though presumably a species survey would still have to be carried out for each area planted in order to supply Headquarters with the necessary tracing usually submitted to them.

An accurately made species map is of great value and it does not seem possible entirely to dispense with it, *e.g.*, census work can be much more easily and quickly done if such a map exists. In later years the map will also be invaluable in arriving at volumes for a particular species in any compartment.

The line-survey method would be a useful way of carrying out a temporary survey of an area if the time did not permit making a proper species map until later. It is also a most useful way of arriving at beating-up requirements of a difficult area.

W. N. Gibson.

A FOREST VISION.

By A. M. Mackenzie.

As you look to the hills don't you dream of the days
When forests grew on their valleys and braes;
    When the boar and the stag 'neath the birch trees fed
    And autumn came with the rowans red;
When that knoll was crowned with a grove of oak,
Where hoary Druids did Baal invoke,
    And the hunter brought his spear and bow,
    To pray that the ash and the yew might grow:
For his arrow to fly and his steel to wield
Against the chase of the air and field;
    Don't you see the fisher lure his trout
    Where the alder spread its shade about:
Or hear again from the hazel glade
The children's whistle the willow made,
    Where the myrtle flowers the pine once grew
    Whose fiery torch with its message flew,
Which though it called to the eagle's plume
Could not foretell of the forest's doom;
    Was it the cold winds that swept them away
    Or man in his folly who brought this decay,
Or was it invaders who failed to subdue,
Set fire to the forests they could not get through!
    Whatever the reason their glory has gone
    But still from the moss when the peats are being won,
A tree of the past from its grave reappears
And brings back a vision of far distant years;
    Then mutely it bids us the woods to restore
    And lays down a challenge we cannot ignore:
So if plants do not grow and faith you may lack
First think what has been—look forward—look back.

WORKING CIRCLE.

By D. H. CHAPMAN.

In describing a tour of the district a contemporary of Dr. Johnson wrote of the Forest of Mercia :—

" I never before witnessed such a scene of desolation. Here are barren rocks and vast quagmires, with wide expanses of land which support but a few sheep and an ox or two; a paradise for the opponents of enclosures ! I craved for the sight of a tree, for though this desert be termed a forest no timber could I see for a league or more. The loneliness of it so oppressed me that I did vow there and then never again to set foot within its accursed boundary. Here, surely, is Ultima Thule."

Two centuries later the Rus et Urbe Luxury Coach Company announced : " Why not spend your holidays in the Forest of Mercia this year, away from the busy rush of town life ? See Rural England at its loveliest. Every form of accommodation available from a hut to a palatial hotel. Get back to the Peace of Nature. Travel in our luxury motor coaches, all of which are equipped with wireless."

A year after the Independent Electricity Council had erected the last pylon of the series which traversed the heart of Mercia, and rather longer since the Tudortype Estates Company had nailed the last stained deal board to the gable of the last of the five hundred houses they had erected on the outskirts (" half-timbered, two-storied little palaces "), the Ministry of Silviculture completed the acquisition of twenty thousand acres of land situated almost in the centre of the district known as the forest. This purchase was a source of considerable satisfaction to the Minister, for land had become increasingly difficult to obtain, and now that most of the country's timber supplies had become exhausted in the manufacture of charcoal by a new (if rather extravagant) process for the purpose of running sawmills to convert the remaining timber into firewood by which the charcoal kilns were heated, it had become necessary for the Government to increase its area of woodland in case the supply of charcoal should fail.

It is uncertain how soon after this acquisition the outcry began, but the controversy to which it gave rise continued to form the mainstay of the correspondence columns of the daily newspapers for several years. Beginning in a spirit of righteous indignation, it developed gradually into such an orgy of mud-slinging as must be without parallel. Much of the original cause of dissension was forgotten as the opposing thinkers (for the Ministry had its supporters) voiced their uncomplimentary opinions of each other.

The following letters, chosen from the newspapers of the period, are characteristic of the earlier stages of the controversy :—

" To the Editor of the National Morning Newspaper.

Sir : I am delighted to see that your correspondent ' Nature Lover ' has written to protest against the Ministry of Silviculture's action in preparing to cloak the Forest of Mercia with trees. The Japanese pine

and the Corsican larch which I understand they are planting are aliens, and have no place in our English countryside. To my mind the Forest of Mercia should be preserved entirely against the depredations of the forestry people. Cannot they go elsewhere?

Yours, etc., (Miss) Myrica Gale.

London, S.W., 3rd November, 1968."

" Sir : I am delighted to see that so many of your readers are protesting against the high-handed action of the Ministry of Silviculture in planting trees over Mercia Forest. I knew the district well as a boy, having four times spent my summer holidays there. It is scandalous to think that this lovely country should be tampered with. I may say I have been a reader of your delightful paper for 40 years and now that I am bed-ridden its perusal means even more to me than before.

Yours, etc., Evelyn John.

Rapallo, 14th January, 1969."

" Sir : I have refrained from writing to you previously on the subject of the afforestation of Mercia Forest, as I believed the repeated pleas for preservation of this land would have made the Minister of Silviculture see reason. I consider that the Government is making a fatal blunder in virtually closing this land to the public, for by so doing they have curtailed the enjoyment of thousands of working-class people who were able to make this area their playground. This wilful closing of the countryside against the masses is a dangerous step towards revolution. I may say I know the district well, as I held the shooting rights for many years, until the advent of the Ministry of Silviculture so ruined the sporting that I was forced against renewing my lease.

Yours, etc., Eric Tetralix (Lt.-Col. Retd.).

Tunbridge Wells, 6th March."

The Ministry, as has been mentioned, also had its defenders, and at intervals a letter would appear expressing appreciation of the aesthetic satisfaction derived from observing how the baby larches changed colour almost daily, shed their leaves, and miraculously grew a new crop the following spring. Space, however, does not permit the quotation of any such correspondence which shows signs at times of rather generous editing.

For some time after its creation Mercia Forest underwent a series of misfortunes which caused its detractors no little satisfaction. It started with a fire in which nearly 400 acres were burned beyond hope of survival. " A cigarette dropped out of an aeroplane ", explained the Society for the Preservation of Mercia, hiding their elation beneath sympathetic countenances. "An Act of God ", stated the local representative of Poppitout Fire Extinguishers, Ltd. The following year brought a plague of rabbits which destroyed all the fruits of the previous year's planting. " Australia's

revenge ", declared the Lovers of Mercia Forest, winking covertly at each other. " Defective fencing ", asserted the local salesman of the Keepemout Wire Netting Corporation, concealing his cutters in an inside pocket. Finally, an invasion of roe deer coinciding with a severe attack of *Fomes annosus* contrived almost to break the heart of those in control. " Nature reasserting herself ", said the local agent for Clean Canned Products, Ltd. (Tinned Venison a Speciality); and, " It's an ill wind . . ." quoted the manufacturer of Spore's Pure Mushroom Ketchup.

The pertinacity of the Ministry of Silviculture, comparable only with that displayed by Bruce's spider, ultimately defeated the hopes of the ill-wishers, and today Mercia Forest stands as a tribute to their foresight and sound management.

The above is, of course, ancient history, much of which is now forgotten. It may be wondered why I have gone to the considerable trouble of searching through numerous files and papers to unearth a chapter which might have been better left hidden in the past. The reason lies in a letter which appeared in the Daily Broadsheet this morning, and which I dare swear is merely the precursor of many more in the same vein. It runs as follows :—

" Sir : Doubtless many of your readers will be as shocked as I was to read of the wholesale felling which is taking place in Mercia Forest. I have known this beautiful woodland since childhood, and in my opinion it compares more than favourably with the Black Forest in Germany and the overrated Kielder Forest in our own country. This lovely area is a national asset, and should be preserved for all time. Nowhere have we anything to approach its magnificence. The scent of the massive pines, the charming colour of their foliage, the delightful walks through its length and breadth and the impression of majesty it gives are too precious to be spoiled by the ruthless axes of the Ministry of Silviculture. Surely they can go elsewhere for their timber ? Cannot they import it ? Something ought to be done.

Yours, etc., Armillarea Honeydew.

Winchester, S.W."

I believe there is a moral in all this, but for the moment it eludes me.

FORESTRY COMMISSION SOCIAL SERVICE ASSOCIATION.

England and Wales.

The following report on the work of the Social Service Association will be submitted for approval to the Departmental Whitley Council.

Following the appeal, issued to all members of the staff in March, 1936, for regular subscriptions to enable the adoption of a centre in one of the Distressed Areas a fund was started for England and Wales and by the end of 1936 a balance of £72 was in hand. A Committee was appointed to consider the question of a suitable centre and, as reported in the last number of the Journal, an existing club for the unemployed in the town of Chester-le-Street in Durham was selected.

During the 12 months ended 31st December, 1937, 126 members of the staff of the Forestry Commission in England and Wales contributed by deductions from salary to the fund, the amount so received totalling £101 5*s*. 0*d*. In addition a few personal donations were received. The number of members subscribing represents approximately 50 per cent. of the staff (in England and Wales). It is hoped that more members may join the Association and so enable the grant to the centre to be increased.

The scheme has now been running a year and, as the appended balance sheet shows, the sum of £105 has been paid over to the central Community Service Council for Durham, on behalf of the Chester-le-Street Club. The bulk of the money was given in the form of four quarterly donations of £25 each, the balance of £5 being a special donation to permit a certain number of the women to have a holiday in the country at a home run by the Durham Community Service Council.

By arrangement with the Committee of the Association the regular donation of £25 per quarter is apportioned into two halves by the Durham Council, half goes direct to the Chester-le-Street Club to meet current expenses, while the other half helps to pay for instructors in handicrafts, cooking, physical training and other educational activities provided by the Council, and also for general supervision. The Club has other sources of revenue in addition to the grant paid by the Association; the members pay a subscription of 1*d*. per week; there is a canteen, and money is raised by various social functions, such as whist drives, concerts, etc., and by the charges made for boot repairs carried out in the Club.

A considerable part of the money received from the Association is spent by the Club Committee in buying good quality leather and timber. This is re-sold to the members at 25 per cent. below cost price and is a form of assistance which is greatly appreciated.

Towards the end of each year a jumble sale is held to provide funds for a Christmas party to the children. This year members of the Association were asked to contribute any old clothes, books, toys, etc., which they could spare for the purpose. There was a good response and several large cases were sent to the Club. The sale produced the record sum of £10 0*s*. 11*d*. and the party was evidently a great success.

Contact has been maintained with the Club by various means, including correspondence with the Club Secretary, Mr. W. Smith, correspondence and interviews with officers of the Community Service Council, and personal visits to the Centre by Mr. Hopkinson, and by the Secretary of the Department's Association.

At the present time, owing to the improvement in general conditions, many of the members of the Club are now in regular employment. It is most satisfactory that though these men can only attend in the evenings they continue their membership, and the Club is consequently developing from a refuge solely for " down and outs " to a community playing an important part in the social life of the town. The benefit to the unemployed residue in the Club of mixing socially with their more fortunate fellows is evident.

A copy of the last letter received from Mr. Smith and a report on the visit made by the Association's Secretary to the Centre are appended.

RECEIPTS AND PAYMENTS.

Period to 31st December, 1937.

Receipts.	£	*s.*	*d.*	*Payments.*	£	*s.*	*d.*
Subscriptions (deductions from Salary from 1/4/36 to 30/9/37)	147	12	0	Community Service Council, Durham	105	0	0
Donations	3	12	0	Railway Carriage	0	7	2
				Cheque book	0	4	2
				Balance in hand	45	12	8
	£151	4	0		£151	4	0

(Sgd.) F. CHADWICK,
Treasurer.

Audited and found correct.

(Sgd.) W. E. COGGINS,
10th February, 1938.

Chester-le-Street & District Social Service.

To Mr. Guillebaud,
Forestry Commission,
London.

18th January, 1938.

Dear Sir,

I again wish to thank you for your cheque of last quarter, and other goods received for our Jumble Sale and my members fully appreciate your kindness.

The membership is rising every week in both sections, and we are all pleased as the work is also increasing and the socials we held for the members are a great attraction to outsiders. During the past quarter ending 31st December our members made numerous desks, chairs, stools, boards and easels, and cots for dolls as Xmas presents for the children. Our activities are very similar to the last quarter's report, but there are one or two changes as we have stopped the whist drives to let the members have another night for recreation after working on the benches all day.

Monday.—Boot-repairing and woodwork during the day and an adult school in the evening.

Tuesday.—The work is the same as Monday and the women's section have a needlework class in the mornings. Also both sections meet in the evenings for a lecture as we are running a six weeks' course on " What is happening in the world today."

Wednesday.—The same as Monday with recreation in the evening.

Thursday.—The women have the place after 12 noon until 7.0 p.m. and then the two Committees meet separately to arrange for the following week.

Fridays.—Boot-repairing and woodwork until 5.0 p.m. Recreation in the evening.

Saturdays.—Recreation until 5.0 p.m. and then a dance or a social is held until 11.30 p.m.

The recreation for the members consists of cards, billiards, darts, ring-board, draughts, dominoes and deck quoits.

The women's activities are at present, needlework, keep-fit class, choir and folk dancing.

I am yours with thanks.

WILLIAM SMITH (*Secretary*).

REPORT ON A VISIT TO THE CENTRE.

I visited the Jubilee Club in Chester-le-Street on 18th November in company with Mr. J. B. Twemlow, District Officer of the Community Council for Durham County. We were greeted by the Secretary, Mr. W. Smith, and by other members of the Committee. Being a Thursday afternoon my visit coincided with the half day set aside for the women, of whom there was a fair number present. While I was there they were having singing instruction and evidently enjoying themselves. The Committee showed me over the hall and the numerous additional rooms which they themselves have built on to the main structure as their need for more accommodation became felt. The hall itself is painted inside in green and old gold as a compliment to the Forestry Commission and the effect is quite pleasing. The hall lies on the side of a hill at one end of the town and is rather hidden away and difficult for a stranger to find. The Committee told me that even in Chester-le-Street there were a good many people who did not know of its existence. They proposed to rectify this by displaying a large board on which one of the men had painted on a white ground the name and other particulars of the Club. The lettering was nicely done but the notice read a little quaintly owing to the somewhat uniform size of the letters and the absence of stops. As far as I can recollect it runs as follows :—

CHESTER-LE-STREET AND DISTRICT UNEMPLOYED ASSOCIATION
JUBILEE SOCIAL CENTRE
FOR THE UNEMPLOYED
FORESTRY COMMISSIONERS.

The hall is relatively well-equipped now with a good wireless set, piano, tools for carpentry and boot-repairing, etc., though I was told they require more tools as there is an increasing demand for this type of work. The boot leather purchased with the aid of our grant was displayed and I was informed how much the members of the Club appreciate being able to buy really good materials at a price within their means.

The members of the Committee whom I met were exceedingly appreciative of the help given by the Association. It is making all the difference between a badly-equipped Club, lacking many essentials and constantly struggling to keep going, and the Club as it now is, an efficient social organisation bringing a certain measure of comfort and encouragement into the lives of men and women who, for no fault of their own, have been deprived of all but the bare means of subsistence.

On Mr. Twemlow's suggestion, I paid a visit to the office of the Unemployment Assistant Board in Chester-le-Street and got some information regarding the general position as regards employment in the town. It appears that unemployment has been greatly reduced in the last few months but there still remain many hundreds of men without prospect of work. They fall in the main into two groups, men of 45 and over, numbers of whom are suffering from some physical disability, usually of an occupational character such as miners' nystagmus, and youths of 18 to 24 who have never been in work and who are more or less content with life on the dole. A social centre, such as the Jubilee Club, is an incalculable boon to the older men, while it gives the youths a chance of finding a purpose in life which at present is lacking.

W. H. GUILLEBAUD.
Secretary to the Committee.

SNOW STORM IN THE NEW FOREST.

By D. W. Young.

The New Forest, together with parts of Dorset, gained unwanted notoriety last December from a snow storm—a blizzard the press called it. Strictly speaking, a blizzard is accompanied by wind; this snow fell on a perfectly windless night. The kind of snow which is associated with a blizzard is generally fine and powder dry. The snow that fell on this occasion was wet and in flakes as big as hawthorn leaves; they often spread out to the size of a penny when they landed on a windscreen or other flat surface. As a matter of fact, if this had been a blizzard, the world at large would have heard much less about it. As it was, the storm was notable less for the quantity of snow that fell, than for the extraordinary amount of damage it did and the kind of damage in particular. Most parts of the North of England get one or two heavier falls than this most years. We say we had 18 in. in the north of the Forest where the fall was heaviest. I am doubtful whether honest measurement could show much more than 12 in.

The day had been chilly but did not feel nearly so cold as it would have done if there had been a wind. There had been skurries of snow in the morning, but it did not settle down to snow properly until about 2 o'clock. Even then it was not really heavy, but it became heavier as evening approached.

I was attending to some business in Bournemouth that day. Starting back about 4 o'clock one had not gone a hundred yards before the windscreen was opaque with snow except in the small triangle cleared by the windscreen wiper; another couple of hundred yards and the wiper was jammed. The 20-mile journey home which generally can be made in 40 minutes took 3½ hours. What added to the difficulty was the icy covering of the road which the wheels refused to bite into when one tried to start again after a minute's stop. It was not only the windscreen which was blocked but the headlamps also. We were fortunate, however, as two hours after we got home trees and telephone poles began to fall and something like two hundred cars had to spend the night on that road.

About 9 o'clock the real damage began, then the noise became continuous. My house has woods at the back and trees all round, so I had a good opportunity to hear it. First one branch would go with the noise that a tree makes when it has been felled and crashes to the ground. Before that had finished, one, two and even four or five would follow in a crescendo of noise and an unwonted absence of echo. Dead silence would follow and then the noise would begin again and might be protracted for five or ten minutes with scarcely a break.

It was only when daylight came one was able to take stock, but bad as the damage was it turned out to be far less than the noise had led one to expect. The Post Office was easily the worst sufferer. The whole system of wiring throughout the Forest came down bodily. Stout poles

had broken across like carrots while others had been pulled right out of the ground. Where this had not happened, the wires were sagging to the ground. The behaviour of the snow on these wires explains the whole of the damage. These wires are about $\frac{3}{64}$ of an inch in diameter. I measured the snow standing on one wire and it was four inches deep and that depth was substantially maintained where the wires sloped at an angle of 45° towards the ground.

Obviously what had happened was that the scarcely frozen snow flakes wrapped themselves round the wire and half thawed, freezing the rest. A succession of these increased the thickness of the wires to an inch on which succeeding snow piled itself and there was no wind to blow it off. As with the wires, so with the fine twigs of trees like the birch. This species, which is well designed to avoid snow damage from snowfalls of a normal type, was quite unable to bear the weight thrust upon it that night, and there was hardly a birch tree throughout the Forest which escaped more or less serious damage. Some trees broke off a yard or two from the ground. Sometimes they had their tops broken and few escaped without one or more large branches being torn away.

In the absence of the multitude of small twigs the oaks were not called upon to carry an undue weight, except where a ride or gap in a plantation had tempted a branch to grow out in a horizontal position. Beech of normal shape rather curiously did not suffer heavily except in the case of the many old pollards where the branches were more or less rotten at their bases. The escape of young Scots pine from serious damage was rather curious, too. Their branches carried a heavy weight of snow and were bent low though they never broke. Spruce escaped serious damage. Old Douglas, on the other hand, suffered severely; in the worst cases the trees were stripped of all green branches excepting the leading shoot.

Gorse and rhododendrons were laid flat and where these formed the weed growth in young plantations, they brought the young plants down with them.

It is to be feared there is nothing to be learned from the experience. If the temperature had been a few degrees higher it would have been sleet and would not have lain. If it had been a little colder the snow would not have clung as it did, and had there been any wind the snow would not have been allowed to accumulate in any case. One can only be thankful that such a combination of meteorological circumstances can occur only occasionally.

CLAY-COLOURED WEEVIL.

By B. GALE.

The clay-coloured weevil (*Otiorrynchus picipes*) is seldom encountered but the damage caused periodically by severe attacks is sufficient to warrant a study of protective measures, and a close watch should be kept for the pest. The attack is so insidious that a daily inspection of plantations may fail to reveal more than an occasional harmless looking weevil.

The damage is first of all done to the leading bud just as it is opening; the bud is eaten completely away and the weevil then proceeds to strip the buds on the leading shoot. In larches the attack looks like a die-back as the lower branches are often untouched. Secondary damage consists in the destruction of young tree roots by the larvae. These are small and therefore difficult to find. There is reason to suppose that roots are their normal food and that all the plants in an affected area suffer some root damage with the consequent death of the most seriously injured. The plants usually die in spring at the time growth should commence, after appearing healthy enough the previous summer. Owing to the small size of the larvae there are no obvious signs of gnawing on the roots of dead trees, and none have been found there, but living trees in an affected area generally yield one or two freshly gnawed roots showing the weevils' activity.

The species attacked are larch (Jap. and European) and Sitka spruce; Douglas fir is almost immune. The weevil always chooses the leading bud as its first objective. The extent to which the destruction of buds is carried down the stem depends on the severity of the attack, weather conditions and protective measures. It feeds at night, early morning while the dew is on, and during the daytime on dull, damp days from April to July. On dry sunny days it is not to be seen. Shaded areas suffer more than areas in full light. Trees may be attacked from the seedling stage up to two years after planting, but larch have been known to lose the leading bud at as great a height as 5 ft.

As regards the locality of attack one end of a compartment may be infested and the other end may be immune over a period of years although crop and soil conditions seem identical.

All ordinary methods of weevil trapping fail. Hand-picking in early morning and on wet days checks the damage. The weevils' habit of always feeding first on the leading buds, their love of moisture and taking cover during the day might be turned to account by using a slight variation of the gardener's earwig trap. An inverted flower pot containing a sod, with a larch twig through the hole mounted on a short stake would seem to satisfy requirements of buds to feed on and a moist hiding place (whence it can be collected). This will be tried next spring and results noted. Any form of trap on the ground does not yield much result as the colouring of the insect is such that it is practically invisible on forest soil.

COMMISSION'S LIBRARY: NEW BOOKS.

The following books were acquired during the past year:—

"The Preservation of our Scenery" (pp. 91), Dr. Vaughan Cornish.
"Handbook of Home Grown Timbers" (pp. 47), Forest Products Research Laboratory.
"A Beast Book for the Pocket" (pp. 378), E. Sanders.
"Wolstenholme's Law of Landlord and Tenant" (pp. 158), (3rd Edition), Grange Turner.
"A Bird Book for the Pocket" (pp. 246), E. Sanders.
"Old Oak" (pp. 195), J. E. Linnell.
"Public Enterprise" (pp. 416), Edited by W. A. Robson.
"Insects of the British Woodlands" (pp. 338), R. N. Chrystal.
"Britain and the Beast" (pp. 352), Edited by Clough Williams-Ellis.
"The Forests of West Africa and the Sahara" (pp. 245), E. P. Stebbing.
"A Pocket Book of British Trees" (pp. 182), E. H. B. Boulton.
"Statistical Methods" (pp. 341), George W. Snedecor.
"A Handbook of the Law Relating to Landlord and Tenant" (pp. 675), B. W. Adkin.
"Textbook of Dendrology" (pp. 527), W. M. Harlow, Ph.D., Ellwood S. Harrar, Ph.D.
"In Breckland Wilds" (pp. 200), W. G. Clarke, F.G.S. Revised edition, R. R. Clarke, B.A.
"Saws and Sawing" (pp. 141), S. Lister.
"Agricultural Surveying" (pp. 128), John Scott.
"Foundations of Silviculture on an Ecological Basis", W. G. Toumey. Revised edition, 1937, C. F. Korstian.
"Forest Protection" (pp. 262), Ralph C. Hawley.
"Timber, its Structure and Properties" (pp. 169), H. E. Desch.
"Practical British Forestry" (pp. 387), C. P. Ackers.
"Die Laubgehölze" (pp. 380), Gerd. Kruszmann.
"Taschenbuch der Gräsen" (pp. 200), Dr. Ernst Klapp.

BIRDS IN CHOPWELLWOOD.

By A. D. Hopkinson.

For fifteen years, perhaps longer, Chopwellwood has been a sanctuary for birds and wild animals—rabbits excepted. About seven hundred acres in extent, it is situated in the County of Durham, close on the borders of Northumberland, and contains a variety of woodland which doubtless helps to make it attractive to so many different species. Old hardwoods are liked by Woodpeckers, and young conifers harbour many Warblers during spring and summer.

Outside the wood there are collieries and ugly pit heaps which few birds frequent, but inside all is peace and quiet and birds love quiet places to make their homes. The avine population is naturally far greater in the summer when the residents are reinforced by many summer migrants, but there is a faithful band that remains through frost and snow, and perhaps a few that find food and safety here and nest farther north. It is noteworthy, for instance, that Woodcock which are plentiful during the nesting season are scarce in winter and it may well be that the summer birds migrate southwards and the winter birds are at the southern extremity of their migration zone.

It is a matter of considerable interest to watch how the growth of a pure conifer plantation such as, say, Sitka spruce, affects the species which frequent it. When first planted it is, from the bird point of view, just rough land covered with brambles and bracken. A pair of Partridges may find this a useful shelter for their nest, especially if near agricultural land, where they feed. A pair of Curlews may fancy it too and Grasshopper Warblers are sure to be there and Whinchats. As the trees form cover these find other sites to nest and rear their young, but the Willow Warbler, the Blackcap and the Garden Warbler and others take possession, finding food and security in the dense growth of trees and weeds. Later, the trees grow tall and the lower branches are cut and then the Warblers have lost the thick cover they love, and they move elsewhere. Not deserted, however, are such woods. The Mistle Thrush likes to nest well up from the ground and so does the Jay, the Kestrel and the Wood Pigeon—and so the cycle follows on; each species in turn finding what it seeks, for a while, and then turning elsewhere as conditions change. Hardwoods are a great help to birds, especially to the insectivorous summer migrants, and I hope there will always be some here for this reason alone. Pure conifers form but a transitory home for some of our best-loved birds.

Now let us examine more closely the birds that fifteen years' observation have revealed—a list probably far from complete—but at least an indication of the wealth of species found in seven hundred acres of mixed woodland in the north of England.

Neither Rooks nor Jackdaws nest in the Wood, but given abundance of tortrix caterpillars on the oak, they are there in numbers. The Carrion-crow, however, nests and is perhaps a little too common for the safety of other species. The "Corbie" mostly finds his food elsewhere, but evening sees him winging his way homeward night after night from the same quarter—perhaps some refuse heap miles away. There is something different but definite in the flight of a Carrion-crow, difficult to describe, which proclaims him to be what he is and not a Rook.

There are Magpies and Jays in abundance—too many of the latter haunt the woods. These handsome and cunning rascals do not, however, find complete sanctuary and their predilection for green peas is often their undoing.

Unless driven away temporarily by snow and frost the Mistle Thrush remains all the year round and a welcome resident he is for his fine wild song does not wait for spring—this winter soloist of the woodlands. Should they come near his nest he can curse the Jays in no uncertain language, and with every excuse because early in the year his young are tender morsels which make excellent eating for these robbers.

The Song Thrush leaves us during the severest part of winter, but not so the Blackbird. He remains, and in hard weather feeds regularly at the bird table.

Only an odd half-starved Redwing finds food and shelter from the storm in the wood. Fieldfares pass in in small flocks during winter. Other birds about the garden are Chaffinches, Yellow-hammers, Robins and Hedge and House Sparrows. All stay near their homes throughout the winter, but they require feeding in severe weather. Green Finches nest, but migrate.

Tits also stay with us all the year. The Great Tit comes first in size and numbers, followed by the Blue Tit and the Coal Tit. The latter is rather uncommon and somewhat shy of the bird table, only appearing now and then—not waiting every morning like the Great Tit, scolding if the peanuts are finished. Margarine and desiccated cocoanut run into a cocoanut shell is good, but peanuts are better, so when the latter are not replenished, the Great Tit does something about it and the little Blue Tit agrees.

That beautiful little acrobat, the Long-tailed Tit spends the winter with us. Small parties search the tops of the larches and the spruces all hours of daylight. I have never found a nest or noticed them in summer.

A few Starlings nest in the wood, some in holes in trees, others in ivy or holes in walls. In small numbers like this the Starling is a cheery and useful neighbour. Except for an occasional small flock that arrives at the bird table during snow the Starlings only stay for the breeding season. To judge by their excellent imitations of Gulls and Curlews, they spend the winter near the coast. No large flocks gather to roost in the plantations.

One of the most beautiful summer migrants we have is the Redstart. Only one or two pairs breed and one has lately nested in a hole in the stable wall. Two other interesting arrivals in the spring are the Tree Pipit and the Spotted Fly-catcher. Tree Pipits are fairly common but Fly-catchers are scarce. A pair used to nest regularly in the ivy clad walls of Beda Lodge. I have seen Pied Flycatchers both in Northumberland and Durham and they breed regularly in both counties, but I have never noticed one in Chopwellwood. In these counties I have always found it in open birch woods, beside a stream.

All the four species of the Swallow family may be seen from time to time during summer as they nest in the neighbourhood but as far as I am aware none nest in the Wood. Woodlands obviously do not attract them. Bullfinches are not common, but may be seen, especially in the early spring, feeding in small flocks on the bursting larch buds. They probably nest here, as odd ones can be observed during the summer.

Three Lesser Redpolls visited the garden last February for a short while, but that is the only occurrence of this species I have noted. Curiously enough, considering the amount of pine wood, I have never seen Crossbills in the Wood or noticed cones which they have torn off in search of the seeds.

The greatest joy of the woods are the Warblers of which no less than eight species nest regularly. The Willow Warbler arrives first, usually about the 25th of April. He is a charming little fellow with his somewhat melancholy song. He nests all over the woods and may be heard at any time during the spring and summer. Nothing seems to stop his song. I have a note that on the 17th May, 1935, when there was two inches of snow and the trees and all the foliage were covered, the only birds which were cheery enough to sing were the Willow Warblers and Chaffinches.

Quite the most beautiful songster is the Garden Warbler, which with its burst of deep rich notes rivals the Nightingale. Its song is so lively and animated that it gives the impression of great joy and happiness, but the bird itself is somewhat secretive and keeps, for the most part, well under cover of the foliage. This Warbler is fairly abundant. Less common is the Wood Warbler, which sings high up in the larches and oaks, often singing as it flits gracefully from branch to branch.

Whitethroats arrive early in May and add their hurried unmelodious song to the ever-increasing chorus; a beautiful creature, but a poor singer. Only once have I seen a Blackcap. They are rare and very shy, keeping close in amongst dense foliage, but probably they nest every year in the Wood.

Chiffchaffs are common and well distributed through the Wood, not being particular as to the nature of the woodland they live in. But it is different with the Grasshopper Warbler—conditions have to be just so for him and when the branches of the young trees get close together he finds

nesting quarters elsewhere; but there is always some ground in the Wood which he favours and his excellent imitation of a grasshopper can be heard all night through, as well as during the day.

Another nocturnal singer is the Sedge Warbler, but he is far from common unfortunately. I remember one June night several years ago going out of the house about midnight and hearing the song of a bird some two hundred yards away on the far side of the Nursery. This was a Sedge Warbler and, standing not ten yards away, I listened to it for half an hour, pouring forth an incessant song in which were included marvellous imitations of all sorts of other birds. I left it still singing on that fine still night as if it would never stop.

Those then are our eight warblers.

Other nocturnal birds include the Wood Owl and the Nightjar. Wood Owls are common and all through the winter nights their eerie call may be heard, and in summer the young sit in trees and call incessantly for food all through the hours of darkness. The Little Owl has not yet reached this district and Barn Owls do not nest in the Wood. A few pairs of Nightjars nest here every year, but they are not abundant as they are in certain districts elsewhere in England.

The Wood is full of Wrens—cheery little fellows that are not daunted even by the severest weather. When snow lies they live and feed mostly underneath it—that is to say, in amongst the bushes of whins, brambles, young firs, etc., which are burdened down with the weight of snow, but still leave gaps underneath where in some mysterious way, the Wren manages to find a living. Loudly and early it proclaims the spring, with a song which is marvellous for such a tiny creature.

Until about three years ago, the only Woodpecker seen was the Lesser Spotted, but now both the Green and the Great Spotted nest. It is a pity Woodpeckers are so shy as they are interesting birds to watch. The Lesser Spotted Woodpecker for years found a good sounding board in the dead branch of an oak at the foot of the meadow in front of Chopwellwood House, but it required careful stalking to get within 30 yards of it, when drumming. They nest mostly in dead birch trees, which are easy to hollow out, but one year a pair nested in a rotten fence post at Carr House Nursery. This species is far commoner than the other two and probably only one or two pairs of these frequent the Wood. One wishes there were more, especially of the Greater Spotted, as he is such a handsome creature. Woodpeckers are very quick at finding bark beetle larvae and must consume thousands in the course of a year as well as other harmful insects.

Although it breeds in the County of Durham, I have only once seen a Wryneck in Chopwellwood and never a Nuthatch. Gold-crested Wrens are abundant in winter, moving from tree to tree in small parties calling quietly to one another to keep the party together. They are birds of ceaseless movement which find a great deal of their food in spruce trees. It is probable that a few remain to nest, but I have no proof of this.

A stack of seedbed covers in an open shed was for years the nesting place of a pair of Tree Creepers and as they entered their nest, through my kitchen garden, they were easy to watch, especially when feeding their young. I have never observed parent birds work so quickly or return so frequently to feed their young. No sooner was one parent away than the other was waiting with a fresh supply of dainties, picked from the bark of nearby trees.

Perhaps because there are no Meadow Pipits, only a few Cuckoos frequent the Wood, but the Tree Pipit arrives every spring and nests sparingly throughout the Wood, especially where there are tall trees and where the Wood is open.

The River Derwent flows along the southern boundary of the Wood and this accounts for a few birds not normally seen in woodlands. Such are the Pied Wagtail, the Water Ouzel and the Waterhen. Occasionally in hard weather a pair of Mallard may be seen and sometimes a Heron.

To turn to birds of prey : both Sparrow Hawk and Kestrel find safe nesting sites in the tall larches in remote parts of the Wood. They do not abuse the privilege but, of course, they have to live. Twice I have seen a Merlin probably on migration from its nesting quarters on the moors.

Curlews are not birds you would expect to find in Chopwellwood, but they regularly nest within a mile of its boundary and one year a pair established themselves in a clearing and stayed all through the breeding season. Their nest was not found but most probably they nested.

Lastly we come to the game birds. Woodcock nest fairly abundantly, but are curiously scarce during the winter. If it is very dry about the time their young can fly and fend for themselves, they suffer greatly and numbers must perish. I remember one very dry year when several young ones came into my garden to try to find food.

Both Common Snipe and Jack Snipe may be occasionally flushed in the clearings during winter. A few Pheasants manage to survive, but only a few and it is not safe for these to cross the boundary into the fields outside. If it were not that these wild birds are full of cunning and elude both men and Foxes with great skill they would soon be exterminated. At one time some years ago the number got so low that I introduced about half a dozen from a game farm and since then they have managed to keep going. What is interesting is that with numerous Foxes, Badgers and Sparrow Hawks, Pheasants can survive without any human interference or protection.

A pair or two of Partridges usually nest if there happens to be a felled area near the outside of the Wood, but they never seem very successful with their broods, perhaps owing to the deep drains with which the ground is intersected. Far rarer, however, are Black Game. Only one has been seen in recent years, but old miners tell of days long ago when they regularly came down to the top end of the Wood in winter.

That woodlands enrich the avifauna of the country there can be no doubt. Some birds prefer evergreen and some prefer deciduous trees. Thus in mixed woods we have the greatest variety of bird life—doubtless a minor consideration in State Forestry, but one worthy of a thought, for birds help the forester far more than they hinder him.

Records of wild life in our forests are likely to prove valuable and more papers on the subject are to be desired. Bird life in relation to British forestry is a subject of which the fringe has hardly been touched; the standard text books are as unreliable as they are sketchy on this aspect of forest protection. Germany has not been so neglectful. It is certain that birds play a greater part in the protection of forests than has hitherto been ascribed to them and we should no longer afford to regard them as a minor consideration. The quantity of insects destroyed by the insectivores is enormous and many of the seed-eaters normally feed their nestlings on insect life. It is to be doubted if any native bird is wholly harmful and there is awaiting investigation a wide and complex field that can scarcely fail to prove fruitful.

W.L.T.

PLANTING GRANTS.

By R. E. Fossey.

In their Tenth Annual Report, the Forestry Commissioners expressed at some length their concern with the fact that planting by private owners had fallen far short of the hopes of the Acland Committee. The question was further discussed in the Twelfth, and again in the Fifteenth Annual Report, where it was once more pointed out that no measures had been devised which would assist in solving the main problem—that of getting the privately owned woods of Great Britain into a satisfactorily productive condition. The area annually planted with the aid of the Commission's grants—presumably a reliable indication of the total amount of private planting in the country—has in recent years fallen fairly steadily. In a word, there has been little success in prevailing upon those who would not, or thought they could not, replant.

The following is a brief note of the impressions of a District Officer making the inspections of the Schemes allotted to him. The observations are set down with a certain diffidence, inasmuch as they are necessarily based on experience limited both in duration and as to locality.

In an article published in the Journal of 1931, Mr. D. F. Stileman suggested that an increase in the scale of grants would probably induce many, particularly the smaller landowners, to plant areas, both waste lands and old woodlands, with which they would not otherwise deal. The writer has gained the same impression; he has frequently heard, "We should like to take this block in hand, but it would cost us too much; now if only your help were a little more substantial . . . ." This has often seemed sincere enough, and a true reflection of the position in many cases after due allowance has been made for the kind of enthusiasm which is never translated to practical achievement. Cases have occasionally been met where, largely irrespective of the financial aspect, the idea of afforesting some waste area has occurred as a result of the owner having heard of the Commission's system of grants, and having gained the impression that he should "do his bit." Generally, however, it appears that the present grants are welcomed by those who would undertake planting schemes even without them, while they can rarely be sufficient to turn the scale in favour of such expensive undertakings where either the financial position or the predilections of the owner would not otherwise allow. The Commissioners, nevertheless, have been advised by their Consultative Committees that no reasonable increase of the scale of grants would assist them in the main problem; not merely so, but the grant for scrub clearing has been discontinued.

It is evident that, with exceptions, the knowledge of forestry possessed by the average owner is small. The actual operation of planting and espacement is nearly always well carried out; preparatory clearing of ground is likely to be too thorough. Drainage is apt to be neglected, presumably because trees of a kind may often be seen growing, or should one say standing, in almost waterlogged land. The havoc that can be

wrought in young plantations by a few rabbits is not always credited. In one 50-acre scheme an attempt had been made to do without wire-netting! The failures averaged 60 per cent., some portions being completely wiped out and this was the second planting. Beating-up and weeding are either done with unnecessary exactitude or the importance of these operations in maintaining something like a full crop is not appreciated. In fact, in so far as the practice of forestry runs parallel with that of gardening or of farming, it is properly done; the failures begin where ignorance begins. Choice of species is rather by rule of thumb than by judgment; choice of planting stock is left in the hands of the supplying nurseryman, usually with deplorable results. As for later operations such as maintenance of fences and drains and, most important of all, thinning, if one may judge from the majority of older plantations alongside, the outlook for the grant schemes is indeed black.

Curiously enough, owners frequently seem unaware, at least until well embarked on a scheme, of the complexity of the subject, and therefore of the extent of their own ignorance. Planting is often commenced without any advice at all, not even that of a nurseryman with certain trees he is very anxious to dispose of, or more usually a land agent who has acquired the minimum knowledge necessary for his qualification. Occasionally it is believed that the Commission require at least to inspect and approve, if not actually to advise, prior to planting; but it is very rare for an owner to ask for advice previous to planting. Perhaps requests would be made more frequently if it were generally known that visits would be made free or for a very small payment; in the past it has been the rule, so far as the writer is aware, for a fee to be charged for all advisory visits which, though perhaps no more than covering outlay and in any case a very small proportion of the cost of a planting scheme, constitutes a discouragement at a vital point. Only one case in four years can be recalled of a small woodland owner anxious to pay for advice on the preparation of a scheme and he was one who needed it less than the others.

If an owner has proved sufficiently interested in planting to have completed a form of application for a grant, it seems desirable that he should receive every reasonable encouragement as well as advice. Possibly another reason why many hesitate to ask for advice is that Government Departments are commonly believed to be soulless institutions, not concerned with the needs and circumstances of individual citizens; the highly "Departmental" flavour of the standard form of letter approving an application must serve to confirm this unfortunate belief. Surely all the necessary information, advice and warning could be incorporated in a form which would leave no doubt in the recipient's mind as to the pleasure with which his application has been received. Perhaps it might further express the hope that he would look upon the Commissioners as co-operating with him in a venture of national importance, however small individually; and would not hesitate to consult them at any time. This again implies some modification of past practice in regard to advisory visits.

With those who do not understand the practice of beating-up, it is common to find that some or all blanks have been filled only in the season preceding the second inspection, this being regarded as complying with the regulations governing the scheme. Occasionally cases are met where the imminence of the second inspection has been overlooked and no beating-up carried out. This point was mentioned by Mr. Stileman in the article already referred to; he recommended that a warning notice should be sent out during the autumn prior to the inspection. Actually in cases of this kind, and sometimes in others where it could hardly be said that the owner was guilty of real neglect, it has been usual to give a year's grace and allow a third inspection. Both of these seem to be second-best courses, designed to make the best of things and to avoid discouragement and perhaps exasperation to the owner; but it would be better if the difficulty could be prevented by proper advice at an earlier stage.

On some difficult sites, establishment will not be effected within four years, even when all reasonable care has been taken, and signature of a final certificate to that effect imposes a certain strain on the veracity of an inspecting officer.

With reflections of this kind we are brought hard up against the magnitude and complexity of the real problem which was mentioned at the beginning. The question is not only, perhaps not mainly, one of planting or replanting; not even of preventing the ruin of good young plantations through faulty thinning or no thinning at all ; but also of getting a reasonable standard of production from enormous areas of scrub, coppice and so forth which at present are yielding little or nothing of any value. The Commission ought also to be reasonably sure that grants, whether as now made or such as might be made under some improved and extended system, will not in the end, when beyond their control, be completely thrown away. At the General Meeting of the Royal English Forestry Society in March 1937, a discussion was opened by our Chairman, reports of which will have been seen by readers of this article, and there can be no doubt of the grave concern with which the Society view the matter. A fitting conclusion can be made with a quotation from that excellent and most outspoken brochure, " Estate Woodlands," issued by the Society :—

" The woodlands of England . . . are in such a state as to serve neither the country nor their owners. On a few scattered estates trees are honestly cultivated, but on the rest they are so neglected that the annual growth of timber in the country as a whole is less than a quarter of what the existing woodland area should provide. In no other country of north-western or central Europe is such waste allowed.

" There is no need for this neglect . . . the real reasons for which are ignorance and indifference."

SITKA SPRUCE AT HARWOOD.

By W. Hodgson.

Last year having been so exceptional for tree growth the following figures relating to the growth of Sitka spruce at Harwood may be of interest.

Comp. No.	Max. Height.	Max. annual Growth P. 37.	Average Height.	Average annual Growth P. 37.	Comp. No.	Max. Height.	Max. annual Growth P. 37.	Average Height.	Average annual Growth P. 37.
	ft. in.	*ft. in.*	*ft. in.*	*ft. in.*		*ft. in.*	*ft. in.*	*ft. in.*	*ft. in.*
		P. 30					*P.* 31		
10	10 3	3 6	7 8	2 0	8	10 3	3 0	7 6	2 0
11	12 0	3 6	7 9	2 0	9	10 6	3 6	8 1	2 1
12	12 3	3 0	8 3	2 2	25	10 5	3 0	7 6	2 0
13	9 6	3 0	6 6	1 5	26	10 0	3 2	7 3	1 10
28	11 4	3 4	7 7	1 8	27	10 3	3 1	7 10	1 11
29	12 4	3 8	8 4	2 5	43	9 3	2 9	5 10	1 8
		P. 32					*P.* 33		
4	6 6	2 8	5 0	2 0	59	3 10	2 0	2 5	1 0
5	7 9	2 8	5 4	2 0	60	5 0	2 5	3 1	1 2
6	7 6	2 8	6 0	1 9	61	5 10	2 6	3 5	1 5
7	6 6	2 0	5 0	1 5	62	5 9	2 4	3 5	1 5
22	7 2	3 0	4 11	1 11	63	5 8	2 10	3 10	1 5
23	6 2	2 3	4 4	1 5	57	5 1	2 6	3 8	1 3
24	6 9	2 5	4 10	1 6	56	3 11	2 4	2 6	1 1
14	7 6	2 9	4 7	1 5	55	4 2	2 5	2 10	1 3

It will be noticed that the maximum height in eight years is 12 ft. 4 in. while the maximum growth for the present year is 3 ft. 8 in. This I think is quite good and the averages taken prove that growth is very satisfactory.

The figures are all taken from trees grown on peat with a molinia vegetation, the peat varying from a few inches to two feet or more in depth. At the time of planting there was a large percentage of *Juncus* along with the molinia but the former is disappearing.

The trees are growing at an elevation of 900 to 1,000 ft. above sea-level, and so far the altitude has had very little adverse effect on the growth although it is decidedly noticeable that where there is shelter the trees have done better. As will be seen from the table this is particularly evident in Compartment 9, which is sheltered between two higher points on the S.W. and N.E. Apparently the nature of the soil has much more effect on growth than elevation. Trees planted P.30 and growing on deep peat average about 2 ft. in height and 9 in. last annual growth and those on heather average 3 ft. and 1 ft respectively. This compares very unfavourably with the trees grown on molinia.

The whole of the trees in the table were planted 5 ft. apart and in many parts of P.30 the branches are now meeting and I expect in a year or so will begin to kill out the under vegetation. During P.30 and P.31 a number of plots of Norway spruce were intermixed with the Sitka spruce and it is interesting to note how the growths of the two compare. So far the Norway spruce are quite unable to keep pace with the Sitka spruce. The average height of the Norway spruce P.30 is about 4 ft. 6 in., the growth for last year being 1 ft. 3 in.

Before ending I should like to draw attention to my note in the Journal of 1936 (page 86) dealing with the effect of distributing peat on Sitka spruce. The growth continues to be most satisfactory, in fact the beneficial effect is more marked than ever. In some cases where peat was placed round the plants there is a shoot this year of 18 in., while those not so treated have only made shoots of 4 to 6 in.

TRACTOR PLOUGHING AT ALLERSTON.

By T. E. Anderson.

Allerston was I believe the first area to use the now familiar caterpillar tractor and deep furrow plough; this was in 1931. Previous to that various types of plough had been used, but none met the requirements so essential to this form of cultivation, that is, to be deep enough to break up the pan and in so doing stir thoroughly the heavily leached layer above. The ground ploughed by the caterpillar tractor and ploughs may be classified as typically moorland, mainly covered with various types of heather. The soil profile shows two distinct soil types; the largest consists of from 2 to 3 in. peat, overlying a compacted mass of greyish soil heavily leached from 4 to 7 in. thick, while the other consists of the peat layer which overlies the sands of the Passage Beds. The pan, although not continuous, is present over most of the area and is usually about $\frac{1}{8}$ in. thick and varies in depth from 4 to 10 in.

For the first two years or so after deep ploughing began at Allerston it would appear that the double-furrow plough was chiefly in use, and the ground not subsoiled. Although the double-furrow plough may serve a useful purpose on some areas, our experience is that it cannot get deep enough to break up the pan and leached layer above; this we believe to be one of the reasons why plants checked so badly after such ploughing. Certainly areas planted recently after using other methods are showing much better results. The ideal combination appears to be the single-furrow plough followed by the subsoiler; some may prefer the subsoiler in front of the plough, but we think that the former method is, if anything, the better, although good results have been obtained by both methods.

As regards planting after ploughing, nothing so far as we know has ever been laid down as being the best method, nor can there be as conditions vary in different parts of the country. Several methods have been tried out here. The first planting appears to have been done on top of the first furrow, which, when the double-furrow plough was in use, usually lay on the top between two furrows; a great fault of this method of planting was that you had two surfaces of heather coming together and this formed an air pocket into which the plant roots were placed; this was no doubt the cause of so many plants going into check.

Probably the method chiefly used after the plough is to plant in the second furrow slice, which usually occupies the place from where the first has been moved. This method may give good results provided the soil is loose, or the furrow slice cut through with the spade at right angles; two cuts should be made about a foot apart and the piece between broken down so that contact is made with the soil beneath. If the soil is fairly stiff and the above method is not used the death rate will undoubtedly be high, as this furrow if not broken down usually lies at an angle of 45° and the air pocket is more marked than is the case with the first method of planting.

During the last two or three years we have adopted the method of planting in the bottom of the furrow (mainly pines, although we have tried a few Sitka spruce); by this method you are sure that the roots are placed in the " B " horizon. It may be asked what about plants being water-logged, but all experience so far points to the fact that if the furrow has been subsoiled drainage is ample and we have found very few cases where plants even after heavy rainfall were standing in water; while in dry weather any moisture naturally finds its way into the furrow.

Since we have adopted the above method of planting no beating-up has been necessary. At least 95 per cent. of the plants in the areas so treated are alive and growing vigorously. One or two points however should be emphasised if this method is to be successful; the first is no delay must take place between ploughing and planting if heather is the surface vegetation, and the second is that fairly large plants should be used, although this is not essential. The reason why no delay should take place after ploughing is that in strong heather this may fall and smother the plants, although we do not anticipate any danger in that respect to the plants we have put in the furrow bottom, as the majority are now above the heather and growing vigorously.

Great difficulty and expense are being met with at present owing to extensive areas having been ploughed between 1931 and 1933 and not planted until 1934 or 1935. The growth of heather was not excessive up to the time of planting, due no doubt to the very dry seasons during that period, but with the return of more normal climatic conditions since 1935, heather has made very rapid growth; as a result pine areas have to be heather-weeded very extensively, and spruces also to a lesser degree; this applies to whatever position the plants were originally put in.

Of the species planted on ploughed areas, which include S.P., P.C., C.P., J.L. and S.S., the best at present are in order of size:—P.C. planted in P.31 are now 5 ft.; S.P. planted P.31 are 2 ft 6 in.; J.L. P.31 vary considerably, the maximum heights being 6 ft. and the minimum 1 ft. The S.S. are so far most disappointing, but a large proportion now appear to be coming out of check and beginning to grow; the next two or three years will show whether this species will make a crop or not. Probably the best method of dealing with S.S. is to mix them with pines. C.P. P.35 are showing promise when planted on suitable soil.

Finally it may be said that deep ploughing has solved many problems of planting on the inhospitable soils of our moorlands, where it is essential that the ground be thoroughly stirred. It may be too early as yet to say definitely whether any particular species is going to be a failure as so many factors can be brought into the argument; especially is this the case here in connection with the earlier ploughing.

NOTES ON ALLERSTON I.

By T. E. ANDERSON.

Allerston Forest is made up of four working Sections, of which Allerston I is the largest, extending to approximately 6,800 acres, and after P.38 nearly 5,000 will have been planted.

Planting was begun in 1921 and has continued with the exception of one year (P.32) ever since. The area is situated in N.E. Yorkshire and consists of two main valleys, from which run subsidiary dales; these contain the best soil, practically all of which is planted. The dales run from the main valleys out to the moorlands, which are at an elevation of 700–813 ft., this latter being the highest point on the area. The geology is of the Jurassic sequence, and the middle Oolite series; it consists of Lower Calcareous Grit, Passage Beds, and Lower Limestone (Oolite).

A marked feature of the dales which run east and west is the different soil types met with on each side: on the north side we have the sands of the Passage Beds, where the vegetation is mainly bracken, while on the south side is the Calcareous Grit, with Limestone (Oolite) outcrop; on the upper slope the vegetation is entirely different, consisting mainly of bracken, bilberry, etc. These conditions called for entirely different treatment, both as regards choice of species and planting; but owing no doubt to the fact that in the early years of the Commission's activities large planting programmes were undertaken with whatever species were available (in many cases regardless of the suitability of the soil), it was inevitable that many of the original plants failed. The chief failures were Norway spruce, Douglas and Japanese larch, when planted on heather. Where, however, the soil was suitable we have flourishing plantations of J.L., S.P., C.P. and to a lesser extent D.F. Some hundreds of acres of J.L. are approaching the thinning stage, a good proportion of which have been brashed; many areas of S.P. also are coming to the stage when they will need brashing.

Owing to the many gaps mentioned above, a comprehensive plan was drawn up in 1933 with the object of going over the whole planted area systematically to fill in the blanks. This has entailed a tremendous amount of work which normally should not have been necessary. Many of the areas to be treated had some trees which were growing rapidly, and great care had to be exercised not to overdo the beating-up process. With the exception of some S.S. areas which were left for observation but which will be taken in hand this winter, most of the blank patches have been made good; there still remain, however, some areas which will need attention for a year or two, to make sure that they are properly stocked.

Some of the original planting on the moorland has been ploughed out and completely replanted. Where the plough could not work care

has been taken to cultivate the soil sufficiently to make sure that the plants have a reasonable chance to grow, this often being slow and expensive work, but we think that the end justifies the means. No doubt the many failures here as elsewhere were due to lack of cultivation, and this was caused through the constant excessive insistence on keeping down costs. Little regard was paid as to whether plants would grow when planted under such conditions so long as a large planted area could be shown on paper and planted at as low a figure as possible. Happily for all concerned this state of affairs has been remedied to some extent, initial cheapness no longer being the password, but rather economical working and supervision to see that money is not wasted. Necessary money is now spent to assure proper cultivation and it does not need a host of abstract statistics to prove that this is a more paying proposition.

TURF-PLANTING AT KIELDER.

By A. B. Weir.

Turf-planting on a fairly large scale has been carried on at Kielder since 1933. The areas planted being P.33, 312; P.34, 344; P.35, 1,008; P.36, 1,140; P.37, 1,133 acres.

In arranging for the planting of these large areas on bleak hill-sides which lie between 750 and 1,250 ft. above sea-level, one must first think of the best time of year for the work. Spring planting has now become accepted as the best; January and February can be ruled out because of bad weather, which leaves March and April, and those who know this border country are aware of the severe weather sometimes experienced during March. Last March, for example, we had three weeks of snow. One has, therefore, to count on doing 75 per cent. of the planting during April.

When the weather is favourable a start to plant may sometimes be made about the end of February, but this should be done on a small scale, just a few men planting so that supplies of plants taken on to the hill would not be in large quantities. If a large number of men be put on to plant at this time, large consignments of plants would have to be ordered, or large supplies taken from the home nursery, and should there be a change to wintry conditions, these large stocks have to be left heeled-in, probably for weeks, or you may be faced with several trucks of plants arriving at the railway station, and the ground too hard to heel them in. As the month of March goes on, given moderately good weather, the number of planters can be increased. Small consignments of plants from outside sources can be increased by supplies from the home nursery. The home nursery is always used as a standby in case outside supplies are delayed. About the third week in March, orders are issued for large consignments of plants to be delivered regularly during the first three weeks in April, and in sufficient quantities to keep the whole staff planting. In this way very few plants are heeled-in for any length of time, and all supplies should be on hand by the end of the third week in April.

The transport of large stocks of plants has also to be considered, when as many as 50,000 trees are planted in one day, and continuous supplies are a necessity. A motor lorry is therefore used to do all haulage from the railway station or the nursery, and plants are taken by this means as near to the planting areas as it is possible to go, afterwards horses and carts are used to take the plants up the hill-sides; where it is impossible for a cart to go a sledge is used and where the sledge cannot go, boys are put on to carry the plants to the planters. This transport has to go on practically the whole time.

The method of planting is by semi-circular spade; 1,000 plants are issued per day to each planter, and if bad weather prevents them from working every day during April, the deficiency on any day is distributed over the next few days, so that the maximum of work is done by each man; it only means that they work a little longer each day to get the trees planted. This has to be done as this district is so remote from village or town life, the nearest village in England being 19 miles away and the nearest in Scotland, 17 miles. No more men could be put on during the busy season as there is no accommodation for them, every house having several lodgers as it is. The staff, numbering about 60, has got through the past years well.

SITKA SPRUCE ON SMALE FARM.

By J. T. Anderson.

The area described below is a farm situated in the valley of the North Tyne and was the first to be planted up in the locality by the Forestry Commission. It now comprises a unit of Kielder Forest.

The general aspect is east; the elevation varies from 560 ft. to 1,295 ft. above sea-level. The soil is clay with a covering of peat, the peat varying from a few inches to 2 ft. or so on firm ground. Where bogs occur the depth of peat ranges from 4 to over 12 feet. The vegetation can be roughly divided into four types (1) *Molinia*, (2) *Calluna* and *Molinia*, (3) *Calluna*, (4) *Calluna* and *Scirpus*, and the growth in each type is described.

Molinia.—There is no perceptible check of growth after planting on *Molinia*. The trees during the first year put on a shoot of 4 to 5 in., increasing in length each year as the trees grow stronger. After 10 growing seasons the trees in sheltered positions have attained a height of 15 to 20 ft. On the more exposed elevations the average height is from 10 to 15 ft. Growth in 1937 was exceptionally good, shoots from 36 to 40 in. being quite common.

Calluna and Molinia mixed.—On this vegetation type, 12 in. of peat on clay, growth for the first three years is rather slow, the shoots averaging two or three inches per year. As the trees become more firmly established the growth becomes more rapid, shoots varying from 10 to 12 in. After 10 years of growth trees planted on this mixture have attained an average height of 6 ft. Growth in 1937 averaged 20 in.

Calluna.—On pure *Calluna* I have found growth to be very slow but varying according to the depth and quality of peat on which the spruces are planted, although the check period is much the same. On the shallow type, 4 in. of peat on clay, the check period was 5 years. During this time the trees grew slowly, adding scarcely half an inch per year. After this the yearly shoots increased until after 10 years they have reached a height of 3 ft. Their colour now is a lovely dark green and they look capable of vigorous growth next season. On deeper black friable peat 2 ft. in depth, well-drained, the total height is 4 ft. per 10 years although the check period is the same—5 years.

Calluna and Scirpus.—On *Calluna* and *Scirpus* with 4 in. shallow peat on clay, growth has been extremely slow. During the 8 years' check the needles were abnormally short and the colour of the trees a very light green. By this time the neighbouring trees had grown to a height of 10 ft. and I believe this shelter had a great deal to do with their recovery.

On the deeper *Calluna* and *Scirpus* the peat is over 12 ft. deep and is composed mainly of decayed sphagnum. The area was turfed and planted in the usual way during P.31 with S.S. On a small portion of the area a 4 oz. dressing of basic slag per plant was applied. At a later date a certain number of drains were deepened to about 3 ft. The plants on each side of the drains showed a marked improvement, but very little change took place among plants in the interval rows. During 1935 more drains were deepened and the excavated peat placed round the plants. This last treatment seemed to have great effect as the majority of the plants came out of check during 1936.

THE LAY-OUT OF TURF DRAINS.

By I. MACDONALD.

Turf-draining is at present being carried out on a large scale in Northumberland, and I would like to describe the lay-out of the drains.

The area is first of all surveyed, and major rides, minor rides, roads and paths are marked out on the ground with pegs branded Mar, Mir, R and P respectively. The major rides are surveyed so as to run in the direction of the prevailing wind and along these rides at 10-chain intervals and running at right angles we find minor rides, which are extended for 25 chains to the next major ride. This produces rectangular compartments of 10 × 25 chains (25 acres), which give the whole area a kind of blocked appearance. Roads 25–35 ft. wide and paths 10 ft. wide then intersect these compartments. The first thing to be done therefore on a new P. area is to cut 2 drains 30 ft. apart for the major rides, the turfs being spread out 5 ft. apart on the plantation side of the drain, the actual ride being kept clear of turfs. The same operation is repeated for the minor rides. Then the roadside drains are made and the turfs spread out in the same manner as from the roadside drains. These road drains are more difficult to cut than ride drains as they are seldom straight and often follow the contour.

Paths may be put on existing tracks on the hill or wherever most convenient. All our rides, roads and paths being cut, the area is well broken up, and we carry on with our ordinary draining. First of all it will most likely be necessary to open up some existing old drains which we may call leaders or main drains; it is seldom that turfs can be got from these existing drains. Into these leaders we run our new drains. These drains are aligned so as to run with the contour, or at least across the slope of the hill. They must have as little fall as possible, and yet sufficient to keep themselves clear. The main reasons for this are to catch as much seepage water as possible and to prevent quick washing-out of the drains after heavy rainfall, with consequent loss of mineral soil. The new drains are cut 20 ft. apart, have a 20 in. top, and vary in depth from 6–18 in. according to the nature of the soil, the 18 in. drains being made on peat areas.

The method adopted for laying-out new drains is first of all to line out the drain with a length of cord. The length of drain may vary from a few links to several chains according to the lie of the ground. The drain is then cut 20 in. in width and cross-cut every 15 in.; this gives us the exact number of turfs required for two rows of inverted turfs on each side of the drain. The operation is repeated, and so on until the piece of ground being worked is covered by turfs, 5 ft. × 5 ft., and parallel drains at 20 ft. apart. In order to expedite the laying-out and also to keep the turfs regular the cord may be set for the second row of turfs, the first row being sufficiently near the drain to be lined straight with the eye. For measuring between the drains and turfs a 5 ft. stick is found very useful. The more regular the turfing and draining is carried out, the easier the planting and subsequent weeding are done.

DEER, FOXES, ETC., IN DIVISION I.

By W. Forsyth.

Foresters in Division I were circulated and asked to give the numbers of deer, foxes and badgers in their units and to state opinions regarding the increase or decrease of these animals, also to make any general observations concerning the fauna in their unit. The following is a summary of the returns.

There were no red deer, but 7 fallow deer, five at Harwood and one each at Allerston and Hamsterley. Roe deer numbered 39, all in the border units of Kielder and Redesdale with the exception of Chopwellwood and Rothbury where there were 8 in each unit and at Slaley where there were two. That there were 8 roe deer in Chopwell, which has an area of approximately 800 acres and is situated in a densely inhabited district, is rather surprising.

Foxes numbered 414 and of these 200 were returned for Redesdale, where the Forester reports that they have increased considerably during the past two years owing to the hunt being unable to go over the ground where there are turf drains. Forty foxes were returned for Thornthwaite and 20 for Ennerdale. Eleven of the twenty-five Foresters submitting returns stated that foxes are on the increase, due to the protection offered by the plantations and owing to the local hunts being unable to go inside the woods on account of the dense growth and in some cases presence of wire fences. Another reason for the increase is that the surrounding country is hunted and the foxes make the forest their retreat. Only two Foresters reported that foxes are on the decrease owing to systematic shooting by gamekeepers. Twelve reported that the numbers show no change.

Eighty-eight badgers have been returned as found in the Division, twenty at Allerston and sixteen at Ampleforth. Three Foresters reported that they were on the increase and there were no badgers present in thirteen of the units.

In no case was damage by deer reported to be severe and in all forests where damage was done trees of 3 to 5 ft. were attacked, the main species being Douglas fir, European larch and *Pinus contorta*. There do not appear to be any definite sources from which the deer have come on to the units; in some cases, such as Kielder, they were there before the Forestry Commission took over, but in most cases they have come in from neighbouring estates. The American grey squirrel was reported from Allerston.

From the above information one may draw the conclusion that unless steps are taken or natural enemies appear, foxes will go on increasing. It is reasonable to assume too that when the plantations get to the thicket stage roe deer will increase. The fact that at Rothbury and Chopwell, both with considerable areas of trees over 20 ft. high, there are eight roe deer in each, suggests they they may multiply in other units when the crop reaches sufficient size to afford protection.

TRANSFERRING OF FOREMEN AND GANGERS.

By W. L. McCavish.

Many will have experienced, upon being transferred to another area, that there is a lack of information about it, and this is a great drawback.

Each Foreman or Ganger is generally placed in charge of a certain area of the forest termed a beat and he receives his instructions from the Forester. When a change is made and a new man arrives the Forester usually shows him over the area which is to be in his charge, but this is not sufficient to enable the Foreman to follow on as though no transfer had taken place, as should be the case.

The new man is supplied with a map of his area to enable him to find his way from place to place, but this does not enlighten him as to the conditions of his compartments, a knowledge of which is essential for nearly all operations. For example, it is difficult at the commencement of the weeding season, especially where older crops have recently been beaten-up, perhaps in patches, to know exactly what to do, and he may very easily be the unintentional cause of a number of deaths due to lack of weeding.

It would therefore be a good plan and a great help if each Foreman or Ganger obtained a copy book from his Forester and entered data concerning the following items, and revised the record annually.

Most men in the employ of the Forestry Commission are acquainted with the method in which the Store Ledger is made up; this information laid out in the same method would do away with re-writing the headings annually and also leave room for a number of years' entries to be made in the manner shown on page 120.

I am sure this method would enable a new Foreman to become acquainted with the area in his charge much more quickly.

Foresters might benefit from information such as :—

(i) Preparation of Estimates for the following year;
(ii) An aid in preparing the census of plantations;
(iii) A running record of the condition of the compartments.

The book could be handed over to the Forester on a Foreman being transferred to another area.

Original Crop.					F. U. B.			Compartment Description.	Observation Notes.	Protection (Insects, Fungi, Vermin, Game, Snow and Fire).
Compt.	Sub Compt.	Spec.	P. Yr.	Area.	Spec.	P. Yr.	Area.	Vegetation and Number of Weedings needed.		
				Acres.			*Acres.*			
1	A	S.P.	29	16—	C.P.	36	6—	Bracken and heather in open spaces, other vegetation dying out. 1 weeding needed.	Badger earth in S.W. corner.	Attack of pine sawfly, noticeable along west side. (Larvae hand-picked).
	B	J.L.	29	12—	Established.			Grass and bracken. No weeding needed.	Constant watch must be kept for growths of honeysuckle.	Nil.
Revised 30*th Sept.*, 1938	A	S.P.	29	16	C.P.	36	6	As P. 37. 1 weeding needed.	Young badgers observed, 7th May.	Damage by snow. (Many trees staked.)
	B	J.L.	29	12	Established.			Same as P. 37. Bracken in a drawn up and etiolated condition.	Fox observed twice, when upon an inspection.	Occasional lateral branches broken by snow of preceding season.

NURSERY WORK AT HALWILL FOREST.

By C. R. WELLINGTON.

Land in this district is exceedingly difficult to work owing to underlying clay and a day's rain can upset operations in the nursery for a full week.

Tilth is therefore difficult to obtain ; in an average year the late spring has proved to be the best time to work land hereabouts and the seasons are therefore late for forestry operations.

All weed growth is very heavy, the chief of which are spurry (*Spergula arvensis*) known locally as devil's beard, couch grass (*Agropyrum ripens*) and sheep sorrel (*Rumex acetosella*). Spurry is quite a problem as this weed, incidentally, shows only after cultivation of soil, or in lesser quantity, coming through poor grass leys which have been poached by animals in winter grazing. It has been known to germinate after permanent pasture has been ploughed up, after intervals of 20 years. It would seem therefore that the weed has very lasting germinating powers, considering it is only an annual.

The best deterrent for spurry that has been found here is the use of Bude sand, obtained off the sea front at Bude, Cornwall. This sand is used widely by agriculturists for checking the weed as well as for manurial dressing. I have endeavoured to obtain conclusive evidence as to the element contained in this sand for which spurry has a dislike; I had suspected salt, but while in conversation with an old agriculturist in the district he informed me that an experiment was laid down on his farm some years ago, using agricultural salt and Bude sand separately, with the result that the agricultural salt had no apparent effect upon spurry in any way.

I would suggest that the sand has the effect of holding the soil open for aeration, but it would be interesting to obtain a chemical analysis as this sand has proved to be of great value where nursery work is undertaken, both for manurial purposes and for non-caking of heavy soils, and is outstanding for its cheapness. It also has no harmful effects on seedlings when used as a covering.

Seasons.—Seasons here are much later than most districts and the land lies low and wet. As stated above, tilth in average years does not come readily before the spring sun has warmed the ground. Okehampton, 12 miles N.E., and Bude, 18 miles S.W., begin the tillage season some 3 weeks earlier than Halwill. Seed has been sown here as early as February and as late as the second week in June (1937).

The later work has shown the best results, particularly with seed. The heavy autumn rains of 1936 made land overlying clay subsoils sour and heavy and consequently earlier work of sowing and lining-out became under-aerated; it is not possible to hoe between lines when land is well-soaked. Referring to *Nursery Investigations* (Commission Bulletin No. 11) on early sowing and lining-out, in practice earlier work in our

nurseries at Halwill has proved definitely inadvisable unless the season is specially favourable. As is the case with all forestry operations, times of various works connected with forestry and nursery practice are best suited to local conditions; various experimental work, which becomes generalised, loses much of its intended value when applied to distinct localities or forests.

Operations.—Plants for lining-out or re-lining are graded when lifted into the three recommended grades—I, II and III—culls or doubtful plants coming into the third grade group, these being heeled-in and their subsequent use determined by the District Officer. In the case of large plants allotted to Grade III through frost damage to leaders, it is quite worth while to prune plants of this description and line-out, irrespective of age. Small batches have been dealt with at Halwill in this manner with good results, especially Sitka spruce or Japanese larch, which have good recuperative powers and put on a good leader in the growing season after lining-out. Pure molinia grasses are used by digging-in, using the lining-out operations, the method being as follows :—after the trench is dug and boards in position, the roots are covered with soil to a depth of 2 in. to 3 in. molinia spread over and the trench filled up.

Molinia experiments have been tried with controls of untreated ground; these show a marked increase of root growth as opposed to untreated plants, root growth being on an average twice the length and much more fibrous. Heavy type land works better after heavy applications of molinia. Farmyard manure is also used for lined-out plants at the rate of 10 tons per acre. For lasting fertility I much prefer farmyard manure, but the effects of molinia grass applied in good quantities would, with the use of say, basic slag or lime in the second year after application, uphold a good state of fertility. Providing good fertility of soils are practised with the use of farmyard manure, basic slag, lime, superphosphate, etc., green cropping could be put down once every 5 years.

Seed Sowing.—The usual gear for this operation consists of a roller for drilling, covering boxes to hold leaf mould, sand, etc., for covering, and scoup trays made of galvanised iron, which slip their contents better than wooden ones.

Various coverings to prevent caking have been used, consisting of sieved leaf mould, coarse sand as used for building, large chippings and Bude sand. Bude sand has the advantage over large, coarse or silver sand, leaf mould and chippings, in that it holds the moisture much better in drought periods. It has been found that the seedling crop suffers from wilt in drought times by using coarse chippings even when beds are lath-sheltered before germination. Bude sand costs 12*s.* 6*d.* per ton delivered locally; it is cheaper than other covering material available and works well from covering boxes.

Seed is sown from tins, each pressed in at the mouth to form a lip, and when accustomed to the density of sowing, the men become proficient with this method both in speed and uniformity of seed spread.

Manuring of seedbeds is done with farmyard manure, molinia, artificial manures, and watering with liquid animal manure. I do not recommend the use of the last, which encourages damping off; I could not say what effect liquid manure would have on lighter soils, but in my own experience it is not good for heavy soil.

Protection of Seedbeds.—Lath shelter is used together with conifer brushwood. In a wet winter and on heavy soils the one drawback with the use of lath shelter is drip which can do a considerable amount of damage, and is sometimes mistaken for frost-lift. Laths have the advantage of cheapness in removal for summer shelter as opposed to brushwood, but for winter work I prefer the latter, using pegs running along the centre of the bed longitudinally, and one single strand of fencing wire strained along brushwood stuck in each side of the bed to meet the wire and so tied up.

Another way of protecting beds is by using 1 in. planking with legs attached for inserting in the ground and lath shelter rolled out on the boards; this is, I think, quite the best method of protecting beds, but it has the disadvantage of being expensive. Where this method is in operation it is most important that the boarding does not make contact at ground level, and large stones or wooden battens should be inserted under the boards to stop sinking, otherwise damping-off will occur. It is quite safe, I have found, to let air currents circulate, and the boards will prevent frost-lift.

Weeding.—The first weedings of seedbeds, owing to prevalence of spurry is practised by blow lamp method as advocated by Duthie (*see* Bulletin 11). The beds are gone over at the 7th or 8th day after sowing and again in 9–10 days. Care is required in this operation as a powerful lamp will penetrate seed covering if played on a section too long. It is advisable to do the operation twice or even three times lightly, but in no case, when dealing with well-soaked spruce seed, after the twelfth day. This method of destroying weed growth in young stages has proved very effective on beds which if weeded by hand after seed germination would cost as much as 20*s.* per 100 sq. yds. There is also some loss from seed being inadvertently pulled up with the weeds.

CHECKED PLANTS: CULTIVATION AND SLAG.

By W. E. JONES.

Wilsey Down Forest is an area which suffers from "plant check." It lies on the north coast of Cornwall, 800 ft. to 900 ft. above sea-level, and is very exposed, being a typical example of the wild wind-swept Cornish moorland without any kind of shelter. It suffers in turn from flooding and drought and the presence of salt air. The vegetation is dwarf gorse, calluna, heaths, molinia, *Agrostis*, *Potentilla*, *Scirpus* and milkworts; the soil is largely a fibrous peat of two inches to four inches over a peaty loam of 3 inches to 5 inches over a hard-packed skillet 5 inches to 6 inches overlying greyish brown clay; there are also traces of an iron pan and the soil in general is very hard and close which makes it difficult for the roots of plants to penetrate. In 1932 it was decided to continue basic slag experiments on a small scale and in 1933 by wholesale sowings, and the following is a short table of the response shown to wholesale sowings of 2 oz. per plant.

	Basic Slag sown.	—	1932 Shoot.	1933 Shoot.	1934 Shoot.	1935 Shoot.	1936 Shoot.	1937 Shoot.	Remarks.
			in.	*in.*	*in.*	*in.*	*in.*	*in.*	
(1) P. 32 S.S.	October, 1933.	Average of 10 trees on best part of area.	1¾	¾	1⅜	7⅛	6¾	9	Slag sown 1 year 8 months after planting.
		Average of whole area.	1½	½	¼	1½	2⅝	5	Slag sown 1 year 8 months after planting.
(2) P. 33 S.S.	September, 1933.	Average of 10 trees on best part of area.	—	2¼	1⅝	7¾	6¾	7¼	Slag sown 7 months after planting.
		Average of whole area.	—	1¾	1⅛	3½	3	4¼	Slag sown 7 months after planting.
(3) P. 34 S.S.	March, 1934.	Average of 10 trees on best part of area.	—	—	1½	4	6½	9¼	Slag sown immediately after planting.
		Average of whole area.	—	—	1½	2	2	3½	Slag sown immediately after planting.

As the P. 32–33 areas were not treated until September and October, 1933, and plants seldom respond to slag until 12 months after sowing, this would be too late to affect the 1934 shoot and therefore after a gradual falling-off in the growth of the current shoot each year the 1935 shoot shows a fair response to the slag, which continues; growth in general was less in 1936, but the wet summer was largely responsible for this. As the above table shows plants will respond fairly well even when sowing is delayed for 2 years, but to avoid the initial falling-off it is best to treat immediately after planting.

As it was not known in 1934 how many years the effect of slag would last and whether it may wear off and the plants fall back in check again it was decided in November of that year to try soil cultivation to maintain and, if possible, increase the effect, and various experiments have been tried such as: mound planting with drainage pits, spit soil mounds,

spit soil and turf mounds combined, and deepening mound drains to various depths from half a spade to 2 ft. 6 in. and scattering the excavated soil over the surface between the drains.

Taking the deepest as an example, an acre was marked out in P.32 S.S., part in a small area which was slagged on alternate rows in April, 1932, and part in the wholesale slagging of October, 1933; alternate mound drains were deepened to 2 ft. 6 in., a good spade's width in the bottom and 2 ft. 6 in. wide at the top. The excavated soil was spread over the surface to approximately the same depth as the mounds and reaching to the third row of plants on the one side of the drains only and leaving the other side free of soil, with the following results.

P. 32.	S.S.	1935 Shoot.	1936 Shoot.	1937 Shoot.	Colour and Appearance.
		in.	*in.*	*in.*	
(*a*) Slag-sown April, 1932, immediately after planting. Alternate rows.	Slagged plants in scattered soil area.	3	10	10¼	Dark green, good.
(*b*) Ditto	Slagged plants in non-soil area.	2	3¾	4¼	Light green, fair.
(*c*)	Non-slagged plants in scattered soil area.	½	1½	1¾	Green, rather poor.
(*d*)	Non-slagged plants in non-soil area.	½	½	gone back, not measurable.	Yellow, very poor.
(*e*) Slag-sown October, 1933, nearly 2 years after planting. Wholesale sowings.	Slagged plants in scattered soil area.	2¾	7¾	11¼	Dark green, good.
(*f*) Ditto	Slagged plants in non-soil area.	1½	2½	5	Light green, fair.

The object of these notes is to point out that on areas where conditions are the same as described above and check is experienced, whereas soil cultivation only, or slagging only may keep the plants out of check, movement is slow and a combination of both is necessary to get anything like nominal growth.

While (*a*) was slagged immediately after planting and (*e*) was not slagged until nearly 2 years after planting, the delay of slagging has not prevented the plants from recovering and both are now growing normally as the result of soil cultivation and slagging. Having decided this was the solution of the check problem, tractor ploughing was carried out in 1936 on a large scale both for new planting and for the ground between the lines on areas already planted.

TAIR ONEN NURSERY.

By R. E. PALLETT.

As the above Nursery has only been brought into cultivation during the last year and a half, some notes on the main problem will, I hope, be of interest. On acquisition early in 1936 the area was divided into 4 fields, as follows :—

N.-East	.. ..	Root crop.
South	.. ..	Fallow.
N.-West	.. ..	Bracken and scrub.
S.-West	.. ..	Pasture.

The area of land intended for cultivation was 56 acres and this has been extended recently by the taking in of a further 6 acres. This 6 acres was covered with grass/bracken and gorse. The soil in the South-east field is shallow, the rock almost outcropping in places. The soil is now porous and becomes very difficult to work in wet weather.

Except for some stony patches in the North-east field the soil is deeper, more open and consequently better to work.

The area is situated on a gentle slope, the highest point being 421 ft. and very exposed to east and west. As the land came to hand it was mapped out in sections 200 ft. long by 100 ft. wide. The alleyways between each section are 5 ft wide (since reduced where possible to 3 ft. wide) and each group of 6 sections is surrounded by a 10 ft. roadway.

The 10 ft. roads over which we expect to get the most traffic have been metalled, the work being done by direct labour. We are lucky enough to have a quarry of our own at Tair Onen from which we extract our metal. Several hundred tons were also extracted from the South-east field which was used for roadwork. The cost per chain of metalling a 10 ft. road with an average depth of 8 in. of metal is £6 10*s* 0*d*. A further £1 per chain can be added for cost of " blinding " with ashes at 4–6 in. deep.

Broom seed has been sown along the north and east sides of the 10 ft. roads and will, we hope, give us a quick if only a temporary shelter. Beech hedges have been planted along the south and west sides of the 10 ft. roads and will give us our permanent shelter.

On the more exposed roads shelter is being obtained by planting cuttings of *Salix daphnoides*.

Treatment of Pasture.—The treatment of the pasture was one of our main problems, and the area to be dealt with was skim-ploughed in the early summer of 1936 and left for the turf to rot. The summer proved to be a favourable one for the rotting of the turf. After ploughing there was a period of drought followed by wet weather, when sufficient rain fell to hasten the decay of the grass. After cross-ploughing, cultivating, cleaning and harrowing, the field was fallow and ready for lining-out.

The extension area has been dealt with during the past summer; this season, however, proved to be less favourable. The area was skim-ploughed by tractor and left, and although we had a period of fine weather the rain did not come early enough or in sufficient quantity to cause the grass to decay enough to permit of early cross-ploughing. Consequently we could not cross-plough until November, and even then it could only be done successfully where the grass crop had been browsed down by rabbits. I do not anticipate being able to cross-plough the balance, which is unfortunately the greater part of the area, until about January.

Inoculation of Seedbed Area.—For various reasons it was not found possible to start any nursery work until mid-March, 1936, and consequently only a comparatively small area could be lined-out. However, about 3 acres were lined-out, which gave us an area inoculated with mycorrhiza and available for seedbeds in F.Y.37.

The above area was lined-out in the South-east field and, as mentioned before, the soil was of a sticky type. Before seed sowing the area was given a dressing of peat to help to make the soil more open, more workable, and to raise the humus content. Basic slag was also applied to the area at the rate of 6 cwt. per acre.

The whole of the available area was sown mainly with various conifers, but also some hardwoods during F.Y.37. The results have been good; E.L. seedlings range in height from 4–7 in. and D.F. from 2–6 in., while other species have grown well in proportion except for a patch of J.L. which was sown at double density and came up very thickly. An interesting feature is that where J.L. was sown on ground that had previously been lined-out with Lawson cypress, the results in height growth were definitely poorer than elsewhere. The height at the end of the growing season was only about 1 in. Another interesting point is that where N.S. seed was sown on an area that had been lined-out with ash and sycamore the crop is quite good and compares well with other N.S. seedlings growing on an area previously lined-out with S.P.

Lining-out.—As all the labourers were unskilled, lining-out had to be done with boards. Over 8,000,000 seedlings and transplants were lined-out in F.Y.37, and the weather could not have been much worse.

Senders of seedlings for lining-out helped me by grading before sending, and I was able to get on faster by not having to do this. Grading of stock is, I think, important for the following reasons :—(i) in stocktaking you have a better chance of stating sizes more accurately; (ii) it enables you to lift whatever size of transplant is demanded without having to comb, say, 100 plants to get 20 of the size asked for and having to leave the balance heeled-in for long periods before getting further demands; (iii) in species like N.S., the second grade plant, in any case, almost always becomes +2 before it is tall enough to be planted out into the wood and these grade two plants can then be lined-out into beds when they will not interfere with the rotation of nursery cropping.

Seedbeds.—The F.Y.37 seedbed area was in a very wet condition until just before seed-sowing time. As soon as it could be ploughed this was done with the Auto-culto. When the soil was dry enough the Roto-tiller was used to cultivate the soil in front of the seed-sowing gang. This machine saved pounds in preparation of ground for seedbeds, and where large areas have to be sown quickly I know of no better machine for carrying out the cultivation.

Pests.—We have already had damage done by *Melolontha*, a considerable number being found in our North-east field and some also in the South-west field, following root crop and pasture respectively. Some damage was done to larch and N.S.; losses were high in patches, but not serious generally. A few *Rhizotrogus* have been found but they were not numerous enough to cause serious damage.

Wireworms were there in great quantities but were mainly confined to the pasture field. These did some damage to the roots of broom seedlings just after germination, the damage being sufficient to make a second sowing necessary. Leather-jacket damage was seen in seedbeds, but this was almost negligible. *Meria* was unfortunately introduced by imported stock and most of my stocks of E.L. suffered.

WORKING PLANS AND RECORDS.

By L. A. NEWTON.

Some apology is necessary perhaps for writing an article in the Journal on the above subject. Working Plans and Records have been regarded by many as hardy annuals pricked out for blooming at Divisional and District Officers' Meetings; the inflorescence has never been remarkable for abundance or beauty. Alternately encouraged by Headquarters and blown upon by the cold wind of District Officers' excuses, the amount of achievement has been moderate only. And yet the subject is one of considerable importance—a fact which can be better realised perhaps by a District Officer of moderately long service than by anyone else.

I have one other apology to make. As I wish to give my own experience—for what it is worth—I shall have to write in the first person. I shall endeavour to compress my observations into as short a space as possible. I believe that I perpetrated the first full-blown Working Plan for the Forestry Commission in Scotland. I was given a forest of 7,000 plantable acres (*vide* Acquisition Report). I reduced the plantable acreage to 1,600 acres and wrote a full discourse on the subject with appropriate schedules in accordance with "Technical Instructions" of the day. That was in 1920–21. Since then I have produced several other full-length documents for other forests. Where are they now?

Changes of policy involved wide changes of prescription—as also did increased knowledge. New District Officers had their own ideas and did not in the least want to be hampered by the opinions of a predecessor, and the trouble of altering prescriptions involving, as it must, alterations in numerous schedules of figures is greater than writing an entirely new plan.

The full procedure with a Working Plan includes its preparation by a District Officer, its passage through the Divisional, Assistant Commissioner's and Headquarters' Offices and its return adjusted and approved to the District Officer. I do not know of any Plan in those early days that ran its full course. In fact I recently came upon a minute emanating from the Assistant Commissioner's Office in Scotland in about 1926 recording that very fact. A number of Plans prepared prior to that date in Scotland had never received the Official stamp. I will make only one further dip into history. A Plan was prepared in very great detail by my predecessor in a forest in England. It was worked for one year by him. At the end of the year the T.10 recorded such wide divergences between prescription and performance as to suggest that the detailed prescription for individual years had been a waste of time, although I think in fact that it was certainly not so. During the years that I had charge of that forest I tried to adjust the work in such a way as to reduce the divergencies; but, against this, I recommended that a considerable area should be transferred from one Working Circle to another—a recommendation which I understand was subsequentl y adopted. This alteration mus

have completely dislocated the detailed schedules which had been previously prepared. In spite of these disappointments in the past I am unrepentant in my belief that Plans of a different character and Records (especially Records) are essential.

At the present stage of the Commission's history the Plan and Records for each forest should be contained in a file or files, readily accessible, these files to contain certain separate material documents without any attempt to weave them into a concerted whole—which attempt would be certain to lead to much verbiage and repetition.

The preparation of files of this nature is already officially required. It will be convenient to enumerate first of all what can be left out of such a file :—

1. *Objects of Management.*—Obviously to grow the most suitable species to perfection and sell them at a convenient age in the best markets.

2. *Rotation.*—This can be best left to our successors.

3. *Tenure, Physiography, Geology, Meteorology.*—There can be seen at any time by reference to the Deed file (to be incorporated in the Working Plan file—*see* below), the map, the compartment descriptions, and local knowledge aided by the Acquisition Report.

4. *Order of Felling.*—A subject that cannot possibly be settled yet.

5. *Markets.*—Future markets cannot be forecast.

6. *Labour Supply.*—A matter for the resident forester to adjust to his programme.

7. *Allocation of Area.*—The compartment map, prepared at the earliest opportunity, would deal only with areas to be afforested.

8. *Rate of Working.*—A matter to be seen at once from the five-year plant requirement forecast or the T.10.

9. *Protection.*—Fire protection is already provided for in the standing Fire Plan. Provisions for other protection can be passed by word of mouth from one forester to another in two minutes.

10. *Establishment and Housing.*—Staff returns and lists of F.W. holders are available already.

The type of Working Plan currently required in the majority of the Commission's areas can safely leave out the paragraphs which I have enumerated above from 1 to 10 because the matter contained in them, when necessary, is already incorporated in documents which I now propose should be contained in the Working Plan file.

These documents are :—

(*a*) Copies of all deeds or agreements relative to the forest.

(*b*) Acquisition Report.

(*c*) Map.

(*d*) Compartment descriptions. It is of great importance to divide up the forest, or at least the block of it which is being currently treated, as early as possible into compartments both on the map and on the

ground. The aggregate of the areas of these compartments will equal the area of the forest, or proportionately of the block, as settled in the Acquisition Report or Disposition. The total area will be to the nearest acre and the area of each compartment will be adjusted to the nearest 5 acres, so as to secure the required total.

Anyone who has had to correlate the area which has already been claimed as planted in some of the older forests with what is left to plant will appreciate the necessity of this.

(*e*) A schedule showing vertically the total area of each compartment and horizontally the area in each compartment to be placed under acquired plantations, or separate P. years, or to blanks. For the last, or blank, column the area will be entered in pencil as it is liable to be changed. The absence of an entry in the blank column shows that the compartment is completed.

(*f*) (Not essential but desirable) a schedule similar vertically to (*e*) but showing horizontally the acreage of separate species in each compartment.

Paragraphs (*a*) to (*f*) above deal mainly with records. I have found (*e*) and (*f*) specially valuable for ready reference.

I now pass to paragraphs dealing mainly with prescriptions.

(*g*) Form T.10. This is essential. It should be kept up to date for 6 years ahead. Contrary to present practice the figures entered for planting programme for the next five years should be allocated, on the T.10 Form, to individual compartments instead of being left in the air, as it were. This is important for the following reason. I have several forests in my district where the planting is nearing completion. Those responsible for the earlier years prescribed, say, for first year 50 acres, second year 100 acres, third 100 acres, fourth 100 acres and so on. For no doubt good reasons, planting fell into arrears or was accelerated so that the performance after some years differed from the prescriptions by perhaps 150 acres. A new District Officer taking over finds that he has still, say, 250 acres available for planting and makes his prescriptions accordingly and possibly adheres to them. The resulting sum of the total prescriptions differs by a large figure from the total area of the forest and the T.10 as an historical document is unintelligible.

If, on the other hand, the T.10 prescriptions are detailed by compartments, divergencies can easily be recorded in the last column and the T.10 becomes a useful record.

(*h*) Plant requirement forecast. This form can be made up for 5 years ahead and the plants should be allocated to individual compartments. This makes the form far more useful for annual confirmation or amendment.

(*i*) Three years thinning programme. The present state of the Commission's forests requires that the thinning plan should not be for a longer period than three years. Areas to be treated in any one year should be allocated as far as possible to easily ascertained blocks. The controlling form should be of the simplest and show in parallel columns :— the year of the work, the compartments to be treated, the acreage of

each species, the actual work done and finally the re-allocation of work not completed. The form, like the T.10, would be continuous, and therefore a record.

(*j*) Three-year programmes for fencing repairs and draining repairs. These forms would be extremely simple ones of three columns :—year for treatment, units to be treated (generally P. years), work completed.

(*k*) Form T.13. I would confine the entries on this form to a list of acquisitions or sales with dates and acreages, simply for convenient reference.

(*l*) Standing Fire Plan.

To the above forms should be added R.6 and R.7 which are called for by Headquarters. Personally I find Form R.7 valuable, but Form R.6 is of very little value as all the information it contains can be found in R.7.

There is, of course, a great deal more information that could be recorded with the Working Plan, but it is given elsewhere. When it is remembered that a District Officer may have as many as say ten units under his charge, each one requiring a large volume of current returns, it is obviously impossible for him to do everything that might be wished. Even as it is, the accurate keeping of a Working Plan file for each forest embodying the matter of paragraphs (*a*) to (*l*) is a formidable undertaking. I cannot pretend that all my forests are up to date in this respect. The schedule of compartment descriptions is specially onerous to prepare.

I have one other observation to make on the subject of Working Plans. Forests with mature woods will require felling and regeneration programmes. This will not be for some years for the majority of the Commission's forests. When the time comes I believe it will be found necessary to throw several forests together for this purpose. For instance, the whole of the forests in Fife will be worked together as one Working Circle in respect of felling series.

I was recently in Germany, where the importance of Working Plans was specially stressed. While admiring the detail of these plans I would recall the fact that the charge of an individual forest officer there is territorially extremely small.

In drafting out paragraphs (*a*) to (*l*) above, I have had in mind the collection of that information which would be most useful at present to a District Officer for current frequent reference and of greatest value to his successor.

SITKA SPRUCE.

By J. EDWARDS.

A good deal is heard in praise of Sitka spruce, and its usefulness on the west coast, where conditions appear to favour it, cannot be denied. From observations of the comparison of growth between Sitka and Norway spruce, of what might be called the mid-rotation age of 45 years, it occurred to me some years ago that the planting of Sitka spruce on a large scale in the uplands of Aberdeenshire would be unwise. The particular area I refer to is heather-clad hills above 1,000 feet elevation, and situated more than 30 miles from the sea. Experience during the past five years has led me still further to think that the results with this species will be disappointing. In a district where the growing season seldom exceeds three months, none of which is entirely free from frost, it seems reasonable to expect that the development and "ripening off" are certain to be interfered with to the detriment of the plant or tree.

To say that the Sitka spruce grows well in the same degree of latitude in America is hardly sufficient reason for supposing the same results will obtain here. It is doubtful if the conditions of humidity, exposure, etc. are similar here to that of the Pacific Coast. At the altitude mentioned, and in the part of the country I refer to, the climate is severe, and to witness the struggle the Sitka have, especially plants which protrude above the snow, under the almost "arctic" conditions prevailing here (often for months together in the long winter), it seems unreasonable to expect that such undeveloped stem and needle structure can withstand it. Gorse and broom cannot struggle against it and their ability to "ripen off" their foliage would be considered greater than that of Sitka.

In some sheltered situations even above 1,000 feet, Sitka spruces are growing and ripening off successfully, but it seems doubtful whether their increment will ultimately be greater than that of Norway spruce. It is certainly not the case in older trees found growing in the Cairngorms and Grampians. On the other hand, Scots pine and Norway spruce ripen off their foliage despite the short growing season. Often the height growth of both species is over by the middle of July, and by the time the first severe frost comes, usually about 10th September, they are able to withstand it. Very often the Sitka growth is checked early in the spring; by July they are recovering and commence new growth which is insufficiently ripened when the frost comes. Die-back does not occur on such a large scale as with the Japanese larch, but the growth is thin and the needles have a poor colour compared with the robust stem and healthy needles of the Scots pine.

Norway spruce is, of course, difficult to raise in heather, and for the first rotation at any rate is not a suitable substitute for Sitka, but ground at this elevation which appears wet, and where Sitka is often planted, can generally be made sufficiently dry by draining to be suitable for pine. The damage by snowbreak to Scots pine is often given as a reason for not planting it. Actually the damage to Scots pine above 1,000 feet

is negligible. At that altitude the snow is dry and the foliage does not become laden to the same extent. Our wire-netting fences give a good indication of where the effect of snow is felt most. On the high ground the snow is powdery and blows through the mesh, while lower down the snow is wetter and clings to the fence. Scots pine in this part of the country rarely suffer from snowbreak above 1,000 feet.

The quality of timber any given climate and country can produce should be the deciding factor as to the species to be planted. It is doubtful whether Sitka spruce under these conditions can give either quality or quantity. Increment cannot be large and it is questionable whether repeatedly checked and retarded growth conduces to good quality spruce. Certainly with Scots pine at this altitude large volume growth will not be obtained. It must be understood that the growth up here in the north-east of Scotland, especially above 1,000 feet, is altogether different from that of Scots pine in England, say at Thetford. Here the annual height growth would seldom exceed 9 or 10 inches and the resulting timber is good. I submit that the production of a clean Scots pine pole (or batten), giving a diameter of 5 inches at 30 feet, of close grown strong tough timber, is preferable to what can be expected from Sitka spruce grown under the climatic conditions that are experienced here. In addition the soil conditions 50 years hence are more likely to have been improved by the growth of the more penetrating root-system of the Scots pine than the surface rooted Sitka spruce. The acid conditions now obtaining will tend to increase with Sitka rather than diminish.

As to the mixture of Scots pine and Sitka spruce now being planted in heather on tractor-ploughed ground above 1,000 feet, I am of opinion that the Scots pine will have made sufficient growth to suppress the Sitka within eight years and the removal or cutting back of the Scots pine at that stage would be both costly and risky. If the climatic conditions are taken into consideration, the expected benefit to the plants from the semi-cultivated condition of the ground is likely to have more effect on the Scots pine than the Sitka spruce.

The ability of Sitka spruce to remain so long in check and yet keep alive tends to mislead one into planting it on difficult ground, but the expenditure on basic slag, time and labour in tending, may be such that the resultant crop is uneconomic; if so, the choice of a hardier, less exacting species must be justified. The quality of Scots pine timber produced in this cold climate is excellent, whereas there is no proof of the good quality of Sitka spruce timber grown in such a cold climate with a rainfall of about half that of the west coast.

BOTRYTIS CINEREA ON LARCH TRANSPLANTS.

By J. A. Lamb.

In this nursery during late July it was observed that the needles on the 2 + 1 European larch transplants (Ident. Nos. 34/89 34/90) were browning and *Meria* was suspected. Spraying was carried out during the season at definite periods to control and as a precautionary measure against the spreading of the disease. These affected plants were examined but no trace of *Meria* could be found, so further investigation was necessary.

Later, it was noticed that the shoots of the affected plants developed the bend usually typical of *Botrytis cinerea*. These plants were in a section having a northerly aspect, the soil loamy clay with good drainage, and the roots good and quite healthy. The preceding crop of tares and oats had been sown and ploughed in according to the usual cultural methods, so it was inferred that the source of the infection was not from the section. Adjoining this section, however, was an old weed dump which had been disturbed late in the spring, and which previously had lain dormant for a few years, and it was observed that potatoes were growing on this dump. When the main crop of potatoes had been lifted in the autumn 4 years ago some of the " smalls " had been placed here and ultimately buried with weeds during the following season, and these had lain undisturbed until this spring.

It is reasonable to believe that these old potatoes were the source of the infection, and it is quite possible that when the dump was disturbed in the spring myriads of spores had been released and carried by the wind on to the transplants.

To control the further spread of this fungus the plants were sprayed with Bordeaux mixture and plants whose leading shoots were affected were uprooted and destroyed by burning, as it is well known that a re-occurrence of this disease shows in succeeding years on larch plants whose leaders have been infected; side shoots are not so susceptible to this habit. These control measures up to the present appear to be quite successful as the remaining plants are green, and fresh growths have formed.

To prevent further attacks of *Botrytis* from such sources as weed dumps it is suggested that some treatment should be given to the weeds immediately they are put on these dumps and which will, in the future, be used as compost. The applying of some form of weed-killer lime shells or calcium cyanide should be carried out when the dumps are being formed with fresh weeds. This treatment may not sound economical but the turning over of these dumps to form compost can become a costly operation and the application of some substance, such as is suggested above, especially calcium cyanide, would be beneficial. The calcium cyanide would destroy the weeds in a very short time, form compost relatively much more quickly, reduce the cost in the number of times these dumps are normally turned over and also prevent any infection, such as *Botrytis*, from an organised substance which has not entirely rotted.

MISCELLANEOUS NOTES.

Preparation of Seedbeds with mixed Peat and Soil.

General.—In the preparation of seedbeds with peat/soil mixtures, the important feature appears to be the requisite state of firmness of the surface layers before sowing takes place. It has been found necessary to firm repeatedly the prepared layer by treading and raking until little impression is possible when the surface is pressed with a clenched hand. It might also be an advantage, especially where water is not readily available, to prepare the beds some time before sowing.

Method of Preparation.—To prepare beds where accuracy is required, the following procedure has been adopted at Kennington Nursery :— The seedbed is first roughly prepared, the surface being slightly raised as in normal practice. The top 3 in. of soil are then removed and part is used for mixing with the peat. The peat/soil mixture is prepared by measuring by volume the required proportions of peat and soil, and mixing well by turning several times, after which it is placed back on the seedbed, sufficient being applied to give a 3-in. layer after being firmed. In measuring the proportions for mixing, the peat is measured in a loose state after being pulverised.

Remarks.—During dry conditions, freshly prepared beds require attention to prevent drying out, and liberal watering is often necessary. Coarse sand is used to cover the seed ; this assists in retaining moisture near the surface of the bed. Seedbeds constructed with boarded sides are an advantage and afford protection against drying winds during germination. Boards 9 in. by 1in. have been found suitable. When lifting the crop, care is taken to retain the prepared layer on the surface. Preparation of the beds for successive sowings is effected by cultivating the prepared layer only with a bucco cultivator prior to re-levelling and firming.

W. G. Gray.

To find the Cross-sectional Area of irregular Shapes.

A rule is used on which the graduations are marked off (in inches) by the squares of the numbers, *e.g.* instead of 1, 2, 3, 4, the readings are 1, 4, 9, 16. Mark a point near the centre of the section to be measured and from it draw rays at equiangular distances, *e.g.*, 18 rays at 20 degree intervals. Measure each radial distance by means of the squared rule, add the readings together and multiply the result by a constant; the answer gives the cross-sectional area in square inches, or whatever the unit used. The constant depends on the number of rays and is found by the following formula :—

$\frac{\pi}{N}$ where N is the number of rays. For 18 rays the constant is ·1745.

This method is quite useful and has an accuracy of between $\frac{1}{2}$ and 1 per cent. It is not generally known and would, I think, prove useful to

anyone who has to find the accurate areas of cross-sections of logs, butts, etc., for experimental purposes. More accurate volumes could thereby be worked out from the figures obtained in Sample Plot work, etc.

F. G. Beasley.

Fire Beaters.

I have found the following a good way of making flat birch fire beaters. A forked birch or hazel stick is obtained with forks about 2 ft. long and having a 4–5 ft. handle. A piece of plain fencing wire about 6—7 ft. is also required. Two half hitches are made in the wire towards the centre and 9 in. apart. A half hitch should then be placed over each fork, pulling the forks together should they be more than 9 in. apart. The long ends should be brought down just below the fork, given one or two twists, and the ends of the wire left free for the time being.

Six or more strong bushy twigs of birch should be put between the forks, some each side of the cross wire, and the ends reaching 6 in. below the fork, and about 4 in. or 5 in. above the cross wire. The ends of the wire should then be brought up around the fork and the twigs, and twisted tightly. Tying wire should be used to make the twigs firm to the cross wire.

E. J. Tucker.

Useful Beetles.

A very useful beetle which should be encouraged but is often trampled underfoot in nursery and forest is the devil's coach horse beetle. This is a long narrow insect which assumes a menacing attitude when approached by curling its tail over its back. The violet ground beetle is about an inch in length and bluish-purple in colour, with flattened thorax which has two ear-like projections and it normally comes out at night to feed. These two beetles are very fond of nursery pests such as wireworms and leather-jackets.

S. Watkins.

Storm Damage.

Shallow, spreading roots just beneath the surface of the soil are characteristic of the spruce, and in pure spruce forests the roots of neighbouring trees interlock, forming a wide netmark, and lead to disaster in a windstorm.

Even a sudden gust of wind if it be of sufficient force may do much damage in a spruce forest. In cases where Scots pine have been mixed with the spruce, the spruce may come to grief and the lone pine will be seen standing erect, having defied the elements.

S. W.

The Merits of Turfing.

Turfing should not be regarded as an operation for planting and drainage only, but also for fire protection, weeding and beating-up. Much of the Commission's land bears molinia and when the sheep have been removed the danger from fire becomes greater each year. To minimise this danger, the co-operation of the District Officer and the Forester is necessary in laying out rides and new paths so that they run slightly up and down hill. Then all rides, paths, species and P.Year boundaries should be marked with a drain on the inside, and the planting line boundaries on the outside, so that water can always be available at these important places. With a little forethought a permanent supply can nearly always be found in the drains (*i.e.* having trapped springs, diverted streams and led water from the unplantable ground). The drains should be cut 18 in. wide and turfs put out in the usual way, and the spoil laid out below the drain (so that it does not get knocked into the drain when someone is crossing), and spread about 2 ft. wide from the edge of the drain, so that there is an unbroken line of spoil all along the rides. This makes a first line of defence 3 ft. 6 in. wide; the width of course varies, as does the height of the spoil, according to the depth of drain. Some parts of the drains will need extra deepening because of the knolls or they will have to be rounded and joined up again. The drains, therefore, serve the double purpose of good drainage and fire protection.

Turf drains also are useful but to a less degree. This method has been used at Hafren for P.37 and P.38 and instead of screefing fire-lines I propose to deepen the drains again at " danger " points and spread the soil as before. It is economical to use good turfs, which should be cut 16 in. square and 6 in. deep, and if this operation is done 5 or 6 months before planting, it will be found that 6 in. plants will do. I consider the 1+1+1 or the smallest grade of 2+1+1 plants are most suitable for use in turfs, as these usually have a good root system and will stand the shock of transplanting better than a 2+1 or 1+1.

The cost of beating-up is lessened if the above sized turfs are used, as they can easily be found even when overgrown with molinia. It is not necessary to do any weeding during the first year and even in the second and third years the turfs can be found without trouble, which naturally lessens the cost. I have seen men on their hands and knees when weeding and beating-up unable to find the turfs, which had been cut too small and thin.

H. Williams.

Recovery of retarded Larch.

Larch forming the majority of the surviving crop of mixed woods planted in 1884–1889, have shown an extraordinary increase in growth in the last 23 years.

This increase was noted by Mr. Guillebaud in 1923, the stem analysis being :—

Age.	*Height.*	*Average Height Increment.*
years.	ft. in.	in.
13	6 0	5·5
29	12 0	5·1
37	20 3	12·3

Stem analyses made recently have all shown this sudden increase at about 30 years and that this rate of growth continued afterwards. The last two summers have been cold and wet but it has made no appreciable difference. Diameter increment has also proportionately increased where the plantations have been sufficiently thinned.

The changed factors which might account for this are :—

(*a*) *Soil.*—Peat on poor loam with a subsoil of clay slate. There is a definite thin pan at 8 to 12 in. throughout the area. Recent windfalls show two distinct root systems; the original one which developed in the peat in the manner of spruce, and a more recent growth which penetrated the pan and developed in the orthodox larch manner. In some cases this secondary root system is three feet out of perpendicular with the stem. The peat layer has decomposed to such an extent that the original shallow root system is often laid bare, and where there is no secondary root system the trees die.

(*b*) *Surface Covering.*—This was originally heather and ling which has now given place to fine grasses, bramble, foxglove and mosses. It would appear that the increase in growth is coincident with the suppression of heather and its acid-producing activities.

(*c*) *Exposure.*—The effects of exposure have doubtless been minimised by the mutual protection afforded by the trees.

(*d*) *Pests.*—*Otiorrynchus picipes* is prevalent and this may have checked growth in the early stages and induced the forked and branched habit which is common.

(*e*) *Beneficial Fungi.*—Mycorrhiza development is now fairly active in all areas where trees are thriving. The soil in its original state is devoid of any trace.

The crop in this case was so poor at 25 years that it might have been termed ill-chosen and cleared accordingly, but the factors governing growth were then changing and might have been observed.

That such changes were followed by an increase in growth is beyond question and the crop is now satisfactory. It would seem that when the clearance of an unthrifty crop is contemplated, an investigation into the changes (if any) of the factors of growth which have taken place since planting, might indicate a likelihood of a plantation reaching a profitable (or saleable) size in spite of a poor record of growth.

B. Gale.

Forestry and First Aid.

A few months ago a somewhat serious accident occurred in my unit which seemed to show how desirable it is that someone with a knowledge of first aid should be included in each gang of workmen.

With between three and four thousand workmen employed by the Forestry Commission and this number increasing year by year it is quite evident that accidents will occur from time to time. These will in all probability include cuts, sprains, broken limbs, and bites from adders, any of which might prove serious unless attended to immediately. As most of the Forestry Commission work is carried out on lonely moors and on isolated hill-sides the difficulty of finding a doctor is greatly increased. As time goes on more machinery will be brought into use in the way of sawmills, power-driven cross-cut saws, ploughs, tractors, etc., all of which will tend to increase the number of accidents.

I consider that each squad should have at least one man who has undergone a course of first aid training. This could perhaps be made possible if lectures on first aid were included in the training of students at Forestry Schools. On areas where large numbers of men are employed this might prove insufficient. In that case lectures could be arranged during the winter months, and on smaller areas facilities given for at least one of the men to attend such a course of lectures.

Another suggestion I should like to make is that a rough stretcher be kept in all fire stations. In nine cases out of ten, especially where no old woodland exists, there is no means of carrying an injured man. This could be made from two pieces of timber 2 in. by 2 in. by about 8 ft. 6 in. long, joined about 15 in. from each end by a piece 2 in. by 2 in. by 2 ft. 6 in. long, the whole being covered with strong sacking.

W. Hodgson.

Frost Lift.

During the winter of 1935–36 a series of experiments was tried at Widehaugh Nursery in order to find if it were possible to reduce frost-lifting of seedlings to an absolute minimum. The species chosen was Sitka spruce drill-sown during the spring of 1935. The germination was bad and the seedlings were very thin and poor in the beds. The experiments used for covering these seedlings were as follows :—

(*a*) Lath shelters only.
(*b*) Double layer of lath shelters.
(*c*) Lath shelters covered with hessian.
(*d*) Rushes laid between drills and covered with lath shelters.
(*e*) Coal ashes spread between drills and covered with lath shelters.

From each of the above, three yards of the bed was selected where the seedlings were of the average density and when the first frost-lifted plants were noticed they were counted, pushed back, and marked with a

small ring of wire around the replaced seedlings. These were found to be on each plot :—

(*a*) 22	(*b*) 18	(*c*) 12	(*d*) 8	(*e*) 8	..	First time frost-lifted.
(*a*) 18	(*b*) 16	(*c*) 12	(*d*) 6	(*e*) 7	..	Second time frost-lifted.
(*a*) 16	(*b*) 15	(*c*) 11	(*d*) 6	(*e*) 6	..	Third time frost-lifted.
(*a*) 17	(*b*) 16	(*c*) 11	(*d*) 7	(*e*) 7	..	First time frost-lifted.

This all took place with a west wind as no lifting was experienced when the wind was in other directions. After the seedlings had been pushed back four times it was found at the end of the season the numbers which survived were (*a*) 18, (*b*) 12, (*c*) 8, (*d*) 7, (*e*) 7. So from these figures some idea of the losses amongst thirty sown Sitka spruce can be seen.

Experiment (*c*) gave the most trouble and was not a success as during wet weather the hessian caused a heavy drip to fall on the seedlings and when there was much snow the anchor pegs were pulled out with the weight. Judging from these experiments the lath shelter is the only one which I would recommend provided the germination is normal.

If any of the seedlings are frost-lifted they should be gathered up and bedded out, as a much better plant is produced than by constantly pushing them back, as no matter how carefully this is done a kink appears on the stem with the result that when lifted as 2-year seedlings they are apt to break. Again it is not always possible to push the seedlings back because the surface may be quite soft, whereas 1½ in. to 2 in. down it is still hard with frost in the ground.

C. McNab.

Wireworm Traps.

During the summer of 1936 it was noticed by the Forester that wireworms were numerous and doing much damage among 1-year seedling beech lined-out in the previous winter.

Sticks of rhubarb (12 in. long), being plentiful in the neighbouring nursery, were set like the billet traps for pine weevils. The result was amazing as the area was cleared of the pest in one month. The wireworms bored into the sticks and were easily found and as many as 90 larvae were taken from one trap.

C. M.

Thinnings in Ampleforth Forest.

The thinnings in Ampleforth Forest are in my opinion more difficult than in most units. The plantations in question were privately owned until acquired by the Forestry Commission in 1932. The dates of planting ranged from 1910 to 1914. Imagine a mixed plantation of S.P., E.L., D.F., S.S. and N.S. planted in 1910 which has been allowed to grow just as it pleases from the time it was planted until the present day. I am working on such a plantation now. To begin with it had

to be opened up by brashing. The first thinning seemed hopeless but after consideration it was decided to go through and do "A" thinning which was quite easy as the material to come out was mostly dead, suppressed and obviously diseased. When this has been done the plantation will have to be gone over again. This is going to be harder because we must not open up too quickly or the trees will fall down in the first gale, therefore we will have to have a crown thinning. We must also bear in mind during this second thinning that next year will see another thinning and so will the year after. The local sales for these thinnings are very slow, so that to preserve the quality of the produce thus prepared the thinnings have to be made into pitprops and fencing material. This is lucrative when you have the markets. In 1937, material of this sort showed a profit over expenditure.

There is also a slight demand for birch poles. A number of birch are growing in different places around here, mostly from natural regeneration and some of these were felled in 1937. They were cut into 6½ ft. lengths and spotted, that is small strips of bark taken off at intervals along the poles and on three sides, the diameter ranging from 2½ in. to 5½ in. They were left to season for about two months and were then sold to a factory for making brush backs, broom heads, etc. The average price for these was approximately 10*s.* per 100 running ft. The following figures show the produce and returns from four plantations during 1937 :—

Acres.	*Thinnings.*	*Pit-props.*	*Fence Material.*	*Expenditure.*	*Receipts.*
				£	£
19	5,025	3,355	Stakes 7,700 Strainers 1,000 Struts 1,080	230	396

F. W. Everitt.

Development of Corsican Pine at Rothbury Forest.

In P.25 and 26 Corsican pine were used to consolidate shelter belts, primarily to give support to other species such as spruce. In P.26 they were planted over an area of roughly 160 acres and occupied ground on the south-western boundary of the forest.

After studying the areas it is clear that a good deal of consideration had been given to the sites before planting. To have a mental picture of the ground, imagine an elongated carrier ridge, sloping to the south-west boundary with a stream, or a "burn" in these parts, at the base of the slope and the ridge itself rising abruptly to 800 ft. with a slight plateau, and falling again fairly steeply into a boulder clay basin. The vegetation is pure *Calluna* and the soil is thin peat over a bleached sandstone, with a "pan" varying from the surface of 4 in. to 15 in. The rainfall is about 30 in. per annum.

The planting was done by Schlich spade after screefing and using 2+1 plants.

Of the original crop there exist some 30 per cent. out of check, 20 per cent. in check, and 50 per cent. failures. The trees free from check came

away 8 years ago, and during the interval have produced 8 ft. average growth. There is every indication of this being maintained, judging from purely outward appearance of foliage, colour and vigour. The plants in check owe this to three causes :—(i) the roots being still in the tight surface peat, root development is checked by the humic acid and the subtle effects of physiological drought; (ii) lack of weeding; (iii) lack of drainage. In addition there is the proximity of the pan to the surface and the effects of insufficient aeration.

All the foregoing causes have made for failures—there was an invading fire in FY.26, which destroyed some 12 acres but apart from this did the surviving crop give the necessary confidence to use Corsican pine in beating-up ?

It was decided to screef the surface peat by mattock down to the mineral soil, cultivating and breaking the " pan " and to beat-up P.25 and the north-east slope of P.26 with Scots pine; the remainder of P.26 was beaten-up in 1935 with Corsican pine. The work has now been completed, giving a result of 98 per cent. developing crop. It was also decided to use basic slag (2 oz. per plant in check) to act as a fertiliser in the bleached sand.

Opinions as to ultimate success are varied and in the main sceptical, but the writer is sanguine that during the next few years the area will become " established."

N. Wray.

Skilled and unskilled Labour.

When I was transferred to a new area in Northumberland in June, 1937, my District Officer informed me that 900 acres had to be turfed and drained in preparation for planting in the spring of 1938. To carry out this work I estimated that between 40 and 50 men would be required until at least the end of the year. Being able to find only 18 local men, I had to obtain a further 28 men from the Distressed Area of Haltwhistle.

It is my intention to compare the cost of turf-draining between skilled and unskilled labour, the skilled labour being the local men, who have done various kinds of draining, and the unskilled labour being ex-miners from Haltwhistle, who had not done any such work before. The skilled men do all the draining as piece-work and are paid 1*s.* 2*d.* per chain, which includes the cutting and cross-cutting of the drains, the laying out of the turfs and the cleaning of the drains. On an average it takes 33 chains of new drains to give sufficient turfs, spaced at 5 ft. × 5 ft. to cover an acre; about 3 chains per acre of existing old sheep drains have also to be cleaned out for main drains or leaders, thus making 36 chains at 1*s.* 2*d.* or £2 2*s.* 0*d.* per acre.

The unskilled men have been on day-work, doing exactly the same type of work as the skilled men, but not nearly the same amount. At the end of the first fortnight, their drains worked out at 2*s.* 5*d.* per chain, *i.e.*, £4 7*s.* 0*d.* per acre and after several weeks' work the cost was reduced to 2*s.* per chain or £3 12*s.* 0*d.* per acre, which is still much above the cost

of the skilled men's work. These men are, however, improving rapidly and recently I gave some of the best of them a trial on piece-work, at the same rate as the skilled men, and they were quite satisfactory. In a short time I hope to have several more on piece-work which will reduce the cost per acre considerably.

I. MacDonald.

The Gale of February, 1937.

The gale came from the north-east and it is stated in the monthly weather report of the Meteorological Office that a mean hourly speed of 64 m.p.h. with gusts up to 107 m.p.h. were registered in the early hours of 28th February. Apparently it was then that most of the damage was done at Kielder; the gale had blown itself out by 8 o'clock. Only the north-west of Great Britain seems to have suffered to any great extent and there certainly does not appear to have been much damage east of Kielder; in fact Kielder caught the tail end of the gale.

There are probably three main reasons for the alarming blow out. In the first place the trees were mature and if it were not for their amenity value they would probably have been felled some years ago; they are mostly Norway spruce about 75 years old with a maximum height of 100 feet. The second reason is that the plantations have been neglected, they have been under-thinned and the stocking is irregular. The third reason, and probably one of the commonest reasons for wind blow, is bad drainage. When the Commission bought the property from the Duke of Northumberland in 1933 an attempt was made to improve the drainage of the existing woods and much good work was done with the old drains, but they had been badly planned and owing to growing roots it was found impossible to dig many new drains.

The February gale did a considerable amount of damage in all the older woods and in one young plantation of about 35 years. In the policies' woods alone probably 50,000 cu. ft. of timber was blown but this is a very rough estimate.

G. J. L. Batters.

Black Game Damage to Scots Pine.

Where black game are numerous a considerable amount of damage in young Scots pine plantations is inevitable. Such was the case at Smale Farm where Scots pine was planted during P.26. This area suffered repeated attacks, the terminal buds being destroyed each year until the S.P. resembled bushes more than trees. Each tree had six or seven leaders, was badly shaped, and looked as though it would never grow into anything useful. During one plantation inspection the Divisional Officer suggested that a plot should be marked out, the superfluous leaders cut out, and the side branches pruned to prevent the black game perching on them and destroying the buds. This operation was carried out last year before the black game had an opportunity to do any damage. Ordinary pruning

secateurs were used and care was taken not to prune the trees too hard. The result has been very gratifying as no damage has been observed on the treated plots; the trees have now one good terminal shoot and the average growth for the year is from 9 to 22 inches.

J. T. ANDERSON.

FIGHTING FOREST FIRES.

It is not possible to lay down hard and fast rules on fire fighting, as there are so many variable factors which affect the situation, such as the nature of the land, vegetation, dangerous zones and wind. The one essential is an organised plan, haphazard methods being merely a waste of time.

Let us deal with a fire in a young plantation; it is most important that any available assistance should be sent for immediately. The Forester should not spend his time fighting the fire, but should do the thinking and directing which are so necessary if fires are to be fought with the maximum efficiency. On arrival at a fire, an attempt should first be made to try to beat it out by driving it into a wedge shape. This should be done by having men concentrating on the flanks who would gradually edge the fire to a point. Should this method fail, the men should fall back to a fire-line or on to some definite line as detailed below. Fire-lines in themselves, unless very wide are of little value as fires will often jump them. In the absence of a fire-line some other line should be chosen, *e.g.* rides, the object being to prevent the fire crossing. Where water is at hand this should at once be put to use in soaking the ground. The " Hill " pumps and old sacks can be usefully employed. The importance of having small reservoirs made at intervals along fire-lines, boundaries and other strategic places may be stressed and the exact position of these should be clearly marked by driving a fence post, partly painted red, into the ground. In the absence of water it is necessary to beat out fires. Beaters should work with the wind; there is less risk of damage to clothing and person, and the smoke is not so suffocating, but on the other hand this is not always possible as it is often essential to work on the leeward side in order to prevent the fire spreading. Where heat is very intense, short rushes should be made at intervals by parties of 4 to 12 men working as closely together as possible and making two or three beats, each man on the same spot, before withdrawing for a " breather ". Three or four men combined will achieve far more than the same or even double the number working separately and apart.

The scene of a fire should not be left unattended until it is certain that the fire has been completely extinguished. Fires in smouldering peat and decayed vegetable matter take a long time to die out ; even a light breeze will cause them to break out afresh.

J. F. SCOTT.

Gale Damage, Brechfa Forest.

During the gale of February 1937, 14 spruce trees were uprooted and fell on the roof of a farmhouse here.

The largest tree contained 27 cu. ft. and was 43 feet long; three of the trees rested on the roof ridge and the others fell on top of these. The house is only 3 feet above ground level at the back where the trees fell.

It was decided to try to lift the trees off one at a time in their full length with pulley and tackle, but suitable tools could not be obtained; an attempt was then made to lift the smaller ones with an ordinary pulley and chain but this was found impossible. The only thing that could be done was to cut the trees into lengths and slide the pieces down the roof on skids. Two men were put on the job with the usual felling tools plus two ropes.

Not much difficulty was experienced with any of the trees until the largest one was reached. The top of the tree stuck out above the roof ridge about 20 feet; taking advantage of a calm day the top was sawn off, partly from above and partly from below, as far above the ridge as it was possible to reach. This came down on its extreme end and, turning over once, skidded down the roof, not a slate being dislodged. An 88-foot length was then taken off the remaining portion and the butt stood nearly upright; with the ropes to pull it away it was an easy matter to saw it off and swing it back from the roof.

Only about two dozen slates were broken, both by the trees coming down in the gale and by the removal of the timber. In a job such as this the men have to realise that it is better to cut to lengths easily handled and to remember that the roof is of more value than the timber.

L. Edwards.

Planting Poplar.

During P.36, owing to a shortage of spruce here, it was proposed to plant a low-lying field, adjoining the river with poplar.

One-year rooted cuttings were used and planted in large turfs; the cost was as follows:—

	Cost per acre. £	*s.*	*d.*
Drains 20 feet apart at 1*s.* 9*d.* per chain	2	16	0
300 plants per acre were used and planted at 1*s.* 6*d.* per 100		4	6
As some of these plants were dying back from the top, part was cut right back to the lowest bud at a cost of		5	0
During the next year, alder were mixed with the poplar, these alder being pitplanted at a cost of 1*s.* 6*d.* per 100, 300 being used per acre		4	6
Total	£3	10	0

As a control, on half an acre the plants were cut back to below the dead wood, and these are now very vigorous, some being 6 feet in height;

the average height of the trees cut back to ground level is 3 feet. To get large enough mounds four turfs each 18 inches square were laid in the form of a square and 3 turfs the same size put on top. The plants were then planted right down through the turfs. Out of 900 poplar plants only about 5 died.

The main points to watch appear to be to get large enough mounds and also to get the tree roots right down through the turf; it does not appear to make much difference whether plants are cut back to ground level or only just back to a good bud.

In very peaty soils it is advisable to give two ozs. of slag to every poplar so as to give the plants a start.

L. E.

Workmen's Shelters.

Usually the workpeople filling planting boards are not protected from the weather and the plants are exposed to drying winds. It is reasonable to expect that if shelter is afforded more work is done and better results are obtained.

At Tair Onen Nursery the shelters are made of four uprights, 4 in × 4 in. timber being used; the two inside uprights have an arm protruding from the bottom which helps to support the frame and the outside timbers each has a block underneath on which it stands and is also brought forward in order to protect the ends; the angle is not acute, about 40°. The total length is 6 yds., 4 yds. being the straight length and the two ends each being 1 yd.; there are three cross bars on the back (*i.e.*, the long length) and two on each of the ends. These bars are 3 in. × 1½ in. timber and are held by bolts. The height of the shelter is 6 feet. The cross bars on the back are placed at the top, centre and bottom, while the two on the sides are at the top and centre only; the bolts for the back cross bars are put in squarely while those for the sides are crossways at an angle of 40°. In this way a frame is made on which hessian is nailed (felt nails being most suitable). The whole thing is easily moved and can be turned round according to the direction of the wind, also there is ample room behind the shelter to work.

Plants may be placed under the table for the fillers as the roots are sheltered from any drying winds; thus if the plants are being brought to the lining-out ground as required from a clump on another part, time is saved by not having to heel them in. There is also no danger of the plants being blown out of the notches after being placed there. Time is saved in little odd ways and even if the nursery is small and the lining-out programme does not take all the winter to complete, the cost of providing a shelter is amply repaid. It is necessary of course to have at least two ropes and pegs to hold the shelter against the wind. The frame is easily taken apart and stored during the summer months and if creosoted should last for years.

H. G. Law.

Forestry and the Public.

By securing the co-operation of local residents the writer can vouch for great assistance obtained; for although there are wild ponies and sheep all round us and we have a large sanatorium of young people the work has been made much easier.

By following this principle I have also been able to draw up a system whereby the forest is connected by telephone with local people who draw attention to outbreaks of fire. On at least two occasions this has checked very threatening fires.

A considerable amount of trouble was experienced through sheep and ponies breaking into the plantations, but by writing to the owners in a brotherly fashion and inviting them to my house for a cup of tea, a smoke and a chat, the forest was soon rid of destructive animals.

There are various ways of securing the co-operation of the local residents and the Coronation was found to be a golden opportunity. The school children and many others were brought together to plant trees thus forming a plantation to be named "The Coronation Plantation." At the same time a record was kept showing the persons who planted each individual tree and a plan of the area was hung up in the school—a matter which received favourable notice in the local newspapers. I can recommend action of this sort to others.

H. Laney.

Effects of Seedbed Rotations.

It is interesting to observe the difference in growth and colour of N.S. 1-year seedlings produced from identical seed, sown over a section of nursery on which the preceding crop varied rather widely.

The area concerned is about 700 sq. yds., comprising eleven seedbeds. It was intended to green-crop this area, but demands on sowing space made it impossible.

Bed 1 was fallow the previous year, owing to the non-germination of the crop sown; beds 2–10 had previously grown N.S. which were lifted as rather poor 2-year seedlings, and bed 11 had produced red oak followed by beech. The difference in the present crop is especially noticeable, not in regard to numbers, but in size and colour. As may be expected the last bed stands out conspicuously for fine seedlings of healthy appearance, followed by the fallowed bed and lastly by the beds having previously produced the same species. A count showed the following size percentages (all beds are drill sown at eight drills per yard):—

Bed No.	*Average Seedlings per sq. yd.*	*Under 1 in. per cent.*	*1–2 in. per cent.*	*2–3 in. per cent.*	*3–4 in. per cent.*	*Colour.*
1	648	12	85	3	—	Fair with some yellow.
2–10	600	100	—	—	—	Yellow.
11	664	8	50	37	5	Very healthy, none yellow.

These crops will obviously have to remain where they are for another year, during which I see little hope of improvement unless some form of stimulation can be brought about. With this aim in view I propose to apply humate fertiliser to the nine sickly seedbeds in the spring of 1938. I may add that this preparation was tried, rather later in the summer of 1937, on 2-year seedbeds of three species—N.S., S.S. and J.L. Although administration was too late to produce extra growth, it had very definite effects. The portions of beds treated were the most yellow at that time, but by the end of the growing season their healthy green appearance and total absence of yellow plants, made them distinguishable from the untreated beds.

With these encouraging results one can even hope to produce good 2-year seedlings from beds that at 1-year old were deficient both in size and colour. At the same time the application of humate fertiliser on a large scale would prove costly and the natural remedy appears to be to avoid successions of the same species and to green-crop more regularly.

G. W. Hollis.

Eggesford : Brashing and Pruning Operations.

Some 30 acres of D.F. and S.S. P.20, 21 and 22 have been brashed here in F.Y.37. The whole of the work was done by boys aged 14 to 17 years and being a new operation the cost and other particulars had to be noted. This work was not supervised closely after the commencement was made as it is essential for the workers to get confidence and to make a choice quickly without relying on someone else. It was found that by telling the lads not to brash bad and small trees few mistakes were made; after a day or so, the improved appearance of the brashed trees aroused their interest and quicker work resulted.

The average cost was 13*s.* to 14*s.* per acre. A brashed plot was then pruned to a height of 12 ft. at a spacing of about 18 ft. by 12 ft. with a long-handled saw giving roughly 200 per acre. The cost was 6*s.* 10*d.* per acre.

This work teaches boys to use their powers of observation in picking out good types of trees and this training will be useful in later years, when thinnings have to be made.

E. C. Kibble.

Notes on Protection.

The severe snow storms we had in the early part of 1937, besides causing considerable damage to plantations, must have greatly increased the cost of protection from vermin during the period the storm lasted. In west Perthshire we had seven storms in succession and the following points noted may help to reduce costs on similar occasions in the future.

The danger here was caused by the fences, deer and rabbit, being drifted over to a depth of 7–9 ft. The fences on the top of the hill, over three miles, had to be cleared four times and some days the part cleared in the morning was drifted in before night. I am convinced that had we waited until the storm was over one clearing would have been sufficient.

Firstly, because when snow is a foot deep or more it can be taken that no animal life (deer excluded) moves for the first 3–4 days. Rabbits prefer to lie up in their burrows and feed on the roots of ground willow, trees, etc. Hares usually move to some sheltered part of the hill before the storm starts and only shift when hunger drives them. I have seen, before a storm, a bare hill face, mostly scree and rocks with little or no feeding, actually moving with hares, while on the exposed hill-side with good feeding not a hare could be seen.

Secondly, in young plantations up to five years old (S.P. on higher ground) where the snow has fallen to a foot in depth, it forms a natural protection from hares and rabbits.

Most damage occurs when a storm is prolonged or when there is frost on the high ground and animals scrape for food on lower ground. I have never seen rabbits attack trees for food during a storm until the fourth day.

Lastly, if hares and rabbits get into an area through drifting, clear away the snow at least four feet from the fence on the outside, but leave the snow against the fence inside the area and you will find that most of the hares and rabbits have got out during the night.

W. L. Ross.

Notes on Draining.

I think it is now generally agreed that much more care should be given to the draining of areas to be planted than was the case in the early years of the Forestry Commission.

The want of draining was not always due to neglect; on many forests the land was only acquired at the start of the planting season and the Forester had not the time nor the labour to do the necessary draining. Where this occurred the necessary drains should be added now. As this will be charged to "draining repairs" the costs will be high and the Forester should go over all the P. years requiring attention, estimate the total number of chains and then make a rotation scheme, spreading the work over a number of years according to his estimates.

Whereas new draining is now carried out according to programme, draining repairs are still apt to be neglected and it should be remembered that a drain made in the summer is only doing half its work by the end of the year owing to being half full of decayed vegetation; I speak of areas where there is a heavy growth of grass, bracken, etc.

The following table has been found helpful on this area :—

Plantations 1–4 years old.	Drains cleaned annually.
,, 5–7 ,, ,,	,, ,, every 2 years
,, 8 years old or more or where the canopy has formed.	Every 5 years or longer according to conditions.

W. L. R.

Fire Beaters.

Dry spring winds following frost are responsible for disastrous heathland and forest fires each year, but with men armed with suitable fire-fighting appliances, these fires may be prevented from spreading.

In extinguishing fires, fire beaters are generally used and those in charge should satisfy themselves that they have the best type and that these are available at suitable places. The fire beater in use at Tentsmuir is undoubtedly superior to the usual birch broom or wire-netting beater and for the benefit of those foresters who have not seen this type its construction is described. It consists of old mill belting fitted to a socketed shaft and is quite simple to make. Two pieces of 5-inch belting 22 in. long are fixed to an ash shaft, 5 ft. 6 in. by $1\frac{1}{4}$ in., by means of an iron socket, to which the belting is fixed by $\frac{3}{4}$ in. mushroom-headed bolts. The socket, which may be made by the local blacksmith, is similar in shape and size to that on the bucco cultivator shaft. The belting should be that which is reinforced with copper wire, the type of belting which has a grease dressing between the layers of canvas being avoided as the latter becomes soft with heat.

During a recent fairly extensive fire, about forty "belting type" beaters were in use and after fighting the fire for an hour and a half, were none the worse for wear; they required no repair and were returned to their respective depots in readiness for further service when required. The cost of making beaters of this type is about 3*s*. 3*d*. each, but as they are everlasting, the expenditure is justified and foresters who are within reach of any factory or mill where old belting may be obtained cheaply (a supply to make thirty beaters cost only about 5*s*.) should endeavour to have a few made and test their efficiency for themselves.

Advantages over the usual wire-netting and birch broom type of beater are that no sparks are raised and, as the beater comes down flat on the burning material, the air is totally expelled from the fire, thus quickly extinguishing it. Again no matter how badly used the beater may be it reverts to its normal shape, which is not the case with wire-netting beaters when subjected to hard rock, and such brooms soon burn out.

If twenty of the type just described were made annually a supply could readily be obtained and their future upkeep cost would be practically nil, as only a preservative dressing applied to the shafts every three years as protection against weather is necessary.

R. Shaw.

Fire Rides.

A great many of the Forestry Commission plantations have now reached the stage when crown fires may do extensive damage if such fires once get a hold. Up to the present, the rides as laid down are I think, quite inadequate and no human efforts could possibly stop a crown fire with their aid.

Coniferous forests should be divided into blocks of, say, not more than 100 to 150 acres in extent, a larger block being considered too much to sacrifice should a crown fire start in a plantation 15 years old or more. The rides surrounding such blocks should be at least 60 feet wide, made at the time of planting, and having a 10-foot, strip ploughed or made bare by other means, running along the centre of the ride, to check ground fires. To many this 60-foot ride may seem a waste of ground, but this may be overcome in later years by proceeding as follows :—

At the end of five years after first planting begin by planting one row, on each side of the ride five feet from the conifers and at six or seven feet spacing, of a quick-growing hardwood, say, silver birch or grey alder, or any other quick-growing species suitable to the soil and situation. The plants should be well-rooted 2-year seedlings. Every second year repeat the process of planting one row, until the last row is five feet from the ploughed strip, thus making four rows of uneven aged hardwood on either side of the ride. The row nearest the centre should be a species which coppices freely, say, sycamore or chestnut. By introducing the hardwoods in this manner, the 60-foot ride, which at one time seemed a waste of ground, is gradually narrowed down to 20 feet, and the resulting timber ultimately obtained from the six rows of hardwood would be quite valuable for marketing. The rows on either side of the ploughed strip should be kept coppiced in later years.

It is thought that rides so formed around stands of conifers of 100 to 150 acres would serve as protection both against ground fires and crown fires.

By the time the conifers would have reached the age of 12 years, the first rows of quick-growing hardwoods, although five years younger, would be equal in height to the conifers, or nearly so. They would continue to keep pace with the conifers and so help, together with the leafy shade of the still younger hardwoods, to prevent the growth of the very coarse side branches usually found along the edges of main rides in coniferous plantations.

R. S.

Wind Damage.

Although the early part of 1937 was remarkable for the severity of its gales, with consequent extensive wind damage in young plantations throughout the country, I cannot but think that correct silvicultural practice would to a certain extent have mitigated the evils. I meet many foresters who complain of the instability of Douglas fir and yet on the Binsness Estate at Culbin there is a row of these trees which, in their

isolation, have withstood the blasts for over half a century, and they grow on pure sand. The other species in open formation there, particularly the Scots and Corsican pines, also produce extensive root systems which effectively anchor them on this seemingly insecure site.

From observation I should say that the risk of wind damage in a heavily thinned wood decreases with age, but with opposite treatment the danger increases. The wider spacing employed by the Forestry Commission in the formation of their plantations will certainly promote a better root-hold in the initial stages than that induced by the closer spacing advocated by the older school of estate foresters. This advantage should not be lost, however, by delayed thinning, and I think that treatment is required when the canopy, becoming complete, leads to compressed crowns. If this were done the individual tree could not rely to the same extent on its neighbour for support and to compensate for this would undoubtedly produce widespreading, vigorous roots capable of withstanding gales.

W. MACKAY.

UNUSUAL GROWTH OF CORSICAN PINE.

There is at Culbin a Corsican pine which has dispensed with the usual procedure of forming and making use of branches. For the first five years the growth was normal, being exactly similar to that of neighbouring pines. There are the usual lateral branches to a height of four feet and these have a length of three to four feet; above this the tree has grown an average of 19 inches annually until it has reached a total height of 15 feet, the last 11 feet of stem being entirely devoid of branches and side shoots. The annual growths can be clearly seen as the needles are persistent at the base of each annual extension of the shoot; the needles are short, they lengthen towards the middle and shorten again to the upper end.

On examination it is seen that this unusual but not unique mode of development is the result of the lateral buds becoming adpressed to, and their tips fusing with, the terminal bud. If the branches at the base are given sufficient light to function properly it will be interesting to see how the tree, at present ranking with the dominants, will grow and how long it will live, assuming, of course, that this abnormal condition continues.

J. B. HENDRY.

RECUPERATIVE POWERS OF JAPANESE LARCH.

I expect most foresters who have had experience in the planting and later management of Japanese larch plantations will have noticed how this species recovers from damage by rabbits and other pests. The effect on seedlings may not have been noticed, however. The following experience and subsequent results at Altonside Nursery may, therefore, be of interest. The injury in this case was done by pheasants.

In the winter of F.Y.36 the leading shoots of fully 75 per cent. of the 1-year seedling Japanese larch were eaten off, and in some cases the plants were cropped almost down to ground level. When the plants were bedded out the decapitated seedlings were rejected and the following results should, I think, justify the utilisation of any 1-year Japanese larch seedlings which may suffer similar damage.

Number of bedded-out plants (F.Y.36), 60,000; number available (F.Y.37), 45,000; size 7 inches. The 75 per cent. of available plants had recovered so well that at time of lifting, during planting season of F.Y.37, they showed practically no signs of the previous year's damage. The uppermost buds on the damaged stems had developed into leading shoots, and the wounds on the stems had healed up sufficiently practically to obliterate the scars.

I found a very striking example of severe damage and subsequent recovery in a young Japanese larch plantation on a private estate recently. The plantation was grossly overstocked, the trees in some cases being less than a foot apart. The explanation was the beating-up of rabbit-damaged plants. The original plants had been severely damaged by rabbits, and the following season the area had been beaten up, some parts being practically replanted. The damaged plants recovered, however, and were finally indistinguishable from those used in beating-up; in consequence there was nearly a double crop of trees. There is no doubt that Japanese larch recover well after severe cutting back, and on this account one would usually be justified in delaying beating-up.

D. J. URQUHART.

DRAINING.

In the draining of land adjoining rides the fact that the rides will be used some time in the future for the haulage of the timber crop should be kept in mind. When the roads are wanted for this purpose the presence of a network of drains will mean outlay in material and labour in the bridging or filling in of the drains. This expense can be avoided in certain cases, however, by planning the draining system so as to avoid the frequent crossing of rides. The ride drains need not always be run directly across to a main drain on the other side of the road, but may be carried parallel to this until a convenient point is reached where the water from all of them is led across the ride into the main drain.

D. J. U.

NOTCH PLANTING SPADE.

As the T-notch method of planting is much in use, it occurred to me that a spade to make the notch in one operation would be an advantage. After giving some consideration to the matter a spade

was produced which makes an effective T-notch, and the following particulars of it may be of interest.

The spade is an ordinary garden one, with the strapping made straight and a moderate set at the neck. The cutting plate for making the leg of the T is a piece of steel, 6 in. by 5 in., fixed to the blade of the spade by riveting at the bottom and secured at the top by two small right-angled pieces. A clearance of three inches is left at the bottom to allow for any screefing necessary and the spade is pointed. Owing to the position of the cutting blade perpendicular planting is the result.

M. A. RITCHIE.

ENAMEL FIRE NOTICES.

In the 1933 issue of the Journal reference was made to fire notices, with a suggestion that if enamel ones were used they would last 20 years. Their lasting qualities in this forest are very poor as shortly after being fixed up they become discoloured and finally become unreadable; it is noted that the red lettering goes first. The following has been tried to prevent this :—paint with a coat of size and leave to dry, following up with an application of clear varnish and black Japanese varnish on the back to prevent rusting.

I would like to know if these plates go like this in other forests, or whether it depends on the district, as this is a fairly smoky one.

M. A. R.

FORM S.O.136.

The following hint may be useful to keep your 136 notebook in good condition when being carried about and used in all sorts of weather.

Procure two thin pieces of plywood, cut them slightly larger than the book, smooth them and round off the corners; make two holes in each piece one inch or so in from the ends and similar holes in the edges of the book. Obtain two rings, such as are used in loose-leaf books, and pass them through the boards and book. Covers made in this way last for years and always keep the book straight and clean.

M. A. R.

LIST OF TECHNICAL STAFF.

Headquarters.

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

Story, Fraser, Education and Publications Officer.
Guillebaud, W. H., Chief Research Officer.

Census and Plans (temporarily at 55, Millbank, London, S.W.1.)

Sangar, O. J., Divisional Officer.
Chard, J. S. R., District Officer.
Maund, J. E., District 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.
Wynne Jones, E., Chief Land Acquisition Officer.
Edwards, S. W., Chief Estates Officer.
Smith, R. H., District Officer (Acquisitions).
Pearson, F. G. O., District Officer (Utilisation).
Cownie, F., District Officer (Acquisitions).
Chapman, D. H., District Officer (Acquisitions).

Division 1 (Chopwellwood House, Rowlands Gill, Co. Durham).

Hopkinson, A. D., Divisional Officer.
Batters, G. J. L., District Officer.
Fossey, R. E., District Officer.
Forsyth, W., District Officer.
Stiles, W. J., District Officer (Estate).

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.

Division 3 (59/60, *High Street, Exeter*).

Broadwood, R. G., District Officer, Higher Grade.
Ballance, G. F., District Officer.

Division 4 (*Grand Buildings, Trafalgar Square, London*).

Felton, A. L., Divisional Officer.
Lowe, George, District Officer, Higher Grade.
Muir, W. A., District Officer.
Stileman, D. F., District Officer.
Barrington, C. A. J., District Officer.

Division 5 (*Llandaff Chambers, Regent Street, Cambridge*).

Macdonald, J., Divisional Officer.
Connell, C. A., District Officer.
Ross, J. M., District Officer.
Rouse, G. D., District Officer.
Williamson, J. Q., District Officer.
Morrish, C. G., District Officer (Estate).

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.
Kenyon, L. G. T., District Officer.
Roper, John, Survey Clerk.

Division 8 (26, *Lowther Street, Carlisle*).

Ross, A. H. H., Acting Divisional Officer.
Thom, J. R., District Officer.

Division 9 (*Graham Buildings, Newport Road, Cardiff*).

Ryle, G. B., Acting Divisional Officer.
Cowell-Smith, R., District Officer.
Backhouse, G. W., District Officer.
Haldane, W. D., District 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).
Webster, John, District Officer (Estate).
Beresford-Peirse, H. C., District Officer (Acquisitions).
Short, W. R., District Officer (Estate).

Northern Division (51, *Church Street, Inverness*).

Fraser, James, Divisional Officer.
Spraggan, D. S., District Officer.
Gibson, W. N., District Officer.
Robbie, T. A., District Officer.
Fraser, A. M., District Officer.

Southern Division (52, *Buccleuch Street, Dumfries*).

Oliver, F. W. A., Acting Divisional Officer.
Mackay, J. W., District Officer.
Watt, A., District Officer.
Wood, R. F., District Officer.

Eastern Division (12, *North Silver Street, Aberdeen*).

Scott, Frank, Divisional Officer.
Newton, L. A., District Officer, Higher Grade.
Bird, D. H., District Officer, Higher Grade.
Warren, A., District Officer.
Woolridge, T. H., Temporary District Officer.

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Gosling, A. H., Acting Divisional Officer.
Whellens, W. H., District Officer.
James, J. E., District Officer.
Dier, H. V. S., District Officer.

School for Forest Apprentices.

Watson, Harry, District Officer, Higher Grade (Instructor).—Benmore, Argyll.

FORESTERS.

England and Wales.

Name.	*Grade.*	*Name.*	*Grade.*
Division 1.			
Anderson, T. E.	Head	Lewis, A. E.	II
Weir, A. B.	I	Macdonald, I. A. D.	II
Anderson, J. T.	II	McNab, Colin	II
Bewick, W. J.	II	Rowell, James	II
Brown, W. C.	II	Scott, J. F.	II
Everitt, F. W.	II	Shaw, J. W.	II
Frank, Harold	II	Smith, W. T.	II
Gough, W. R.	II	Wood, W.	II
Hodgson, William	II	Woodward, George	II
Division 2.			
Butter, Robert	Head	Jones, David	II
Shaw, J. L.	Head	King, B. H.	II
Anderson, J. W.	I	Kirkup, J. T.	II
Cowe, J. F.	I	Lomas, John	II
Fraser, Robert	I	Pearson, W.	II
Jones, H. W.	I	Pye, W. E.	II
Roberts, W. G.	I	Reese, W. H.	II
Brown, G. H.	II	Smith, N.	II
Edwards, D. T.	II	Tucker, E. J.	II
Evans, J. E.	II	Watkins, Stanley	II
Harris, W. A.	II	Williams, H.	II
Harrison, Percy	II	Yapp, P.	II
Jones, Alfred	II		
Division 3.			
Wallington, H. J.	I	Pritchard, Roderick	II
Carnell, Reginald	II	Wellington, C. R.	II
Jones, W. E.	II	Wilkinson, W. E.	II
Division 4.			
Dyer, H. C.	I	Hyett, Samuel	II
Nelmes, F. J.	I	Lingwood, N. J.	II
Wallington, A. W.	I	Massey, J. K.	II
Aston, T. H.	II	McKenzie, Colin	II
Cottenham, W. C.	II	Middleton, W. F. C.	II
Craft, J. H.	II	Phelps, S. E.	II
Gillmore, D. W.	II	Reid, Duncan	II
Gulliver, G. H.	II	Wild, P. R. S.	II
Halsey, H. R.	II	Williams, L. H.	II

England and Wales—continued.

Name.	*Grade.*	*Name.*	*Grade.*
Division 5.			
McGlashan, John ..	I	Hendrie, T. F.	II
Tribe, William ..	I	Jackson, W. V.	II
Beasley, F. G. ..	II	Johnson, Harry	II
Bewick, Robert ..	II	Mitchell, A. L.	II
Birkett, Albert ..	II	Parry, A. A.	II
Bloor, C. A. ..	II	Price, Alfred	II
Button, G. H. ..	II	Redford, C. W.	II
Clark, J. S. ..	II	Saunders, H. J.	II
Davies, D. J. ..	II	Smith, J. J.	II
Gilson, R. B. ..	II	Wyatt, Lionel	II
Gwilliam, G. T. S.	II		
Division 6.			
Forgan, William	Head	Adams, J. H. ..	II
Aston, O. R. T.	I	Longman, F. C. J.	II
Colwill, S. W.	I	Parker, F. H. ..	II
Hale, W. J.	I	Parsons, F. F. G. ..	II
Kennedy, J. B.	I		
Division 7.			
Smith, Frank	Head	Davies, J.	II
Humphries, W. J... ..	I	Lees, George	II
Lewis, Tom	I	Morgan, T. R.	II
Walker, A. E.	I	Roberts, E. James ..	II
Williams, D. N. (School) ..	I	Taylor, G. J.	II
Adams, Isaac	II	Watson, Frank	II
Christie, W. L.	II		
Division 8.			
Simpson, G. A.	I	Liddell, Joseph	II
Jones, George	II	Small, J. R.	II
Division 9.			
Harrison, Phillip	I	Gunter, A. T. G. ..	II
Hollis, G. W.	I	Jones, A. H. ..	II
Pallett, R. E.	I	Laney, Horace ..	II
Squires, C. V.	I	Lewis, T. H. ..	II
Williams, John	I	Little, T. E. ..	II
Adams, C.	II	Richards, G. H. ..	II
Caddy, Thomas	II	West, S. J. C. ..	II
Edwards, L. T.	II	Young, H. C. ..	II

Scotland.

Name.	*Grade.*	*Name.*	*Grade.*
N. Division.			
Anderson, William	Head	Macdonald, C.	II
Macintosh, William	I	Macdonald, Donald	II
Mackay, Kenneth	I	Mackay, William	II
Mason, William	I	Mackenzie, Alex.	II
McClymont, William	I	Mackenzie, George	II
McEwan, James	I	Mackenzie, John	II
Murray, William	I	Mackie, A.	II
Cameron, Roderick	II	Mackintosh, Alexander	II
Campbell, Robert W.	II	Macrae, D. J.	II
Drysdale, Alexander	II	Murray, A. R.	II
Gordon, James	II	Murray, Robert	II
Gray, A. C.	II	Munro, George	II
Gunn, John	II	Stewart, P. C.	II
S. Division.			
Graham, Alexander	I	Macrae, Murdo	II
Macintyre, J. F.	I	Peddie, A. S.	II
Brown, Peter	II	Steel, R. P.	II
Macmillan, Hugh	II	Watson, James	II
E. Division.			
Shaw, Robert	Head	Milne, W. G.	II
Edwards, Johnston	I	Mitchell, F. M.	II
Kennedy, J. A. M.	I	Murray, G. J. A. M.	II
Lamb, J. A.	I	Reid, J.	II
Robbie, John D.	I	Ritchie, M. A.	II
Allan, James	II	Robbie, James D.	II
Allan, Thomas	II	Ross, Allan	II
Anderson, F.	II	Ross, Archibald	II
Corbett, John	II	Ross, W. L.	II
Kennedy, J. M.	II	Scott, John	II
Mackay, William	II	Urquhart, D. J.	II
McConnell, James	II	Watt, D. M.	II
McDowall, C.	II		
W. Division.			
Simpson, A. N.	Head	Mackay, Angus	II
Cameron, Hugh	I	Mackenzie, Ian H.	II
Donald, R. R.	I	Maclean, J. D.	II
Paterson, S. H. A.	I	MacPhee, C. B.	II
Reid, J. M.	I	Macrae, A. D.	II
Calder, J. M.	II	McDonald, J. D.	II
Cameron, Alistair	II	Munro, Duncan	II
Ferguson, J. M.	II	Murray, R. G.	II
Fergusson, W. S.	II	Sinclair, Laurence	II
Kennedy, John	II	Stoddart, W. F.	II

Scotland—continued.

Research and Experiment.

Name.	*Grade.*	*Name.*	*Grade.*
Oxford.		*Edinburgh.*	
Gray, W. G.	I	Dewar, J. D.	II
Nimmo, M.	II	Farquhar, James	II
Weatherell, J.	II	Grant, A.	II

Name.	*Grade.*
Headquarters.	
Mackenzie, A. M.	I.

REGISTER OF IDENTIFICATION NUMBERS.

Forest Year, 1937.

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.

37/1 14 lb.; *Juglans nigra;* 1936; England (Sevenoaks, Kent); gift from J. Harper.

37/2 21 lb.; *Quercus mirbeckii;* 1936; Algiers; gift from French Government.

37/3 763 lb.; *Quercus rubra;* 1936; Holland (Arnhem-Oosterbeek-Dieren, Guelders); Nederlandsche Heidemaatschappij.

37/4 1 lb.; *Ailanthus glandulosa;* 1936; England (Kew); gift from Royal Botanic Gardens, Kew.

37/5 ½ lb.; *Betula papyrifera;* 1936; England (Kew); gift from Royal Botanic Gardens, Kew.

37/6 24 lb.; *Juglans nigra;* 1936; England (Kew); gift from Royal Botanic Gardens, Kew.

37/7 ¾ lb.; *Quercus conferta;* 1936; Hungary; gift from R.C.B. Gardner (ex Sopron).

37/8 410 lb.; *Quercus coccinea;* 1936; U.S.A. (Ohio, altitude 400–600 ft.); Katzenstein & Co.

37/9 20 lb.; *Hicoria ovata (Carya alba);* 1936; U.S.A. (Tennessee, altitude 1,500 ft.); Katzenstein & Co.

37/10 1 lb.; *Acer pennsylvanicum;* 1936; U.S.A. (New Hampshire, altitude 800 ft.); Katzenstein & Co.

37/11 1 lb.; *Acer pennsylvanicum;* 1936; U.S.A. (Ashford, McDowell County, North Carolina); Herbst Bros.

37/12 5 lb.; *Liriodendron tulipifera;* 1936; U.S.A. (Philadelphia, Pennsylvania); Herbst Bros.

37/13 42 lb.; *Juglans regia;* 1936; France (South); Vilmorin-Andrieux & Co.

37/14 1,618 lb.; *Pinus laricio* var. *corsicana;* 1936; Corsica (Valdoniello Forest, altitude 4,000 ft.); J. Grimaldi; 98·8; 67+3.

37/15 5 lb.; *Ailanthus glandulosa;* 1936; Italy; J. Rafn & Son.

37/16 2 lb.; *Acer platanoides;* 1936; Denmark; J. Rafn & Son.

37/17 1,216 lb.; *Picea excelsa;* 1936; Germany (Black Forest, Freudenstadt-Horb and Nagold); J. Rafn & Son; 98·6; 90+2.

37/18 304 lb.; *Larix europaea;* 1936; Austria (Inn Valley, Northern Tyrol, altitude 2,000–2,600 ft.); J. Jenewein; 86·5; 52.

37/19 1,005 lb.; *Picea excelsa;* 1936; Austria (Inn Valley, Northern Tyrol, altitude 2,000–2,600 ft.); J. Jenewein; 98·2; 95.

37/20 892 lb.; *Picea excelsa;* 1936; Germany (Hohenzollern, Wurttemburg, altitude 2,000–2,300 ft.); Schultze & Co.; 95; 85.

37/21 6 lb.; *Chamaecyparis lawsoniana;* 1936; France (South); Vilmorin-Andrieux & Co.

37/22 3 lb.; *Cupressus macrocarpa;* 1936; France (South-west); Vilmorin-Andrieux & Co.; 99·9; 17.

37/23 1 lb.; *Pinus strobus;* 1936; France (South); Vilmorin-Andrieux & Co.

37/24 1,000 lb.; *Larix leptolepis;* 1936; Japan (Nagano); S. Ando; 98·3; 10+26.

37/25 565 lb.; *Pinus laricio* var. *corsicana;* 1936; Corsica (Valdoniello Forest, altitude 3,200–4,600 ft.); O. J. Rossi; 99; 41.

37/26 1,039 lb.; *Picea excelsa;* 1936; Austria (Burgenland, altitude 600–1,600 ft.); Grünwald & Co.; 98·7; 79.

37/27 4 lb.; *Pinus montana* var. *uncinata;* 1936; Tyrol; Vilmorin-Andrieux & Co.

37/28 13 lb.; *Picea omorika;* 1936; Yugoslavia (Serbia); Forestry Department, Banja Luka.

37/29 9 lb.; *Hicoria ovata* (*Carya alba*); 1936; U.S.A. (Tennessee); F. W. Schumacher.

37/30 9 lb.; *Hicoria cordiformis* (*Carya amara*); 1936; U.S.A. (Tennessee); F. W. Schumacher.

37/31 3½ lb.; *Cornus nuttallii;* 1936; U.S.A. (Washington); F. W. Schumacher.

37/32 1 lb.; *Betula lutea;* 1936; U.S.A. (New England); F. W. Schumacher.

37/33 9½ lb.; *Pinus pinaster;* 1936; France (Landes); gift from French Government.

37/34 1¼ lb.; *Pinus pinaster;* 1936; Brazil; gift from Department of Agriculture, Macau.

37/35 264 lb.; *Pseudotsuga douglasii;* 1936; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government; 97·2; 80+4.

37/36 1,815 lb.; *Picea sitchensis;* 1936; Canada (Queen Charlotte Islands, altitude 0–500 ft.); Canadian Government; 97·8; 93.

37/37 6 lb.; *Picea sitchensis;* 1936; Canada (Portland Canal, British Columbia, altitude 0–500 ft.); Canadian Government.

37/38 ¼ lb.; *Picea sitchensis;* 1936; Canada (Campbell Lake, Oyster River, British Columbia, altitude 550 ft.); Canadian Government.

37/39 73 lb.; *Pinus contorta;* 1936; Canada (Prince George, British Columbia, altitude 1,875 ft.); Canadian Government; 97·6; 86.

37/40 31 lb.; *Pinus contorta;* 1936; Canada (Smithers, British Columbia, altitude 2,000 ft.); Canadian Government; 96·3; 84.

37/41 1½ lb.; *Pinus contorta;* 1936; Canada (Vaveby, Chu Chua, Clearwater, British Columbia, altitude 1,500 ft.); Canadian Government.

37/42 1 lb.; *Pinus contorta;* 1936; Canada (Salmon Arm, British Columbia, altitude 1,350 ft.); Canadian Government.

37/43 1 lb.; *Pinus contorta;* 1936; Canada (Hazelton, British Columbia, altitude 1,150 ft.); Canadian Government.

37/44 34 lb.; *Tsuga heterophylla;* 1936; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government. 99·6; 73.

37/45 7¾ lb.; *Tsuga heterophylla;* 1936; Canada (Portland Canal, British Columbia, altitude 0–500 ft.); Canadian Government.

37/46 3¾ lb.; *Tsuga heterophylla;* 1936; Canada (Queen Charlotte Islands, altitude 0–500 ft.); Canadian Government.

37/47 16 lb.; *Thuya plicata;* 1936; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government; 94; 87.

37/48 150 lb.; *Abies grandis;* 1936; Canada (Campbell Lake, Oyster River, British Columbia, altitude 550 ft.); Canadian Government; 98·8; 37+10.

37/49 28 lb.; *Alnus oregona;* 1936; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government.

37/50 1 lb.; *Alnus oregona;* 1936; Canada (Queen Charlotte Islands, altitude 0–500 ft.); Canadian Government.

37/51 ½ lb.; *Alnus sitchensis;* 1936; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government.

37/52 2 lb.; *Arbutus menziesii;* 1936; Canada (Vancouver, British Columbia, altitude 0–200 ft.); gift from Canadian Government.

37/53 6 lb.; *Cornus nuttallii;* 1936; Canada (New Westminster, British Columbia, altitude 25–200 ft.); Canadian Government.

37/54 493 lb.; *Picea sitchensis;* 1936; Canada (Queen Charlotte Islands); Manning Seed Co.; 91·7; 58+3.

37/55 69 lb.; *Pinus contorta;* 1936; U.S.A. (Olympic Peninsula, 60 miles inland); Manning Seed Co.; 96·8; 94.

37/56 1 lb.; *Pinus contorta;* 1936; U.S.A. (Grays Harbour, Washington); Manning Seed Co.

37/57 19 lb.; *Chamaecyparis lawsoniana;* 1936; U.S.A. (Curry County, Oregon); Manning Seed Co.; 93·5; 45.

37/58 24 lb.; *Thuya plicata;* 1936; U.S.A. (Thurston County, Washington); gift from Manning Seed Co.; 95·6; 72.

37/59 1 lb.; *Acer macrophyllum;* 1936; U.S.A. (Pierce County, Washington); Manning Seed Co.

37/60 3½ lb.; *Betula lutea;* 1936; U.S.A. (North Carolina); Barteldes Seed Co.

37/61 4¾ lb.; *Liriodendron tulipifera;* 1936; U.S.A. (Ohio); Barteldes Seed Co.

37/62 9 lb.; *Sequoia sempervirens;* 1936; U.S.A. (California); Manning Seed Co.

37/63 ¼ lb.; *Chamaecyparis nootkatensis;* 1936; Canada (Forbidden Plateau, British Columbia, altitude 4,000–5000 ft.); gift from Canadian Government.

37/64 198 lb.; *Larix europaea;* 1936; Scotland (Morayshire and Ross-shire); C. Meldrum & Sons; 76; 14.

37/65 220 lb.; *Larix europaea sudetica ;* 1936; Czechoslovakia (Ruda State Forest, Moravia); Czechoslovakian Forest Service: 70·5; 43.

37/66 2 lb.; *Cryptomeria japonica ;* 1936; Japan; J. Rafn & Son.

37/67 3¾ lb.; *Sequoia gigantea ;* 1936; U.S.A. (California); J. Rafn & Son.

37/68 3½ lb.; *Pinus insignis ;* 1936; U.S.A. (California); J. Rafn & Son.

37/69 12 lb.; *Platanus orientalis ;* 1936; Italy; J. Rafn & Son.

37/70 5 lb.; *Tilia vulgaris ;* 1936; Italy; J .Rafn & Son.

37/71 1½ lb.; *Alnus glutinosa ;* 1936; Bohemia; J. Rafn & Son.

37/72 15½ lb.; *Alnus incana ;* 1936; Swiss Alps; J. Rafn & Son.

37/73 3½ lb.; *Acer macrophyllum ;* 1936; U.S.A.; J. Rafn & Son.

37/74 10 lb.; *Amelanchier alnifolia ;* 1936; Canada; J. Rafn & Son.

37/75 6¾ lb.; *Sequoia sempervirens ;* 1936; Europe; J. Rafn & Son.

37/76 ½ lb.; *Larix sibirica ;* 1936; Finland (Raivola); gift from Forest Research Institute, Helsinki.

37/77 1 lb.; *Pinus sylvestris ;* 1936; Czechoslovakia (Tusset); gift from Prince Dr. Adolf Schwarzenberg.

37/78 11 lb.; *Abies nobilis ;* 1936; Denmark; J. Rafn & Son.

37/79 2 lb.; *Acer macrophyllum ;* 1936; U.S.A.; J. Rafn & Son.

37/80 10 lb.; *Acer palmatum ;* 1936; Japan; J. Rafn & Son.

37/81 20 lb.; *Acer rubrum ;* 1937; U.S.A.; Herbst Bros.

37/82 20 lb.; *Acer rubrum ;* 1937; U.S.A.; F. W. Schumacher.

37/83 58 lb.; *Pinus sylvestris ;* 1936; England (East); own collection; 96·4; 89.

37/84 11½ lb.; *Pinus laricio ;* 1936; England (East); own collection.

37/85 14 lb.; *Larix europaea;* 1936; England (East); own collection.

37/86 10 oz.; *Pinus cembra*; 1936; England (East); own collection.

37/87 7½ lb.; *Larix leptolepis ;* 1936; England (North); own collection.

37/88 42 lb.; *Acer platanoides ;* 1936; England (East); own collection.

37/89 18 lb.; *Acer platanoides ;* 1936; England (West); own collection.

37/90 4 lb.; *Acer platanoides ;* 1936; England (South-west); own collection.

37/91 70 lb.; *Acer platanoides ;* 1936; England (South); own collection.

37/92 40 lb.; *Acer pseudoplatanus ;* England (East); own collection.

37/93 109 lb.; *Acer pseudoplatanus ;* 1936; England (North); own collection.

37/94 62 lb.; *Acer pseudoplatanus ;* 1936; England (West); own collection.

37/95 30 lb.; *Acer pseudoplatanus ;* 1936; England (Midlands); own collection.

37/96 20 lb.; *Acer pseudoplatanus ;* 1936; England (South-west); own collection.

37/97 60 lb.; *Acer pseudoplatanus ;* 1936; England (South); own collection.

37/98 20 lb.; *Acer campestre ;* 1936; England (East); own collection.

37/99 14 lb.; *Aesculus hippocastanum ;* 1936; England (North); own collection.
37/100 5 lb.; *Alnus glutinosa ;* 1936; England (North); own collection.
37/101 20 lb.; *Alnus glutinosa ;* 1936; England (East); own collection.
37/102 6 lb.; *Alnus glutinosa ;* 1936; England (West); own collection.
37/103 ½ lb.; *Alnus glutinosa ;* 1936; England (South-west); own collection.
37/104 4 lb.; *Alnus glutinosa ;* 1936; England (South); own collection.
37/105 3 lb.; *Alnus incana ;* 1936; England (West); own collection.
37/106 5 lb.; *Alnus incana ;* 1936; England (South); own collection.
37/107 120 lb.; *Araucaria imbricata ;* 1936; England (South); own collection.
37/108 125 lb.; *Betula verrucosa ;* 1936; England (North); own collection.
37/109 2¾ lb.; *Betula verrucosa ;* 1936; England (South-west); own collection.
37/110 222 lb.; *Betula verrucosa ;* 1936; England (East); own collection.
37/111 91 lb.; *Carpinus betulus ;* 1936; England (East); own collection.
37/112 50 lb.; *Castanea sativa ;* 1936; England (West); own collection.
37/113 278 lb.; *Castanea sativa ;* 1936; England (South); own collection.
37/114 60 lb.; *Castanea sativa ;* 1936; England (Midlands); own collection.
37/115 228 lb.; *Fagus sylvatica ;* 1936; England (North); own collection.
37/116 2,116 lb.; *Fagus sylvatica ;* 1936; England (East); own collection.
37/117 899 lb.; *Fagus sylvatica ;* 1936; England (West); own collection.
37/118 837 lb.; *Fagus sylvatica ;* 1936; England (Midlands); own collection.
37/119 2,538 lb.; *Fagus sylvatica ;* 1936; England (South); own collection.
37/120 24 lb.; *Fagus sylvatica ;* 1936; England (South-west); own collection.
37/121 2 lb.; *Fagus sylvatica ;* 1936; Wales (South); own collection.
37/122 100 lb.; *Fraxinus excelsior ;* 1936; England (North); own collection.
37/123 246 lb.; *Fraxinus excelsior ;* 1936; England (East); own collection.
37/124 297 lb.; *Fraxinus excelsior ;* 1936; England (West); own collection.
37/125 20 lb.; *Fraxinus excelsior ;* 1936; England (South-west); own collection.
37/126 115 lb.; *Fraxinus excelsior ;* 1936; England (South); own collection.
37/127 150 lb.; *Fraxinus excelsior ;* 1936; England (Midlands); own collection.
37/128 14 lb.; *Juglans regia ;* 1936; England (West); Evans.
37/129 50 lb.; *Juglans regia ;* 1936; England (West); F. Smith.
37/130 20 lb.; *Quercus cerris ;* 1936; England (East); own collection.
37/131 21,751 lb.; *Quercus pedunculata ;* 1936; England (East); own collection.

37/132 29,052 lb.; *Quercus pedunculata;* 1936; England (West); own collection.

37/133 4,134 lb.; *Quercus pedunculata;* 1936; England (Midlands); own collection.

37/134 69,530 lb.; *Quercus pedunculata;* 1936; England (South); own collection.

37/135 1,200 lb.; *Quercus sessiliflora;* 1936; England (East); own collection.

37/136 12,209 lb.; *Quercus sessiliflora;* 1936; England (West); own collection.

37/137 704 lb.; *Quercus sessiliflora;* 1936; England (South); own collection.

37/138 1,678 lb.; *Quercus robur;* 1936; England (North); own collection.

37/139 784 lb.; *Quercus robur;* 1936; England (West); R.H. Mounsey, Heysham.

37/140 10 lb.; *Tilia vulgaris;* 1936; England (North); own collection.

37/141 3 lb.; *Cryptomeria japonica;* 1936; England (South); own collection.

37/142 1 lb.; *Chamaecyparis lawsoniana;* 1936; England (North); own collection.

37/143 3 lb.; *Chamaecyparis lawsoniana;* 1936; England (East); own collection.

37/144 2 lb.; *Chamaecyparis lawsoniana;* 1936; England (West); own collection.

37/145 2 lb.; *Chamaecyparis lawsoniana;* 1936; England (South-west); own collection.

37/146 1 lb.; *Larix leptolepis;* 1936; England (South-west); own collection.

37/147 30 lb.; *Thuya plicata;* 1936; England (East); own collection.

37/148 1¾ lb.; *Thuya plicata;* 1936; England (South-west); own collection.

37/149 ¼ lb.; *Thuya plicata;* 1936; England (West); own collection.

37/150 2 lb.; *Tsuga heterophylla;* 1936; England (South-west); own collection.

37/151 75,000 transplants (2 + 2); *Picea sitchensis;* crop year unknown; origin unknown; Government of Northern Ireland.

37/152 100,000 2-yr. seedlings; *Picea sitchensis;* crop year unknown; origin unknown; Government of Northern Ireland.

37/153 15,000 plants (12–18 in.); *Picea sitchensis;* crop year unknown; origin unknown; Bryant & May, Ltd.

37/154 21,000 cuttings; *Platanus acerifolia;* crop year unknown; origin unknown; Hyde Park.

37/155 370,000 transplants (1 + 2); *Betula verrucosa;* crop year unknown; origin unknown; Stapleford Wood.

37/156 4,000 transplants (1 + 2); *Betula verrucosa;* crop year unknown; origin unknown; Thoresby Estate.

37/157 47,000 plants (various); *Betula verrucosa;* crop year unknown; England (East); own collection.

37/158 119,000 1-yr. & 2-yr. seedlings; *Acer pseudoplatanus ;* crop year unknown; England (East); own collection.

37/159 36,000 1-yr. seedlings; *Acer pseudoplatanus ;* crop year unknown; origin unknown; Sir Bernard Greenwell.

37/160 90,000 1-yr. seedlings; *Acer pseudoplatanus ;* crop year unknown; origin unknown; Sir R. Blois.

37/161 6,000 3-yr. seedlings; *Quercus pedunculata ;* crop year unknown; England (East); own collection.

37/162 1,000 transplants (2 + 1); *Pseudotsuga douglasii ;* crop year unknown; origin unknown; Buccleuch Estates, Ltd.

37/163 6,000 2-yr. seedlings; *Tsuga heterophylla ;* crop year unknown; origin unknown; G. R. Christie.

37/164 30,000 transplants; *Picea excelsa ;* crop year unknown; origin unknown; Dickson & Co.

37/165 16,000 transplants; *Picea excelsa ;* crop year unknown; origin unknown; Glasgow Corporation.

37/166 10,000 transplants; *Picea sitchensis ;* crop year unknown; origin unknown; Glasgow Corporation.

37/167 10,500 transplants (1+2); *Larix eurolepis ;* crop year unknown; origin unknown; Ayr County Council.

37/168 4 oz.; *Pinus sylvestris ;* 1936; Achnashellach, Ross-shire; own collection.

37/169 10 oz.; *Pinus sylvestris ;* 1936; Glengarry, Inverness-shire; own collection.

37/170 6 oz.; *Pinus sylvestris ;* 1936; Slattadale, Ross-shire; own collection.

37/171 1 bush. cones; *Pinus sylvestris ;* 1936; Slattadale (Rory Island), Ross-shire; own collection.

37/172 2½ lb.; *Larix europaea ;* 1936; Glengarry, Inverness-shire; own collection.

37/173 3½ lb.; *Chamaecyparis lawsoniana ;* 1936; South Laggan, Inverness-shire; own collection.

37/174 2 bush. cones; *Tsuga heterophylla ;* 1936; South Laggan; Inverness-shire; own collection.

37/175 70 lb.; *Fagus sylvatica ;* 1936; Culloden, Inverness-shire; own collection.

37/176 2½ lb.; *Alnus glutinosa ;* 1936; South Laggan, Inverness-shire; own collection.

37/177 3 lb.; *Alnus glutinosa ;* 1936; Glenloy, Inverness-shire; own collection.

37/178 3 lb.; *Alnus glutinosa ;* 1936; Nevis, Inverness-shire; own collection.

37/179 3 lb.; *Alnus glutinosa ;* 1936; South Strone, Ross-shire; own collection.

37/180 3 lb.; *Betula verrucosa ;* 1936; South Laggan, Inverness-shire; own collection.

37/181 18 lb.; *Betula verrucosa ;* 1936; Nevis, Inverness-shire; own collection.

37/182 ¼ bush. cones; *Betula verrucosa ;* 1936; Lael, Ross-shire; own collection.

37/183 5½ lb.; *Pinus sylvestris ;* 1935; Alltcailleach (Crow Wood), Aberdeenshire; own collection.

37/184 5 lb. *Pinus sylvestris;* 1936; Pitgaveny, Morayshire; J. Brander–Dunbar.

37/185 1½ lb.; *Picea excelsa ;* 1936; Durris, Kincardineshire; own collection.

37/186 9 oz.; *Picea sitchensis ;* 1936; Durris, Kincardineshire; own collection.

37/187 9½ lb.; *Tsuga heterophylla ;* 1936; Durris, Kincardineshire; own collection.

37/188 2 oz.; *Tsuga heterophylla ;* 1936; Drummond Hill, Perthshire; own collection.

37/189 3 lb.; *Chamaecyparis lawsoniana ;* 1936; Durris, Kincardineshire; own collection.

37/190 1 lb.; *Picea orientalis ;* 1936; Durris, Kincardineshire; own collection.

37/191 5 oz.; *Picea nigra ;* 1936; Durris, Kincardineshire; own collection.

37/192 50 lb.; *Fraxinus excelsior ;* 1936; Altonside, Morayshire; own collection.

37/193 224 lb.; *Quercus robur ;* 1936; Ross-shire; own collection.

37/194 4,885 lb.; *Fagus sylvatica ;* 1936; Scotland (N.E.); own collection.

37/195 110 lb.; *Acer pseudoplatanus ;* 1936; Scotland (N.E.); own collection.

37/196 4½ lb.; *Pinus sylvestris ;* 1936; Findon, Ross and Cromarty; Capt. Campbell.

37/197 5 lb.; *Pinus sylvestris ;* 1936; Blackhills, Morayshire; Capt. Campbell.

37/198 3 lb.; *Pinus sylvestris ;* 1936; Kirkhill, Morayshire; Capt. Campbell.

37/199 7¼ lb.; *Pinus sylvestris ;* 1936; Auchlunkart, Morayshire; Capt. Campbell.

37/200 76½ lb.; *Pinus sylvestris ;* 1936; Lethen & Kinsteary, Morayshire; Capt. Campbell.

37/201 3 lb.; *Pinus sylvestris ;* 1936; Carron-on-Spey, Morayshire; Capt. Campbell.

37/202 96 lb.; *Pinus sylvestris ;* 1936; Culbin, Morayshire; Capt. Campbell.

37/203 35 lb.; *Pinus sylvestris ;* 1936; Orton, Morayshire; Capt. Campbell.

37/204 34 lb.; *Pinus sylvestris;* 1936; Gordon Castle, Morayshire; Capt. Campbell.

37/205 17 lb.; *Pinus sylvestris ;* 1936; Delfur, Morayshire; Capt. Campbell.

37/206 11 lb.; *Pinus sylvestris ;* 1936; Teindland, Morayshire; Capt. Campbell.

37/207 4 oz.; *Pinus sylvestris ;* 1936; Barcaldine, Argyllshire; Capt. Campbell.

37/208 2 oz.; *Pinus sylvestris ;* 1936; Cumlodden, Argyllshire; gift from Capt. Campbell.

37/209 2 oz.; *Pinus sylvestris ;* 1936; Inverliever, Argyllshire; own collection.

37/210 1¼ lb.; *Larix europaea ;* 1936; Cumlodden, Argyllshire; gift from Capt. Campbell.

37/211 2 lb.; *Larix europaea ;* 1936; Inverliever, Argyllshire; own collection.

37/212 40 lb.; *Larix europaea ;* 1936; Gordon Castle, Morayshire; own collection.

37/213 177 lb.; *Larix europaea ;* 1936; Blackhills, Morayshire; own collection.

37/214 102 lb.; *Larix europaea ;* 1936; Auchlunkart, Morayshire; own collection.

37/215 178 lb.; *Larix europaea ;* 1936; Lethen & Kinsteary, Morayshire; own collection.

37/216 ½ lb.; *Larix europaea ;* 1936; Glenfinart, Argyllshire; own collection.

37/217 18 lb.; *Larix europaea ;* 1936; Mulbuie, Morayshire; own collection.

37/218 7 lb.; *Larix europaea ;* 1936; Balquhidder, Perthshire; own collection.

37/219 46 lb.; *Larix europaea ;* 1936; Seafield, Morayshire; own collection.

37/220 29 lb.; *Larix europaea ;* 1936; Carron-on-Spey, Morayshire; own collection.

37/221 2 bush. cones; *Larix europaea ;* 1936; Blackcraig, Perthshire; own collection.

37/222 385 bush. cones; *Larix europaea ;* 1936; Kirkhill, Morayshire; own collection.

37/223 117 bush. cones; *Larix europaea;* 1936; Orton, Morayshire; own collection.

37/224 38 bush. cones; *Larix europaea ;* 1936; Innes, Morayshire; own collection.

37/225 43 bush. cones; *Larix europaea ;* 1936; Delfur, Morayshire; own collection.

37/226 5½ bush. cones; *Larix europaea ;* 1936; Monaughty, Morayshire; own collection.

37/227 52 bush. cones; *Larix europaea ;* 1936; Fanellan, Inverness-shire; own collection.

37/228 1 bush. cones; *Larix europaea ;* 1936; Minard, Argyllshire; Capt. Campbell.

37/229 2 bush. cones; *Larix europaea ;* 1936; Melfort, Argyllshire; Capt. Campbell.

37/230 5 lb.; *Larix leptolepis ;* 1936; Cumlodden, Argyllshire; Capt. Campbell.

37/231 2½ lb.; *Larix leptolepis ;* 1936; Gordon Castle, Morayshire; own collection.

37/232 7½ lb.; *Larix leptolepis ;* 1936; Blackhills, Morayshire; own collection.

37/233 ¼ lb.; *Pseudotsuga douglasii ;* 1936; Kilsture, Wigtownshire; own collection.

37/234 1 oz.; *Picea sitchensis ;* 1936; Kilsture, Wigtownshire; own collection.

37/235 1¼ lb.; *Thuya plicata ;* 1936; Benmore, Argyllshire; own collection.

37/236 1 lb.; *Tsuga heterophylla ;* 1936; Benmore, Argyllshire; own collection.

37/237 ¾ lb.; *Pinus insignis ;* 1936; Kilsture, Wigtownshire; own collection.

37/238 ¾ lb.; *Pinus pinaster ;* 1936; Inverliever, Argyllshire; own collection.

37/239 ¼ lb.; *Abies nobilis ;* 1936; Inverliever, Argyllshire; own collection.

37/240 25 lb.; *Abies nobilis ;* 1936; Benmore, Argyllshire; own collection.

37/241 ½ lb.; *Abies pectinata ;* 1936; Kilsture, Wigtownshire; own collection.

37/242 1½ oz.; *Cupressus macrocarpa ;* 1936; Inverliever, Argyllshire; own collection.

37/243 ½ lb.; *Cupressus sempervirens ;* 1936; Inverliever, Argyllshire; own collection.

37/244 ½ oz.; *Chamaecyparis lawsoniana ;* 1936; Inverliever, Argyllshire; own collection.

37/245 10 lb.; *Chamaecyparis lawsoniana ;* 1936; Benmore, Argyllshire; own collection.

37/246 90 lb.; *Araucaria imbricata;* 1936; Glenfinart, Argyllshire; own collection.

37/247 26 lb.; *Fraxinus excelsior ;* 1936; Garadhban, Stirlingshire; own collection.

37/248 72 lb.; *Fraxinus excelsior ;* 1936; Inverliever, Argyllshire; own collection.

37/249 34 lb.; *Fraxinus excelsior ;* 1936; Kirroughtree, Wigtownshire; own collection.

37/250 290 lb.; *Fraxinus excelsior;* 1936; Kilsture, Wigtownshire; own collection.

37/251 60 lb.; *Fraxinus excelsior ;* 1936; Fleet, Kirkcudbrightshire; own collection.

37/252 321 lb.; *Fagus sylvatica ;* 1936; Tulliallan, Clackmannan; own collection.

37/253 7 lb.; *Fagus sylvatica ;* 1936; Kirroughtree, Wigtownshire; own collection.

37/254 10 lb.; *Fagus sylvatica ;* 1936; Benmore, Argyllshire; own collection.

37/255 20 lb.; *Fagus sylvatica;* 1936; Forest of Ae, Dumfries-shire; own collection.

37/256 30 lb.; *Fagus sylvatica;* 1936; Fleet, Kirkcudbrightshire; own collection.

37/257 234 lb.; *Quercus robur;* 1936; Tulliallan, Clackmannan; own collection.

37/258 50 lb.; *Quercus robur;* 1936; Inverliever, Argyllshire; own collection.

37/259 1,176 lb.; *Quercus robur;* 1936; Dalbeattie, Kircudbrightshire; own collection.

37/260 3,493 lb.; *Quercus robur;* 1936; Kirroughtree, Wigtownshire; own collection.

37/261 90 lb.; *Quercus robur;* 1936; Benmore, Argyllshire; own collection.

37/262 87 lb.; *Quercus robur;* 1936; Bennan, Kirkcudbrightshire; own collection.

37/263 76 lb.; *Quercus robur;* 1936; Auchenroddan, Dumfries-shire; own collection.

37/264 45 lb.; *Quercus robur;* 1936; Newcastleton, Roxburghshire; own collection.

37/265 462 lb.; *Quercus robur;* 1936; Fleet, Kirkcudbrightshire; own collection.

37/266 150 lb.; *Quercus robur;* 1936; Forest of Ae, Dumfries-shire; own collection.

37/267 224 lb.; *Quercus robur;* 1936; Minto Estates, Roxburghshire; Buccleuch Estates, Ltd.

37/268 500 lb.; *Quercus robur;* 1936; Newbyth & Lennoxlove, Haddington; Newbyth & Lennoxlove Estate.

37/269 560 lb.; *Quercus robur;* 1936; Comlongon, Dumfries-shire; Comlongon Estate.

37/270 39 lb.; *Acer pseudoplatanus;* 1936; Monreith, Wigtownshire; gift from Sir H. Maxwell.

37/271 70 lb.; *Acer pseudoplatanus;* 1936; Tulliallan, Clackmannan; own collection.

37/272 65 lb.; *Acer pseudoplatanus;* 1936; Inverliever, Argyllshire; own collection.

37/273 15 lb.; *Acer pseudoplatanus;* 1936; Auchenroddan, Dumfries-shire; own collection.

37/274 108 lb.; *Acer pseudoplatanus;* 1936; Kilsture, Wigtownshire; own collection.

37/275 10 lb.; *Acer pseudoplatanus;* 1936; Castlemilk, Dumfries-shire; own collection.

37/276 21 lb.; *Acer pseudoplatanus;* 1936; Inverliever, Argyllshire; own collection.

37/277 60 lb.; *Acer pseudoplatanus;* 1936; Fleet, Kirkcudbrightshire; own collection.

37/278 ½ lb.; *Alnus incana;* 1936; Glenduror, Argyllshire; own collection.

37/279 5 lb.; *Alnus incana;* 1936; Inverliever, Argyllshire; own collection.

37/280 2 lb.; *Tilia europaea;* 1936; Glenfinart, Argyllshire; own collection.

37/281 10 lb.; *Acer platanoides;* 1936; Tulliallan Clackmannan; own collection.

37/282 ½ lb.; *Betula pubescens;* 1936; Glenduror, Argyllshire; own collection.

37/283 3 lb.; *Betula pubescens;* 1936; Inverliever, Argyllshire; own collection.

37/284 ¾ lb.; *Cryptomeria japonica;* 1936; Benmore, Argyllshire; own collection.

37/285 120 lb.; *Picea excelsa;* 1936; Roumania (Toplita, altitude 2,600–3,600 ft.); Roumanian Government; 97; 80.

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