R E S E A R C H.

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Experimental Work in England and Wales, December 1926.

ANNUAL REPORT by DR.H.M.STEVEN.

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PART I.

Introduction.

This year the Nursery investigations in England and Wales were located at the Bagley Nursery and the new Kennington Nursery, Oxford. There were two transplant experiments terminating at Rapley Nursery, Bagshot.

Nursery insect and fungal pests.

It is of interest to record the occurrence and status of the different pests and diseases which have had to be dealt with during the season.

The same insect pests were present as in 1925, namely, the chafers, Melolontha vulgaris, Serica brunnea and Rhizotrogus solstitialis; cutworms, larvae probably of Agrostis and Mamestra spp.; Chermes cooleyi on Douglas fir and C.strobilobius on larch. In general chafers did not give so much trouble this year because there was this summer a major flight of Melolontha and also, probably, of Serica. In consequence damage did not take place until towards the end of August instead of mid June as in a normal year. The same general method of control was used for the chafers as in 1925 and with the same success. It is as follows :-

1. The location of transplant beds as far as possible on ground which has been dug over or disturbed during the previous season while the larvae were within one spade depth of the surface.
2. In seedbeds the delaying of the digging until March when the larvae are normally ascending again and thus within reach of picking when the land is turned over.
3. The larvae which escape observation when digging and those from eggs laid since digging are dealt with by close observation of the beds and on the first sign of damage, Carbon bisulphide applied. Five gramme doses are injected, the number depending on the extent of the damage. In this way the amount of Carbon bisulphide is

restricted to that actually needed. No general application of the soil insecticide is made.

Each patch where damage takes place is recorded, the date of the damage, the number of plants destroyed and the number of injections given. The patch is observed periodically. In the majority of cases no further damage develops after one injection, in others two and, in a few cases, three injections are necessary before the damage ceases. A large body of evidence has thus been obtained on the effect of Carbon bisulphide for chafer control.

As usual cutworm damage began at the end of August, when the first larvae were found. Poisoned bran was used on the advice of Dr Munro but the most successful control was obtained with Carbon bisulphide used as against the chafers.

Chermes cooleyi threatened to do serious damage to rising 2 year seedlings of Douglas fir in experiments at Bagley Nursery. A Nicotine spray was used on the advice of Dr Munro. Trial showed it to be very effective against the adults and larvae and but less effective against the eggs. The spray was therefore repeated when the eggs had hatched and the plants were completely cleared of the pest. Similarly, Chermes strobilobius was destroyed on the larch.

Fungal diseases were more serious this season. A fairly severe attack of Meria laricis developed which did considerable damage and did not cease until the dry weather in the autumn. There are one or two interesting observations to record concerning this disease. In the first place it attacked a Density of Experiment which had varying densities and two methods of sowing, namely, broadcast and drill, the plots arranged on a Latin Square chessboard. The relation between method and density of sowing and Meria laricis was thus observed. It was found that neither method nor density of sowing was in any way correlated with intensity of attack. Secondly, there were plots of European larch from seed of a large range of origins including the Alps, Tyrol, Silesia, and Scotland. There was no correlation between origin of seed and infection or intensity of attack of Meria laricis, all were equally attacked.

Damping off fungi were unimportant except in one instance and that an interesting one. In the Weed control experiment to be described, one treatment was the wetting down of seedbed and paths with 1% Copper sulphate solution one week before sowing. This had the effect of upsetting the tilth and delaying germination about three weeks, until July instead of June in the other treatments. Germination was ultimately almost as good as in the control but towards the middle of July a severe attack of damping off developed and about 75% of the seedlings died. The casual fungus was probably a Fusarium sp. - as in the previous season. The plots of other treatments which germinated earlier escaped damage, although all were scattered together on a Latin Square Chessboard. There are two points of some interest, first of all the apparent close correlation between the time and conditions under which germination takes place and Fusarium damping off and secondly, that the presence in the soil of the copper radicle in the quantity applied did not act as a fungicide.

Microsphaera on the Oak developed in June and again in August. 1% Salt solution was tried but it damaged the foliage. Sulphur was used for dusting. This was only slightly effective and is a costly method,

Soil Conditions.

Bagley Nursery.

See the 1925 Report for details. The soil is a stony loam on Plateau Gravel.

Kennington Nursery.

The nursery was grass land until the end of 1925. There were abundant deep rooted weeds e.g. Dandelion, Plantain, etc., amongst the grasses. The soil is a deep, almost stoneless brown, sandy loam on Calcareous grit sandstone. It works well, its only drawback is a tendency to bake hard under dry hot conditions but this has not yet taken place.

32 samples scattered throughout the nursery were taken for mechanical analysis in three fractions. 65% - 75% is Fine gravel and coarse sand, 15% - 25% Fine sand and silt. 1% - 2% Fine silt and clay with a little hygroscopic moisture and 3% - 5% organic matter. The PH values range from 6.5 to 7.0 for the first 9 inches and 7.0 to 7.25 for the subsoil, thus less acid than most nursery soils. The amount of $CaCO_3$ is almost nil.

Weather Conditions.

The following Table gives an analysis of the meteorological data taken in the Kennington Nursery, Oxford.

Month 1926.	Temperatures in degrees F.				Rainfall in inches.	Mean Humidity %	No. of days 32° F. in screen and under.
	Mean Max.	Mean Min.	Highest	Lowest			
February	53	43	57	35	.29	84	0
March	50	37	59	27	.64	82	7
April	56	40	71	30	2.22	80	2
May	58	41	75	29	2.51	77	1
June	65	47	73	39	2.44	75	0
July	71	54	84	43	2.58	79	0
August	70	51	82	41	1.34	82	0
September	66	50	85	35	1.36	87	0

Features of this season were :-

1. February was unusually favourable for lining out, dry but mild.
2. March had no rain from 10 - 24th inclusive and during that period, there were strong drying N. and N.E.winds, unfavourable to lined out plants.
3. April - July had no deficiency of rain and temperatures were normal for the seasons. There were no prolonged periods of dry, hot weather. Conditions for germination remained favourable throughout the season and also favoured fungal diseases.
4. August and September had dry periods. The highest temperature of the season, 85° F. was on the 19th Sept-

ember. The growing season was prolonged.

Lath shelter, laths 1" wide, spaced ½" apart were applied to the 1926 seedbeds, when the maximum screen temperatures during germination exceeded 65°F. for two or more days and when germination was advanced the index temperature used was 70°F. When the soil was moist 70°F. was used throughout. The following Table gives the movements of shelter :-

On	Off	On	Off	On	Off
30.6.26	5.7.26	10.7.26	19.7.26	30.8.26	31.8.26

Seed Data.

As in previous years, the seedling studies were limited to the species which give difficulty in the nursery, namely, Douglas fir, Sitka spruce and European larch. In the race studies a large number of other species were raised. The following Table gives the seed data :-

Species.	Ident. No.	Purity %.	Germination. Jacobsen %		Hearson %		Sand %	
			%	Fresh Seed.	%	Fresh Seed.	%	Fresh Seed.
Tests. March 1926.								
Douglas fir	26/15	91.9	43	7	36	17	53	-
Sitka spruce	25/16	89.9	71	2	68	4	84	-
European larch	26/1	78.6	35	2	37	2	33	-
Tests. June 1926.								
Douglas fir	26/15	89.5	42	1	37	7	33	-
Sitka spruce	25/16	85.9	68	2	62	1	66	-
European larch	26/1	73.6	31	3	33	4	26	-

The quality of the seed fell slightly below normal for each species. There was a slight falling off in quality during March - June as is usual although stored in air tight bottles.

PART 2.

Nursery Investigations.

(a) Seedling Studies.

1. The relation between Season of Sowing and Germination and Growth.

Registered Experiment N.S. No.1.

This Experiment was carried out with three species, Douglas fir, 26/15, Sitka spruce, 25/16 and European larch, 26/1, at Bagley Nursery.

The sowings were made with the standard zinc plates and the nursery technique was that used in the previous year. The following are data for density and depth of sowing :-

Douglas fir 200 seeds per square foot. ¼" depth.
Sitka spruce 300 seeds per square foot. ⅛" depth.
European larch 300 seeds per square foot. ⅛" depth.

The sowings were made at six seasons between mid-March and June. The unit was two plates each 1 square foot. There were six repetitions of two plates for each of the six season, the plots being arranged on a Latin square chessboard. The seed was soaked for 7 days in tap water, the water being changed at the end of the 3rd day. The seed was red leaded.

The following Tables summarise the results.

Table I. Douglas fir.

Time of Sowing.	Germination % at				Mean Seedling Size.
	16.6.26.	6.7.26.	4.8.26.	12.10.26 x	
A. 17.3.26	50.6	53.2	55.0	53.9 ± 1.11	2½"
B. 1.4.26	43.4	47.4	50.9	47.4 ± 1.46	2"
C. 17.4.26	38.7	44.0	47.7	46.0 ± 1.49	2½"
D. 3.5.26	21.0	27.0	34.8	32.3 ± 1.78	2"
E. 20.5.26	19.6	24.6	37.8	37.8 ± 1.33	1¾"
F. 4.6.26	0	10.8	24.3	25.4 ± 1.27	1½"

x Standard Deviation of Mean.

Table 2. Sitka spruce.

Time of Sowing.	Germination % at							Mean Seedling Size.
	5.5.26	31.5.26	7.6.26	16.6.26	6.7.26	4.8.26	11.10.26	
17.3.26	25.8	52.6			52.0	53.3	51.4 ± 1.34^{x}	1¼"
1.4.26			25.7		38.8	43.8	43.7 ± 2.25	1"
17.4.26			44.6		55.1	57.4	55.7 ± 2.28	1¼"
3.5.26			36.5		57.3	60.5	57.4 ± 1.93	¾"
19.5.26				60.0	61.4	62.0	59.9 ± 1.69	¾"
3.6.26				0	58.8	58.6	55.9 ± 1.80	½"

^{x}Standard Deviation of Mean.

Table 3. European larch.

Time of Sowing.	Germination % at							Mean Seedling Size.
	23.4.26	4.5.26	7.6.26	16.6.26	6.7.26	4.8.26	12.10.26	
18.3.26	9.4	17.4		22.1	21.6	21.8	21.3 ± 1.04^{x}	2"
2.4.26	2.6	13.3	23.0		21.3	21.6	$20.4 \pm .95$	2"
19.4.26			15.0		13.8	14.2	13.5 ± 1.14	2"
4.5.26			16.4		16.1	16.4	$15.7 \pm .88$	1½"
20.5.26				20.6	20.3	20.4	$19.4 \pm .84$	1"
4.6.26				.7	12.2	13.9	$13.1 \pm .53$	¾"

^{x}Standard Deviation of Mean.

During September there was slight damage from Melolontha grubs and cutworms. These were successfully controlled by Carbon bisulphide injections. The losses were recorded and the seedlings so lost are not included in the above percentages.

Observations and Conclusions.

1. It will be noted that, relative to the percentage of viable seed, the plant percentages are high, and are quite up to those of the previous season. It is now well established that a very high proportion of the possible number of seedlings can be obtained under the best nursery practice.
2. The 1926 results for Douglas fir confirm the requirements of this species, namely, that early spring sowing, not later than

mid April, gives significantly higher production and larger seedlings.

3. In Sitka spruce the rainy spring and early summer made its now established sensitiveness to surface tilth important. The later sowings which germinated more rapidly were significantly better than the first two in production but not growth.

4. The results for European larch are always more irregular. On the whole the March and early April sowings were best.

2. Weed Problems.

Registered Experiment N.S. No.21.

This subject was again studied fully. There was a special study on the efficiency of different treatments on weed control while the relationship of season of sowing, density, etc., to weed growth was studied further.

In the special experiment to study treatments the following methods were used:-

I. Control; no treatment.

2. Covering soil treated with a 1% Copper sulphate solution, 1 gallon to 2 cubic feet of soil, 7 days before use.

3. 7 days before sowing the roughly prepared bed and paths were treated with a 1% $CuSO_4$ solution, 1 pint to 1½ square feet.

4. The seedbed prepared 7 days before sowing and the bed hoed to kill germinating weeds.

5. After sowing the bed was gone over with a blowlamp.

As before Sitka spruce was used as an indicator. The density of sowing was 1 lb. to 450 square feet, broadcast. The unit plot was 9 square feet which was repeated 5 times on a Latin square chess-board. The sowing was made on the 6th May 1926.

The principal weeds which had to be dealt with were Poa annua, Rumex acetosa and Spergularia rubra.

The following Table summarises the results:-

Table 4.

Treatment.	Mn. No. of Minutes of I man on 7.6.26	21.7.26	23.9.26	Total	Mn. No. of seedlings per sq.ft.
I. Control	24	17	2	43	140 ± 23[a]
2. Covering soil treated with 1% $CuSO_4$	7	7	1	15	160 ± 18
3. Seed bed wet down with 1% $CuSO_4$ before sowing	0	0	0	0	129 ± 13[b]
4. Seed bed prepared in advance	34	21	2	57	147 ± 14
5. Blow lamp treatment	20	13	4	37	151 ± 13

[a] Standard Deviation of the Mean.

[b] In Treatment 3 the tilth was upset sufficiently to delay germination for 3 weeks until mid July. Damping off from Fusarium followed and of the 129 ± 13 seedlings only 30 ± 10 per square feet survived. There were few if any damping off losses in the other Treatments. In Treatments 1, 2, 4 and 5, germination took place during the second half of June in dry, cool weather, with low relative humidities. In Treatment 3 germination took place towards the middle of July in showery, hot weather, with generally high relative humidities. This appeared to favour Fusarium damping off.

Observations and Conclusions.

I. No treatment affected seedling production significantly but Treatments 3 affected the tilth sufficiently to cause the losses referred to above.

2. Treatment 3 eliminated weeds. The continuation of the 1925 Experiment showed that the effect persisted during the second season.

3. It is a 75 chance to I that Treatment 2 gave a significant reduction in weeds. The continuation of the 1925 treatment showed that the effect persisted during the second season.

4. Treatment 4 gave no improvement. This method only gives an improvement with late sowing i.e. during a period favourable for rapid germination of weed seeds.

5. It is only a 3 to 1 chance that the blow lamp treatment gave better results.

General Conclusions.

In a copper treatment we have a method of potential value. Method 2 is not considered to be applicable widely in practice and more practical treatments such as No. 3 have produced tilth complications. Now that facilities are available it is proposed to extend and intensify this study.

Relation between Density of Sowing and weed growth.

This was studied in the density experiments. It was reported in 1925 that there was no correlation between density of sowing and weed growth. During the second year there is a correlation, the densest plots take only one half to two thirds the time to weed as the lightest sown plots. However, as little weeding is required during the second year no important sowing is thereby made.

Relation between Method of Sowing and Weed growth.

There was no correlation during the second year thus confirming previous results.

Relation between Time of sowing and weed growth.

The following Table gives the comparative data:-

Season of Sowing.	No.of Weedings.	Total Weeding Time 1 man per sq.yard.
17.3.26	4	50 min ± 12 S.D.
1.4.26	3	51 min ± 10 S.D.
17.4.26	3	31 min ± 6 S.D.
3.5.26	3	28 min ± 5 S.D.
19.5.26	3	13 min ± 3 S.D.
3.6.26	3	19 min ± 3 S.D.

Although less marked than the previous year early sowing involves greater weed costs.

3. The relation between method amd Density of Sowing and Production, growth and quality, as measured by subsequent development.

Registered Experiment N.S. No.10.

An investigation on this subject is in progress for Douglas fir, Sitka spruce and European larch. The two year seedlings are now being lifted and the first results will be available shortly.

Seedlings from the different methods and densities are being lined out in controlled plots with a view to assessing their quality in the transplant lines.

4. Tilth Studies.

Registered Experiment N.S. No.22, Bagley Nursery.

The investigation of the influence of tilth conditions on production was studied further and extended to Douglas fir, Sitka spruce and European larch. As a result of the previous year's work the study was directed to seed coverings.

The following treatments were carried out:-

1. Control, ordinary nursery soil as seed covering.
2. ditto with the sowing of ground limestone at the rate of 2 ounces per 9 sq.ft. (5 - 6 cwts. per acre).
3. A covering of a mixture of nursery soil and hardwood humus in the proportions 2 to 1 by volume.
4. Coarse sand as seed covering.

In view of the adverse influence of Calcium hydroxide in a moderately heavy dressing in the previous season a change to Calcium carbonate was made and the dressing much reduced.

The unit plot was 18 sq.ft. which contained four 3 feet drills of Douglas fir, Sitka spruce and European larch. The plot was repeated four times in a Latin square chessboard.

The density of sowing was :-

Douglas fir - 2 grammes per drill approx.
1 lb. to 290 square feet.

Sitka spruce- 1 gramme per drill approx.
1 lb. to 580 square feet.

European larch-2 grammes per drill approx.
1 lb. to 290 square feet.

The seed was soaked and red leaded as usual and sown on the 30th April 1926.

The following Table summarises the results to date:-

Table 5. Douglas fir.

Treatment (see above)	No. of seedlings per drill at 24.6.26 Mn. S.D.	21.7.26 Mn. S.D.	30.8.26 Mn. S.D.
I. Control	25 ± 1.3	53 ±2.3	50 ± 2.4
2. Lime	30 ± 2.1	62 ±2.7	66 ± 2.7
3. Humus	35 ± 1.6	63 ±2.6	67 ±2.8
4. Sand	26 ± 1.8	54 ±2.6	57 ± 2.7

Table 6. Sitka spruce.

Treatment (See above)	No. of seedlings per drill at 3.6.26 Mn. S.D.	24.6.26 Mn. S.D.	21.7.26 Mn. S.D.	2.9.26 Mn. S.D.
1. Control	24 ± 2.2	123 ± 6.7	144 ±7.1	132 ± 7.5
2. Lime	18 ± 1.6	120 ± 5.5	145 ±7.2	137 ±7.1
3. Humus	23 ± 1.9	122 ± 7.0	139 ±7.9	134 ±8.0
4. Sand	102± 5.9	167 ± 8.4	182 ±9.0	162 ±8.6

Table 7. European larch.

Treatment (See above)	No. of Seedlings per drill at 3.6.26 Mn. S.D.	24.6.26 Mn. S.D.	21.7.26 Mn. S.D.	31.8.26 Mn. S.D.
1. Control	28.0± 2.4	29 ±2.4	30 ±2.7	31± 2.6
2. Lime	28 ± 1.2	30 ±1.7	33 ±1.9	32±1.8
3. Humus	30 ± 1.8	34 ±2.1	35 ±2.7	34 ±2.6
4. Sand	44 ± 1.6	51 ±1.6	53 ±1.6	52 ±1.6

Observations and Conclusions.

Douglas fir.

1. The only seed covering which significantly increased the rate of germination as based on the first count was No.3, the Soil-humus mixture.

2. Treatments Nos. 2 and 3, namely, Calcium carbonate at the rate of 2 ounces per square yard (5 -6 cwts per acre) and the Soil humus mixture both increased final germination significantly.

Sitka spruce.

1. No. 2 Calcium carbonate depressed the rate of germination significantly. No. 4, sand, increased it more than fourfold.

2. The only treatment which increased final germination was No.4, sand.

3. These confirmed, in general, the previous year's results.

European larch.

1. Treatment 4, sand, increased the rate of germination significantly.

2. This treatment also had a marked influence on the final germination.

General conclusion.

It is clear that these three species react differently to tilth. Douglas fir is relatively insensitive hence the success of early sowing. Sitka spruce and to a less extent European larch are very sensitive and respond markedly to coverings which do not cake, e.g. sand. Important increases in production can be obtained in these two species by appropriate seed coverings. The use of suitable sand, when available, is worthy of trial on a larger scale for Sitka spruce and European larch as both species only require thin coverings.

5. Hardwood Studies.

Registered Experiment N.S. No.23, Bagley Nursery.

A preliminary experiment was carried out with oak, the subject being winter and spring sowing, in conjunction with different methods of acorn storage. It was as follows:-

1. Acorns sown in December.
2. Acorns stored in sand in the open air, protected with netting and sown in April.
3. Ditto but under hardwood leaves and sown in April.
4. Acorns stored in a dry open shed and sown in April.

Two lots of acorns were used :-

(a) Reputed sessile, Floating test gave 79% sound cutting test 70%.

(b) Pedunculate from Swaffham, Floating test gave 68% and cutting test 72%.

1,000 of each lot for each treatment were used and sown in drills of 50 in five repeated plots.

Although the beds were enclosed with fine mesh netting, covered with strong netting and trapping was done systematically, the December sowing suffered damage from mice and jays. Excluding the drills so attacked the results were as follows:-

Treatment.	Germination % 13.10.26 Reputed Sessile	Pedunculate.
1	69%	66%
2	69	66
3	68	61
4	29	17

Observations and Conclusions.

1. It will be noted that the winter sown acorns germinated well but where there is danger of damage from mice etc., as at Bagley, such sowings are undesirable.
2. Storage in moist sand or leaves gave good results although 70% of the acorns had sprouted before sowing.
3. Dry storage gave poor results although the acorns looked sound and fairly plump when sown.

6. Studies on Race and Type of Trees.

Registered Experiment N.S. No.24.

This investigation was continued and added to. The species now under study include Scots pine, European larch, Oak, Douglas fir, Sitka spruce, Pinus contorta and Pinus ponderosa.

Two year seedlings of European larch from a range of origins, including the Alps, Silesia and Scotland are being lifted and the first assessment of quality made.

These species are being studied at each nursery stage and will be followed out into the field. Particularly in Douglas fir, differences are appearing in botanical characters, growth and liability to frost damage.

Part 2. Nursery Investigations.

(b) Transplant Studies.

7. The relation between spacing of transplants and losses, growth and subsequent survival and development.

Registered Experiment N.S.No.18.

The results obtained when the transplants from this experiment in 1925 were lifted in March 1926 have already been reported (See Appendix I.) and will not be included here. Data is now available for losses in these plants of four species at the end of the first season in the forest.

Table 8.

Species.	Where planted out.	Percentage Losses and S.D. at end of 1926 in stock raised in nursery lines spaced			
		10" x 1"	10" x 1½"	10" x 2"	10" x 3"
Scots pine	Bramshill	1% ± .5	2% ± .6	2% ± .6	1% ± .6
Corsican pine	Bramshill	10% ± 2.2	8% ± 1.9	11% ± 2.3	10% ± 1.9
European larch	Swaffham	20%	21%	24%	24%
Douglas fir	Swaffham	34%	26%	31%	29%

Conclusion.

1. The results in the forest are similar to those obtained in the nursery, namely, that the losses do not appear to be influenced by spacing in the nursery lines.

The second repetition of this study, was carried out at Kennington Nursery, Oxford, with Scots pine, Corsican pine, Norway spruce, Sitka spruce, European larch and Douglas fir. The stock was graded to give average plants i.e. the very large and culls were excluded. The following Table gives relative data :-

Ta le 9.

Species.	Seed Ident. No.	Age.	Nursery of Origin.	Seedbed soil.	Shoot length limits	Seedbed Density.
					inches	per sq.ft.
Scots pine	24/26	2 yr.	Rapley.	Sand	3 - 6	67
Corsican pine	24/13	2 yr.	Rapley.	Sand	1½- 3	60
Norway spruce	-	2 yr.	Alice Holt.	Clay loam	2 - 4	222
Sitka spruce	24/15	2 yr.	Bushfield.	Sandy loam	3 - 6½	61
European larch	24/11	2 yr.	Bushfield.	Sandy loam	3 - 6½	29
Douglas fir	24/1	2 yr.	Bushfield.	Sandy loam	4½-10	35

The unit for each species was a plot of 3 rows, each ten feet long. This was repeated four times in a Latin square chessboard. The spacing between the lines was 10" throughout and the spacing within the lines 1", 1½", 2" and 3" respectively The open trench system with boards was used. The Lining out was done during February and March, 1926, the Scots pine was lined out first and the Corsican pine last. There was no error due to difference of time of lining out, as the four spacings were scattered evenly throughout the period of lining out for each species.

The following Table summarises the data to the end of the first season. The species other than the spruces will be lifte[d] and graded in the spring 1927 and studied further when planted out in the New Forest.

Table 10.

Species.	Losses per cent. and Standard Deviations in Nursery Spacings.							
	10" x 1"		10" x 1½"		10" x 2"		10" x 3"	
	16.7.26	7.10.26	16.7.26	7.10.26	16.7.26	7.10.26	16.7.26	7.10.26
[Sco]ts pine	4%	8 ± .9	6%	7 ± 1.3	7%	8 ± 1.9	5%	6 ± .8
[Cor]sican pine	38	43 ± 1.7	31	42 ± 2.6	37	50 ± 2.5	38	58 ± 3.2
[Nor]way spruce	6	8 ± 1.0	7	8 ± 1.8	5	6 ± 1.3	5	6 ± 1.2
[Sit]ka spruce	2	4 ± .6	2	2 ± .4	2	4 ± .6	2	2 ± .7
[Eur]opean larch	4	7 ± 1.1	2	4 ± .7	2	2 ± .6	2	2 ± .6
[Dou]glas fir	2	3 ± .5	2	2 ± .4	1	1 ± .3	1	1 ± -

Observations and Conclusions.

1. It will be noted that, with the exception of Corsican pine, the losses are low especially for a new nursery, which was grass land the previous season. The Corsican pine suffered from the dry N. and N.E. winds in March after lining out.

2. With the exception of Corsican pine, spacing in the transplant line within the limits of 1" and 3" has had no influence whatever on losses. In the case of Corsican pine the two wider spacings gave significantly higher losses than the two closer spacings. This may be correlated to mutual protection from drying winds.

General conclusion.

It is not proposed to draw final conclusions until the investigation covers three seasons with field trials of the stock following. The evidence from the seasons 1925 and 1926, both in the nursery, and the field, indicates that close spacings are safe and that under conditions which seem to favour wider spacings namely, luxuriant growth. If this is finally substantiated and applied, important economies will follow because labour charges for digging and weeding are on an area basis,hence the cost per unit number of stock falls with increasing density. Further, as has already been shown, the cost of lining out per unit number, particularly with boards, falls almost pro rata with closer spacing.

8. The influence of the Grading of seedlings on losses,growth, subsequent survival and development.

Registered Experiment N.S. No.19.

The results obtained when the transplants from this experiment in 1925 were lifted in March 1926 have already been reported on (see Appendix I).

Data is now available for losses in these plants for four species at the end of the first season in the forest. No quality assessment for culls etc., can yet be made fairly.

Table 11.

Species.	Where Planted out.	Percentage loss and S.D. at end of 1926 in stock from seedlings graded before lining out as Grade I.	Grades 1 & 2.	Grade 2.	Grade 3.
ots pine	Bramshill	4% ± 1.1	7% ± 3.0	4% ± 1.0	12% ± 1.0
rsican pine	Bramshill	16 ± 3.0	13 ± 2.2	18 ± 4.6	28 ± 2.0
ropean larch	Swaffham	8 ± 2.5	17 ± 2.8	19 ± 1.2	54 ± 4.7
uglas fir	Swaffham	24 ± 3.2	31 ± 3.0	26 ± 1.0	40 ± 4.7

Conclusion.

This first trial indicates that there is no marked difference in losses in these species from stock from seedlings Grades I, I & 2, and 2. In the case of Grade 3, the culls, the markedly heavier losses encountered in the nursery are continued in the forest but to a less extent excepting European larch. It should be noted that no grading was done at the time of lifting in the nursery and these plants represent the product from the original seeding grading.

This subject was studied further at Kennington Nursery during 1926 with Scots pine, Corsican pine, Norway spruce, Sitka spruce, European larch and Douglas fir.

The same system of seedling grading was applied as in 1925 namely:-

Grade I. Seedlings one half the maximum shoot length (not considering exceptionally large plants), with the exceptions noted in Grade 3.

Grade 2 . Seedlings less than one half the maximum shoot length, with the exceptions noted in Grade 3.

Grade 3. Culls, i.e. badly rooted, suppressed, drawn, weakly, damaged and diseased seedlings.

This worked out for the different species as follows :-

Table 12.

Species.	Grade Description and Proportion.		
	Grade I.	Grade 2.	Grade 3, culls.
Scots pine	4" and over 33%	Under 4" 59%	Multiple tops and badly rooted 7%.
Corsican pine	2" and over 13%	Under 2" 63%	Unripened lammas shoots and badly rooted 23%.
Norway spruce	3" and over 32%	Under 3" 42%	Multiple tops, suppressed and badly rooted 25%.
Sitka spruce	5" and over 10%	Under 5" 66%	Severely cockchafer damaged roots and very small seedlings 23%.
European larch	4½" and over 32%	Under 4½" 66%	Multiple tops and very small seedlings 1%.
Douglas fir	7" and over 9%	Under 7" 43%	Suppressed and severely cockchafer damaged roots 46%.

For origin and description of stock, lay out and technique used see Registered Experiment N.S. No. 18 just described. The spacing was 10" x 2". In the section "Grades I and 2" only the culls were removed. The following Table summarises the data to date:-

Table 13.

Species.	Losses per cent. and Standard Deviations in and at							
	Grade I.		Grades I & 2.		Grade 2.		Grade 3.	
	23.7.26	7.10.26	23.7.26	7.10.26	23.7.26	7.10.26	23.7.26	7.10.26
ts pine	1%	2 ± .4	6%	7 ± 1.6	10%	18 ± 1.6	32%	36 ± 2.1
sican pine	13	28 ± 2.5	18	24 ± 2.6	27	35 ± 1.9	53	56 ± 2.4
way spruce	3	3 ± .7	3	4 ± .4	5	7 ± .6	15	18 ± 2.4
ka spruce	0	2 ± .6	5	7 ± 1.4	3	3 ± .6	14	17 ± 1.9
opean larch	1	2 ± .7	3	4 ± .7	2	3 ± .5	10	13 ± 1.6
glas fir	1	2 ± .4	3	3 ± .9	2	3 ± .7	13	15 ± 1.3

Observations and Conclusions.

I. This season's results agree closely with those obtained in 1925 at Rapley nursery.

2. In Scots pine and Corsican pine significantly higher losses were obtained in Grade 2 and Grade 3 seedlings compared with the better grades.

3. In Norway spruce, Sitka spruce, European larch and Douglas fir, there are no really significantly increased losses until one comes to Grade 3 and the losses there are relatively higher than in the previous season.

General Conclusion.

It is not proposed to draw final conclusions until after three seasons and with forest trial assessments. The evidence to date, however, is that it is in Scots pine and Corsican pine that culls suffer the greatest mortality.

Part 3. Planting Investigations.

I. Relation between Season of Planting and losses and growth of Corsican pine.

Registered Experiment P.S. No.501.

This experiment was continued at Wangford, Thetford Chase. The influence of autumn planting was studied particularly and the first year's results from the monthly planting from September 1925 to April 1926 are now available.

For description of the site and methods see the 1925 Report.

The following Table summarises the results up to December 1926:-

Table 14.

Season of Planting.	Loss Percentage and S.D. at 3.7.26	18.12.26
15. 9.25	11%	21% ± 3.1
15.10.25	1	6 ± 1.3
15.11.25	1	3 ± .6
15.12.25	.5	5 ± .6
15. 1.26	1.5	4 ± .7
15. 2.26	4.0	8 ± 1.2
15. 3.26	4.0	18 ± 2.0
15. 4.26	9.0	32 ± 3.3

It will be noted that an endeavour was made to meet the objection that a favourable day is selected for planting by having the planting done on the same date in each month.

Although the 1 ft. plants had the lowest losses, the majority have been frosted.

Wykham, Allerston.

3 feet plants once transplanted, 2 feet plants twice transplanted.

Type of Plant.	Loss % during the first season.
3 feet	12%
2 "	1
1 "	3

There has been little frost damage to date.

Allerston.

Type of Plant.	
2½ feet twice transplanted	Few deaths, no frost damage.
1 foot once transplanted	Few deaths but much frost damage.

Observations.

1. No conclusion can yet be made but it is indicated that the use of larger plants of Sitka spruce avoids frost damage.
2. Twice transplanted large stock, where it is to be large, is more easily established than once transplanted stock.

Part 4. Major Afforestation Problems in England and Wales.

As a result of divisional visits in 1925 the following major afforestation problems were defined :-

1. North Tyne Peat Areas.
2. North Wales Peat Areas.
3. Eastern Yorkshire Moor Problems.
4. Direct Sowing Problems.
5. Bagshot Sand Problems.
6. The Oak Problem.

The Technical Commissioners directed that the North Tyne and North Wales areas were most pressing.

North Tyne.

During July 1926 a silvicultural study was made of the North Tyne Valley. This is the subject of a special report.

The following subjects were dealt with :-

1. The definition of the principal vegetation types and their succession in relation to silviculture.
2. The study of the data afforded by existing plantations on the plantability of different vegetation types, the choice of species and their establishment.
3. The formulation of a scheme of Experimental work.

Experiments are now being planned at Smales on the basis of this report.

North Wales.

Three experimental areas have been demarcated at Hafod Ruffwd and work has been proceeding on them since the spring of 1926. The only point of interest to report is the satisfactory results obtained during the first season with Belgian turfing.

General.

1. At the request of the Technical Commissioner a study of the literature on the cultivation of Walnut was made and a Report entitled "Walnut Culture" submitted.
2. The Sample Plot party was supervised in England and Wales and visits to plots at Welshpool, Vyrnwy and Bagshot made. The whole of the temporary plots in England and Wales were card indexed and cross referenced. Similar work is proceeding on the Permanent Plots. Data on the condition of the permanent plots is being collected. A programme for future Sample Plot work in England and Wales was formulated.
3. Ordinary and Advanced lectures on Artificial regeneration were delivered at the Imperial Forestry Institute, Oxford.

31.12.26.

APPENDIX I.

Registered Experiment N.S. No.18. (1925 - 27).

Rapley Nursery.

Table giving the percentage losses during one year in the transplant lines divided into deaths during season and culls when lifted in March 1926.

	Spacing 1".			Spacing 1½".			Spacing 2".			Spacing 3".		
	D %	C %	T % S.D.	D %	C %	T % S.D.	D %	C %	T % S.D.	D %	C %	T % S.D.
.	-	-	- -	Not lifted as 2yr. 1yr.								
.	-	-	- -									
.	2.0	4.7	6.7 ± .82	2.0	2.7	4.7 ± .67	1.1	1.8	2.9 ± .74	1.8	1.1	2.9 ± .67
.	1.9	10.1	12.0 ± .92	2.5	9.8	12.3 ± 1.23	1.0	9.0	10.0 ± 1.29	1.8	7.9	9.7 ± 1.42
.	4.4	5.7	10.1 ± 1.07	5.7	2.6	8.3 ± 1.14	4.4	.3	4.7 ± 1.02	5.8	.4	4.2 ± .71
.	3.4	2.4	5.8 ± 1.14	5.5	1.4	6.9 ± 1.01	6.4	1.7	8.1 ± 1.85	1.8	1.1	2.9 ± .86

Sp. .... Species.

N.S............. Norway spruce.

S.S............. Sitka spruce.

D.F............. Douglas fir.

E.L............. European larch.

S.P............. Scots pine.

C.P............. Corsican pine.

D. % ..... Deaths per cent

C. % ..... Culls " "

T. % ..... Total " "

APPENDIX.

Registered Experiment N.S. No. 19. (1925 - 1927).

Rapley Nursery.

Table giving the percentage losses during one year in transplant lines divided into deaths during season and culls when lifted in March 1926.

p.	Grade I.				Grades I & 2.				Grade 2.				Grade 3.			
	D	C	T		D	C	T		D	C	T		D	C	T	
	%	%	%	S.D.	%	%	%	S.D.	%	%	%	S.D.	%	%	%	S.D.
.	-	-	-	-	-)	Not lifted as			2yr.	1 yr.						
S.	-	-	-	-	-)											
F.	1.9	2.5	4.4	± .67	1.2	2.1	3.3	± .68	3.0	4.4	7.4	±1.50	16.1	24.8	40.9	±1.7
L.	.6	6.4	6.9	±1.24	2.7	11.5	14.2	±1.32	2.0	11.9	13.9	±1.13	9.8	16.0	25.8	±2.1
P.	2.1	0	2.1	± .62	4.2	4.2	7.8	±1.11	13.5	4.0	17.5	±2.19	46.7	20.9	67.6	±2.2
P.	3.7	.3	4.0	±1.01	2.2	.4	2.6	± .76	6.0	1.8	7.8	±1.56	32.9	9.4	42.3	±2.2

Sp................. Species.
N.S................ Norway spruce
S.S................ Sitka spruce
D.F................ Douglas fir
E.L................ European larch
S.P................ Scots pine
C.P................ Corsican pine.

D. % ....Deaths per cent.
C. % ....Culls per cent.
T. % ....Total per cent.

REPORT ON PERMANENT SAMPLE PLOT WORK

1925 - 1926.

I N D E X.

SAMPLE PLOTS.

Annual Report by Mr. J.Macdonald, 1925/26.

The following is a report of the work carried out by the Sample Plot Parties under my supervision in the year ended 30th September 1926 I have to thank Dr.H.M.Steven for carrying on the work during my absence on sick leave in March and to thank also Dr.M.L.Anderson for taking charge of one party in Scotland while I was in England with the other.

The following is the list of plots which have been dealt with in the year under review.

	New Plots.	Remeasurements.
England and Wales	1	14
Scotland	3	24
	4	38

The present position with regard to the number of Plots in each country is as follows:-

	England.	Scotland.
No. of Plots laid down up to September 1925.	84	72
Less plots abandoned (Cressage 1. Dymock 4)	5	-
At beginning of present year	79	72
New Plots 1926	1	3
	80	75
Abandoned 1926	-	3x
Present Totals	80	72
	Grand Total 152.	

x Plot 7 Felled.
Plot 12 Blown.
Plot 63 Blown.

This marks a decrease of one in the number of effective plots.

During the year, Miss Bell and Miss Dunn have departed and their places have been taken by men.

The women assistants had given splendid service and so thoroughly were they acquainted with the work that it was felt that they would be difficult to replace. Nevertheless the new arrangement is working well and the men who have been chosen as Sample Plot Assistants are giving satisfaction.

There follows a series of descriptive notes on the Plots which have been dealt with in the course of the year together with the Final Summary data.

New Plot. England and Wales.

Plot No.85. Mixed Jap.Larch and Douglas Fir. Lake Vyrnwy Montgomery.

This plot was established as a sylvicultural experiment and not for the purpose of obtaining yield table data though this purpose may be served in part.

It was laid down in a plantation formed in 1908 with a mixture of Douglas Fir and Japanese Larch planted alternately at about 4'6". At the beginning, the Jap.Larch sprang ahead and succeeded in maintaining the lead and in almost completely suppressing the Douglas. When the plot was formed, the great majority of the Douglas, though capable of further development, were suppressed and far below the larch which formed a complete canopy over them. Only in one or two places had the Douglas struggled into the upper storeys. The object in treating the plot was to find out whether it would be possible by thinning, to revive the Douglas and to leave a crop of almost pure Douglas on the ground. Accordingly, a heavy thinning was made in the Japanese Larch and the Douglas left practically untouched. It will be interesting to see what the result will prove to be. Further treatment may be necessary in two years time.

A measurement was taken of the Japanese Larch by the usual Sample Plot method while the volume of the Douglas was estimated over-bark.

The figures are:-

Japanese Larch.

Age 19. No. of trees per acre, 483. Mean Height, 37 feet. Mean Girth 16 inches. Form Factor, ·367. Basal area per acre, after thinning, 68.2 sq.ft.

Volume per acre after thinning, 926 cubic feet.

In the thinning, 397 trees per acre were removed, with a mean height of 36 feet, mean girth of 14½ inches. Basal area of 46.4 sq.ft. and Volume of 569 cubic feet per acre.

The total volume was thus 1495 cubic feet and the mean annual increment has been 79 cubic feet.

There were left 1037 Douglas to the acre, with a mean girth of 8 inches and a volume over-bark (estimated) of 271 cubic feet per acre.

Remeasurements. England and Wales.

Plot No.23. Japanese Larch. Leighton, Montgomeryshire.

This plot is in an excellent plantation of Japanese Larch grown at an elevation of 1100 feet and with a northerly exposure.

On establishment, it was thinned to a D.grade, but in 1926 a moderate C.grade thinning was applied.

The crop is of a very good type, wavy and deformed stems being the exception. Growth continues good and there is no immediate danger of damage from exposure as the plantation is sheltered from the prevailing winds which blow from the S.W. along the Severn Valley.

The figures for 1926 are:-

Age 18. No. of stems per acre, 915. Mean Height, 36½ feet. Mean Girth, 14½ inches. Form Factor, .350. Basal Area per acre after thinning, 103.2 sq.ft.

Volume per acre after thinning, 1320 cubic feet.

In the thinning, 651 trees per acre were removed, with a mean height of 32 feet, mean girth of 9½ inches, Basal area of 32.6 sq.ft. and volume of 234 cubic feet. The total volume was thus 1554 cubic feet and the periodic mean annual increment was 210 cubic feet.

Plot No.24. Douglas Fir. Leighton Montgomeryshire.

This plot was established at the end of 1920 when the crop was twelve years old but was not thinned at that time.

In 1926 a C.grade thinning was applied and similar thinnings will be necessary in the near future.

The Quality Class is II. The elevation 900-950 feet.

As a result of the pruning in 1920 which was carried out by inexperienced workmen using bill-hooks, much damage was done to the trees resulting in a very severe attack of Phomposis. In collaboration with Dr.Wilson some work was done on this problem and will be mentioned and more fully described below.

The figures for 1926 were:-

Age 17 years. No. of stems per acre, 1095. Mean height, 32½ ft Mean girth, 14½ inches. Form Factor, .353. Basal Area per acre, after thinning, 122.3 sq.ft. Volume per acre after thinning, 1402 cubic feet.

In the thinning, 618 trees per acre were removed, with a mean height of 27½ feet, mean girth of 11 inches. Basal area per acre of 42 sq.ft. and volume of 328 cubic feet.

The total volume was thus 1296 cubic feet and the periodic mean annual increment was found to be 259 cubic feet per acre.

Plot No.25. Corsican Pine. Leighton, Montgomeryshire.

This plot, established at the end of 1920 is representative of a rather poor plantation of Corsican Pine of Quality Class II grown in a fully exposed situation at 900 feet.

It has been thinned to a B.grade and would probably improve as a result of heavier thinning, but the exposed situation calls for caution.

The figures for 1926 are:-

Age 37. No.of stems per acre, 811. Mean Height 45 ft. Mean Girth 23 inches. Form Factor, .385. Basal Area per acre, 241.7 and Volume per acre, after thinning, 4186 cubic feet.

In the thinning, 149 stems per acre were removed, with a volume of 408 cubic feet per acre. The total volume was thus, 4594 cubic feet and the mean annual increment over the period, 276 cubic feet per acre.

Plot No.26. Douglas Fir. Lake Vyrnwy, Montgomeryshire.

This is a single plot established in September 1920 and remeasured in February 1926. A C.grade thinning was prescribed, but owing to the size of the trees and the increasing exposure, little more than a B.grade could safely be carried out.

The crop is rather irregular as to stocking, and height growth but the type of tree is good and there are few misshapen stems.

The Quality Class is II.

Some damage had been done by Chermes Cooleyi.

The figures for 1926 are:-

Age. 28 years. No. of stems per acre, 490. Mean Height, 63'. Mean girth, 27 inches. Form Factor, .397. Basal Area per acre after thinning, 195.3 sq.ft. Volume per acre after thinning, 4878 cubic feet.

In the thinning, there were removed 93 trees per acre, with a mean height of 56 feet, a mean girth of 21 inches, a basal area per acre of 22.9 sq.ft. and a volume of 504 cubic feet per acre.

The total volume was thus 5382 cubic feet and the mean annual increment over the period 1920-1925 was 400 cubic feet per acre.

Plot No.27.)
Plot No.28.) Douglas Fir. Lake Vyrnwy, Montgomeryshire.

This pair of comparative thinning plots was laid down in September 1920 in a thirteen year old plantation at Lake Vyrnwy.

Plot 27 was thinned on establishment, heavily, to a C.grade standard while Plot 28 received a D.grade or Crown thinning.

The plots were in every way comparable and now offer good examples of these particular types of thinning.

In 1926 the original thinnings were repeated and as growth had been very rapid much material was cut from each.

The figures for 1926 are:-

Plot 27.

Age 18. No. of stems per acre, 745. Mean height, 40½ feet. Mean girth, 16 inches. Form Factor, .361. Basal Area per acre, after thinning, 110. sq.ft. Volume per acre after thinning, 1591 cubic feet.

In the thinning, 576 trees per acre were removed with a volume of 736 cubic feet per acre.

The total volume was thus 2326 cubic feet per acre and the periodic mean annual increment, 343 cubic feet. This is very satisfactory.

Plot No.28.

Age.18. No. of stems per acre, 1329. Mean Height 40½ft. Mean Girth, 13½ inches. Form Factor, .356. Basal Area per acre 137.1 sq.ft. Volume per acre, 1974 cubic feet.

In the thinning, 426 trees per acre were removed, with a mean height of 35½ feet, a mean girth of 12½ inches, a basal area per acre of 37.7 sq. feet and a volume per acre of 486 cubic feet.

The total volume per acre was thus 2460 cubic feet and the periodic mean annual increment was 359 cubic feet. This is rather higher than in Plot 27, but the stocking was much denser.

Plot, No.32. European Larch. Haldon, Devon.

This plot which is situated close to Plots 33 and 34 is five years younger and should be considered separately.

The crop is excellent and of Quality Class I but appears to be of a type rather different from that in the other plots. There is no information as to the origin of the plants or seed.

The plot was established in November 1920 and thinned to a D.grade to give a general comparison with plots 33 and 34 thinned respectively to C. and B.grades.

In 1926 this thinning was repeated but when thinning falls due again it will be necessary to change from a crown thinning to a low thinning.

The D.grade thinning was carried out in 1926 because of the large number of badly shaped dominants, most of which were removed. As a result, the crop appears rather irregular but future thinnings should remedy this. Many of the small trees left in 1920 round the gaps caused by the removal of large trees were found in 1926 to be bent over by the wind. This appears to be a common feature of larch thinned in this way.

Round the edges of this plot and in the plot itself, Ash seedlings are coming up in abundance. This should be borne in mind when the present crop is removed.

Figures for 1926:-

Age. 27. No. of stems per acre, 799. Mean Height, 54½ feet. Mean girth, 17¼ inches. Form Factor .391. Basal Area per acre after thinning, 135.7 sq.ft. Volume per acre, after thinning, 2891 cubic feet.

In the thinning, 178 trees per acre were removed, with a mean height of 51 feet, a mean girth of 16 inches, a basal area per acre of 25.2 sq.ft. and a volume of 480 cubic feet per acre. The total volume was thus 3371 cubic feet and the periodic mean annual increment was 202 cubic feet.

Plot No.33.)
) European Larch. Haldon, Devon.
Plot No.34.)

This pair of plots which adjoin, from an excellent contrast of the B. and the C.grades of thinning.

The crop is very fine. Defective trees are few and indeed in the C.grade plot have all been removed. There is practically no canker.

The Quality Class is I. Plot 33 was thinned to a C.grade in 1920 and in 1926. Plot 34 to a B.grade.

The figures for 1926 are:-

Plot 33.

Plot 33.

Age.32. No. of stems per acre, 438. Mean Height, 56½ feet. Mean girth, 19½ inches. Form Factor .409. Basal Area per acre, 101.3 sq.ft. Volume per acre, 2340 cubic feet.

In the thinning, 194 trees per acre were removed, with a mean height of 53 feet, a mean girth of 16½ inches, a basal area per acre of 28.9 sq.ft. and a volume per acre of 592 cubic feet. The total volume was thus, 2932 cubic feet and the periodic mean annual increment, 169 cubic feet.

Plot 34.

Age.32. No. of stems per acre, 748. Mean Height 55 ft. Mean girth 18½ inches. Form Factor .406. Basal Area per acre 141.2 sq.ft. Volume per acre 3153 cubic feet.

In the thinning, 40 trees per acre were removed with a volume of 76 cubic feet. The total volume was thus 3229 cubic feet and the mean annual increment over the period 175 cubic feet.

Plot No.35.)
" " 36.)
" " 37.) Scots Pine. Bagshot, Surrey.
" " 38.)
" " 39.)

This set of five plots, though originally laid out about 1915 were established as permanent/sample plots in 1921.

Though five thinning grades are represented, the plots do not form a good series. Plots 35 and 36 are of Quality Class III and are comparable with each other. Plots 37, 38 and 39 are of Quality Class II and though Plots 38 and 39 compare well with each other, yet neither is comparable with Plot 37, which is a year younger, was planted with a different spacing of plants and is situated on a soil which departs rather from the type on which the other plots are standing.

Plot 35 was thinned to an A.grade, Plot 36 to a B.grade, Plot 37 to a D.grade, Plot 38 to a C_1 grade and Plot 39 to a C_2 grade.

The plots were first measured in June 1921 and remeasured in

March 1926. The increments have been calculated on a 5 year basis but 4½ years would probably give a truer indication of the development.

The figures for 1926 are:-

Plot 35.

Age. 40. No. of trees per acre, 1638. Mean Height, 34 feet. Mean girth, 12 inches. Form Factor .307. Basal Area per acre 130.9 sq.ft. Volume per acre, 1364 cubic feet.

In the thinning, 78 trees per acre were removed with a volume of 8 cubic feet. The total volume was thus 1372 cubic feet and the periodic mean annual increment, 95 cubic feet.

Plot 36.

Age 40. No. of stems per acre, 1049. Mean Height, 36½ feet. Mean girth 13½ inches. Basal Area per acre, 109.3 sq.ft. Volume per acre, 1369 cubic feet.

In the thinning, 322 trees per acre were removed with a volume of 72 cubic feet. The total volume was thus, 1441 cubic feet, giving a periodic mean annual increment of 98 c.ft.

Plot 37.

Age 39. No. of stems per acre, 845. Mean Height, 39½ feet. Mean girth, 15⅛ inches. Form Factor .360. Basal Area per acre, 115.3. Volume per acre, 1640 cubic feet.

In the thinning, 140 trees per acre were removed, with a volume of 349 cubic feet.

The total volume was thus 1989 cubic feet, giving a mean annual increment for the period of 81 cubic feet.

Plot 38.

Age.40. No. of stems per acre, 650. Mean Height, 39½ ft. Mean girth, 16½ inches. Form Factor, .397. Basal Area per acre, 95.7 sq.ft. Volume per acre after thinning, 1500 c.ft.

In the thinning, 392 trees per acre were removed with a volume of 312 cubic feet. This makes the total volume 1812 cubic feet and the periodic mean annual increment, 110 cubic feet.

Plot 39.

Age 40. No. of stems per acre, 580. Mean Height, 42 feet. Mean girth 16½. inches. Form Factor .389. Basal Area per acre after thinning, 89.9 sq.ft. Volume per acre, 1467 c.ft. In the thinning, 418 trees per acre were removed with a volume of 347 cubic feet. The total volume was thus 1814 cubic feet and the periodic mean annual increment, 101 cubic feet.

New Plots. Scotland.

Plot. No.73. Sitka Spruce. Drumlanrig, Dumfriesshire.

Area = .366 acre.

We have been fortunate enough to obtain another plot of this species at Drumlanrig.

The new plot is younger than the existing Plot (No.9) by three years, being 23 years old.

It was planted at a time when Sitka spruce were rather easier to obtain and the planting distance was 4'6" x 4'6". This makes it difficult to compare with Plot No.9. which was planted at 9' x 9' and is consequently abnormal but it will be all the more valuable for yield table purposes.

We were allowed to fell eight sample trees. Other six were measured standing.

A light thinning was applied in which suppressed trees and low forks were removed.

The number of stems per acre after thinning is 872; average height 45½ feet; average girth 21½ inches; Form Factor .409; Basal Area per acre 221.3 and Volume per acre (u.b.) 4118. In the thinning 198 trees per acre with a volume (u.b.) of 51 cubic feet per acre were removed.

The total volume was thus 4169 cubic feet, giving a mean annual increment of 181 cubic feet.

Plot No.74.)
Plot No.75.) European Larch. Shambellie, Kirkcudbright.

A pair of comparative thinning plots were laid down in a plantation of young larch, 16 years of age, in August. The crop is quite good, though a little irregular and the growth is fast, the quality class being I and II.

Plot 74 is to be thinned to a B.grade and Plot 75 to a C. grade for comparison. The plantation had only recently been thinned and very few trees were removed from Plot 74.

The figures are:-

Plot 74. - Area .298 Acre.

Age 16. No. of stems per acre, 1584. Average Height 29 feet; average Girth 11½ inches; Form Factor .208; Basal Area per acre 114. sq.ft. and Volume per acre, under bark, 925 cubic ft. The mean annual increment has been 58 cubic feet per acre.

Plot 75. - Area .290 Acre.

Age.16. No. of stems per acre, 1369. Average Height 27½ ft. average Girth 11½ inches; Form Factor .284. Basal Area per acre, 99.6 sq.ft. and Volume per acre, 777 cubic feet.
In the thinning, 414 trees per acre were removed with a volume of 74 cubic feet.
The total volume per acre was thus 851 cubic feet, and the mean annual increment has been 53 cubic feet per acre.

The Plots are quite comparable and should form a valuable addition to the list.

Plots Remeasured. Scotland.

Plot No.7. Norway Spruce. Drumlanrig, Dumfriesshire

This plot has not been cut over and in consequence, falls to be removed from the list of Sample Plots.

A measurement was taken by Dr.Anderson in May, just before the plot was felled and we are now in the possession of figures for two three-year increment periods.

The figures for 1926 are:-

Age 48 years. No. of stems per acre, 925; Average Height,51 ft. Average Girth, 23½ inches; Form Factor, .448. Basal Area per acre, 272.5 sq.ft. Volume per acre, 6227 cubic feet.

For the period 1923-26, the annual increment was 157 cubic feet per acre to be compared with 142 feet per acre for 1920-23.

Plot No.10. Japanese Larch. Drumlanrig, Dumfriesshire.

This plot is one of the few which are measured at three-yearly intervals. It was established in 1920 and was measured then and again in 1923. The thinning applied here is a C.grade. In 1920, the plot was not thinned, but in 1923 a heavy low thinning was applied. In 1926, the same grade of thinning was applied but necessarily on a milder scale on account of the short interval between the thinnings. The Quality Class is I.

The figures for 1926 are:-

Age 23. No. of trees per acre 500. Average Height 49½ft. Average Girth 21 inches; Form Factor, .383; Basal Area per acre, after thinning, 119.3; Volume per acre, after thinning, 2275 cubic feet.

In the thinning, 102 trees per acre were removed with a mean girth of 19" and a mean height of 45½ feet. The Volume taken out per acre was 345 cubic feet.

The total volume was 2620 cubic feet and the annual increment over the period 1923-26, 239 cubic feet, as against 199 cubic feet for the preceding 3 year period.

Plot No.11. Douglas Fir. Durris, Kincardinshire.

This plot was laid down in September 1920, along with Plot 12 which adjoins it, to serve as a pair of comparative thinning plots, Plot 11 being thinned to a B.grade and Plot 12 to a C.grade.

In 1920 and later in 1923 both plots were treated on the lines originally prescribed. Since the disaster which has overtaken Plot 12, the comparative element is no longer of account and it has been decided to lead Plot 11 over from a B.grade to a C.grade. This is rendered all the more necessary by the extreme danger to which this plot is subject from wind damage, for to leave it dense by the application of rigid B.grade thinnings would be to invite widespread destruction. Accordingly in 1926 a light C.grade thinning was applied with the object of strengthening the remaining crop as far as possible and such thinning should be continued at intervals of not more than three years.

It is, however, highly probable that windfall will continue and it is possible that the whole plot may be laid.

At present there is only one gap in the plot some ten yards wide by nine, but individual trees are being uprooted especially along the ditches at other points and this will continue. Further, to the south there is an extensive gap in the surround and this increases yearly and in the direction of the plot. In addition a small gap has been formed within the last year in the surround on the north side.

The measurement carried out in September 1926 yielded the following figures.

Age 29. No. of stems per acre after thinning, 755. Mean Height 59 feet; Mean Girth, 23½ inches; Form Factor .392; Basal Area per acre after thinning, 234.8 sq.ft. Volume per acre, after thinning, 5438 cubic feet.

In the thinning, 175 trees per acre were taken out, mean height 54 feet, mean girth 17½ inches, with a basal area of 29.6 sq.ft. and a volume of 651 cubic feet. The total volume thus was 6089 cubic feet.

The mean annual increment for the period 1923-26 was 344 cubic feet per acre, as against 259 cubic feet for the period 1920-23.

Plot No.12. Douglas Fir. Durris, Kincardineshire.

This plot has been so damaged by successive storms that now only 88 trees remain standing.

These were girthed in 1926.

The only purpose which can be served by this plot is to give information as to any changes in form which may occur in the standing trees growing under quite open conditions by way of contrast to the trees in Plot 11 grown relatively dense together. This purpose can be served only if the trees which remain continue to stand.

As it is useless now for any purpose other than this, the plot should be removed from the list of Sample Plots.

Plot No.14. Sitka Spruce. Durris, Kincardineshire.

This plot was laid down in 1920 and was measured then and again in 1923. Owing to its age and exposed situation only the lightest of thinnings could be applied and extreme difficulty has been encountered in obtaining sample trees. The minimum number of sample trees was not obtained in 1926. Those which were felled were not at all representative and as the standing trees were dangerous to climb a sufficient number of measurements on each standing sample tree was not obtained. The figures resulting from the measurement this year are therefore not put forward without reservation. The periodic mean annual increment 1920-23 was 335 cubic feet, for 1923-26 it was 146 c.ft a very marked falling off. That there had been a falling off in growth is shown by the fact that while the mean girth had increased from 28" in 1920 to 30" in 1923, it had only increased to 30½" in 1926 and though the thinning in 1923 was heavier than in 1926 the difference cannot entirely be explained in this way.

But part of the falling off in increment is to be explained by the fact that in 1923 a fairly good set of sample trees was obtained.

The figures for 1926 gave:-

Age 44 years. No. of stems per acre 503. Mean Height 71 feet. Mean Girth 30½". Form Factor .414. Basal Area per acre after thinning 261.9. Volume per acre after thinning 7696 cubic feet. In the thinning, 6 trees per acre were taken out with a volume of 54 cubic feet. The total volume was thus 7750 cubic feet.

Plot No.15. Scots Pine. Glendye, Kincardineshire.

This plot was laid down in 1920 along with Plot No.16. to implement the data on the growth of Scots Pine in the North-east of Scotland and to serve as a pair of comparative thinning plots.

Plot 15 was thinned to a strict B.grade in 1920 and again in 1925.

The figures for 1925 are:-

Age 39. No. of trees per acre 1176. Mean Height 39½ feet. Mean Girth 16½". Form Factor .339. Basal Area per acre after thinning, 175.8 sq.ft. Volume per acre after thinning, 2353 cubic feet.

In the thinning, 209 trees per acre were removed with a mean girth of 11", a basal area of 13.9 sq.ft. per acre and a volume of 100 cubic feet. The total volume per acre was thus 2453 cubic feet and the mean annual increment over the period 1920-25 was 104 cubic feet.

Plot No.16. Scots Pine. Glendye, Kincardineshire.

Thinned in 1920 and in 1925 to a C.grade which was only of a moderate strength in order to meet the wishes of the estate management.

The figures for 1925 are:-

Age 39. No. of trees per acre after thinning, 883. Mean Height 41 feet. Mean Girth, 18". Form Factor .349. Basal Area per acre 156.3 sq.ft. and volume per acre after thinning 2238 cubic feet.

In the thinning, 255 trees per acre were removed with a mean girth of 13", a basal area of 23.8 sq.ft. and a volume of 243 cubic feet.

The total volume was thus 2481 cubic feet and the mean annual increment for the period 1920-25 was 119 cubic feet per annum. The increment here has thus been slightly better than in Plot 15.

Plots 15 and 16 are typical of a large portion of the Scots Pine in the North and North-east of Scotland, having suffered severely from squirrel damage.

Plot No.17. Japanese Larch. Glendye, Kincardineshire.

This plot is of interest on account of the relatively slow growth and of its situation on a granitic moraine at 800 feet elevation.

It forms part of a plantation which was established originally as shelter for deer but has remained protected by a fence.

The crop is very good and uniform. The trees are of good shape and there is a marked absence of wavy or misshapen stems. The figures for 1925 are:-

Age 28. No. of stems per acre after thinning 992. Mean Height 40½'. Mean Girth 16". Form Factor .356. Basal Area per acre after thinning, 139 sq.ft. Volume per acre after thinning, 2003 cubic feet.

In the thinning, 352 trees per acre were removed with a basal area of 25.7 sq.ft. and a volume of 250 cubic feet.

The total volume was thus 2253 cubic feet and the periodic mean annual increment, 191 cubic feet.

Plot. No.18. Japanese Larch. Fyvie, Aberdeenshire.

This plot was laid down in November 1920 and remeasured in November 1925.

The plot is situated on the rather steep slope of a valley in a sheltered place and the growth has been rapid. Some of the trees are amongst the largest to be seen in this country.

The crop has suffered severly from squirrel damage and in addition there are many deformed stems and defective crowns. A heavy thinning was carried out in 1925 with the object of removing as many bad stems as possible but it is doubtful if the crop has been much improved.

The figures for 1925 are:-

Age 24 years. No. of trees per acre, 469. Mean Height, 47 feet. Mean Girth, 20". Form Factor .384. Basal Area per acre after thinning, 105.2 sq.ft. Volume per acre after thinning, 1900 cubic feet.

In the thinning, 450 trees per acre were removed, with a mean height of 40 feet, a girth of 15½ inches, a basal area per acre of 60.1 sq.ft. and volume of 897 cubic feet per acre.

The total volume was thus 2797 cubic feet and the periodic mean annual increment, 230 cubic feet.

Plot No.19. Norway Spruce. Fyvie, Aberdeenshire.

This is a single plot of Norway spruce, now 36 years old and of Quality Class II.

The plantation was formed on old agricultural ground.

There is a proportion of rough and coarsely branching trees in the plot but the general average as to quality is fairly high. The stems, to judge by those which have been felled, are mostly all sound.

The figures for 1925 are:-

Age 35 years. No. of trees per acre, 552. Mean Height, 48½ ft. Mean Girth 25 inches. Form Factor, .409. Basal Area per acre after thinning, 192.5. Volume per acre after thinning, 3817 cubic feet.

In the thinning, 167 trees per acre were removed with a mean height of 46½ ft. a mean girth of 20 inches, basal area per acre of 37.2 sq.ft. and a volume of 696 cubic feet per acre.

The total volume was thus 4513 cubic feet per acre giving a mean annual increment over the period of 216 cubic feet.

Plot No.20.)
" " 21.) European Larch. Fyvie, Aberdeenshire.
" " 22.)

This series of Plots was established in November 1920 as a set of thinning plots, No.20 being thinned on a B.grade scale, No.21 on a C.grade and No.22 on a D.grade. Thinnings on the same scale were applied again in 1925 and the plots now offer good examples of the changes in appearance brought about by the different types of treatment.

Already it appears that the C.grade thinning has had the best result so far as the effect of thinning on the larch canker is concerned for here the cankers are healing over and little fresh infection is to be observed. In the other plots little change is to be noticed.

In the D.grade thinning plot considerable damage had been done by wind in bending over the smaller trees. This result of the particular type of thinning has been noticed also at Haldon for the same species and at Stourton for Japanese Larch. It would appear therefore that D.grade thinnings in larch stands and in coniferous stands generally (with the exception perhaps of Scots Pine, which is slower to respond to treatment) will have to be applied with caution. This set of plots is of considerable value from the silvicultural point of view and any results which will obtained from this side of the work are likely to be of more value than the merely statistical returns.
The figures for the plots taken in 1925 are as follows:-

Plot 20. B.Grade.
Age 25. No. of stems per acre, 985. Mean Height 38 feet. Mean Girth 14 inches. Form Factor .330. Basal Area per acre after thinning 105.6 sq.ft. Volume per acre, 1326 cubic feet.
In the thinning, 423 trees per acre were removed with a mean height of 27 feet, mean girth of 8½ inches, basal area per acre of 17.9 sq.ft. and volume per acre of 44 cubic feet.
The total volume per acre was 1370 cubic feet giving a periodic mean annual increment of 136 cubic feet.

Plot 21. C.Grade.

Age. 25. No. of stems per acre, 586. Mean Height, 38 ft. Mean Girth 15½ inches. Form Factor .335. Basal Area per acre, after thinning, 80 sq.ft. Volume per acre, after thinning, 1019 cubic feet.

In the thinning were removed per acre, 308 stems with a mean height of 32½ feet, mean girth of 12 inches, basal area per acre of 24.4 sq.ft. and volume per acre of 222 cubic feet. The total volume was 1241 cubic feet and the mean annual increment for the period 116 cubic feet.

Plot 22. D.Grade.

Age 25. No. of stems per acre 805. Mean Height 37½ feet. Mean Girth 14 inches. Form Factor .321. Basal Area per acre 84.4 sq.ft. Volume per acre 1014 cubic feet.

In the thinning, 390 trees per acre were removed, with a mean height of 29 feet, a mean girth of 9½ inches, a basal area per acre of 19.1 sq.ft. and volume per acre of 124 cubic feet. The total volume was 1138 cubic feet and the mean annual increment for the period 1920-25, 113 cubic feet.

Plot No.23. Douglas Fir. Glentress, Peeblesshire.

A single plot of this species was established in March 1921 and remeasured for the first time in March 1926.

The Quality Class is II - III.

The crop is of a good type being free from misshapen stems which have been removed in successive thinnings.

The figures for 1926 are:-

Age 23. No. of stems per acre, 647. Mean Height 46½'. Mean Girth 19½ inches. Form Factor .390. Basal Area per acre, after thinning, 134.6. Volume per acre under bark, 2443 c.ft.

In the thinning were removed, 163 stems per acre with a mean height of 42½ feet, a mean girth of 17 inches, a basal area per acre of 26.5 sq.ft. and a volume of 439 cubic feet per acre.

The total volume per acre was thus 2882 cubic feet and the mean annual increment for the period 1921-26 was 363 cubic feet.

Plot No.24.)
) European Larch. Shambellie, Kircudbrightshire.
Plot No.25.)

This pair of plots were laid down at Shambellie in April 1921 and though small in extent they are of some interest.

Plot 24. was thinned very heavily in 1921 and the C.grade thinning, though less intense, was repeated in 1926.

Plot 25. has been treated on a strict B.grade scale and the plots now offer a good contrast as to stocking.

There had been some wind damage in the surround of Plot 24, originating in a wet area but the blow did not extend to the plot itself and the area appears now to be stable.

The heavy thinning in Plot 24 in 1921 appears in no way to have affected the growth for it will be seen that this plot, with only three fifths of the number of trees contained in Plot 24, has put on an increment almost identical.

The figures for 1926 are:-

Plot 24.

Age 37. No. of stems per acre, 322. Mean Height, 59 feet. Mean Girth, 25½ inches. Form Factor .400. Basal Area per acre after thinning 116.2 sq.ft. Volume per acre after thinning, 2776 cubic feet.

In the thinning, 68 trees per acre were removed with a mean height of 54 feet, a mean girth of 21½ inches, a basal area of 17.2 sq.ft. and a volume of 391 cubic feet per acre.

The total volume was thus 3167 cubic feet and the periodic mean annual increment, 192 cubic feet.

Plot 25.

Age 37. No. of stems per acre, 618. Mean Height, 60 feet. Mean Girth, 25½ inches. Form Factor .385. Basal Area per acre after thinning, 188.2 sq.ft. Volume per acre after thinning, 4349 cubic feet.

In the thinning there were taken out 57 trees per acre, with a mean height of 51 feet, a mean girth of 17½ inches, a basal area

of 9.5 sq.ft. and a volume of 170 cubic feet per acre.
The total volume was thus 4519 cubic feet and the periodic mean annual increment, 195 cubic feet.

Plot No.26. Thuja plicata. Munches, Kirkcudbrightshire.

This is a small plot which is of interest on account of the relative rarity of the species, the slow growth to commence with and the very high stocking carried.

The plot was laid down in April 1921 and remeasured in April 1926. In 1921, at 19 years of age, the mean height of the plot was only 25 feet, by 1926 it had reached 34 feet and it is likely that height growth will continue more at this rate than at the earlier and slower, as is general with Thuja. There are still 2163 trees to the acre and the mean girth is only 14 inches. Very few trees had died in the interval between the thinnings though suppressions were numerous.

The figures for 1926 are:-
Age 24. No. of stems per acre, 2163. Mean Height 34 feet. Mean Girth 14 inches. Form Factor .322. Basal area per acre after thinning, 227. sq.ft. Volume per acre after thinning, 2491 cubic feet.
In the thinning there were taken out 492 trees per acre with a volume only of 16 cubic feet to the acre.
The total volume was thus 2507 cubic feet, and the mean annual increment over the period was 305 cubic feet. This is a very high figure.

Plot No.27.)
) Japanese Larch. Kirkennan, Kirkcudbrightshire
Plot No.28.)

Laid down in April 1921, as a pair of comparative thinning plots, these were remeasured for the first time in April 1926.

The crop is good and singularly free from the misshapen stems which are so common a feature of some plantations of this species.

The Quality Class is I.

Plot 27 has been subjected to heavy low thinnings C.grade and Plot 28 to light B.grade thinnings.

The figures for 1926 are as follows:-

Plot No.27.

Age 20. No. of stems per acre 761. Mean Height 40 feet. Mean Girth 14½ inches. Form Factor .382. Basal Area per acre after thinning, 89 sq.ft. Volume per acre after thinning 1345 cubic feet.

In the thinning, 475 stems per acre were removed with a volume of 436 cubic feet.

The total volume was therefore 1781 cubic feet and the mean annual increment for the period, 199 cubic feet.

Plot No.28.

Age 20. No. of trees per acre, 1299. Mean height 39½ feet. Mean Girth 13 inches. Form Factor .331. Basal Area per acre, after thinning, 126 sq.ft. Volume per acre, after thinning, 1491 cubic feet.

In the thinning, 504 stems per acre were removed with a volume of 57 cubic feet per acre.

The total volume amounted to 1548 cubic feet and the periodic mean annual increment 140 cubic feet.

Plot No.29.)
) Scots Pine. Balmoral, Aberdeenshire.
Plot No.30.)

These plots are situated in a famous Scots pine area on the edge of Ballochbuie Forest. Unfortunately they are not typical of the species as it grows in the vicinity and the plantation in which they are situated has probably been formed with plants from foreign seed.

The crop is of the second Quality Class.

Plot No.29 has been thinned to a B.grade both in 1921 and in 1926 while Plot No.30, for comparison, has received C.grade thinnings.

In these plots there is very little squirrel damage.

The figures for 1926 are:-

Plot No.29.

Age 40. No. of stems per acre, 745. Mean Height, 41½ feet. Mean Girth 21 inches. Form Factor .349. Basal Area per acre, after thinning, 185.8 sq.ft. Volume per acre after thinning, 2686 cubic feet.

In the thinning, 175 trees per acre were removed, with a mean height of 35 feet, a mean girth of 14½ inches and a volume per acre of 204 cubic feet. The total volume was thus 2890 cubic feet, and the periodic mean annual increment, 138 cubic feet.

Plot No.30.

Age 40. No. of stems per acre, 560. Mean Height 41 feet. Mean Girth 22½ inches. Form Factor .341. Basal Area per acre, after thinning, 157.8 sq.ft. Volume per acre after thinning, 2209 c.ft

In the thinning, these were taken at 192 trees per acre with a mean height of 35½ feet, mean girth of 16 inches and volume per acre of 330 cubic feet. The total volume was thus 2539 cubic feet and the periodic mean annual increment 110 cubic feet.

Plot No.31. Douglas Fir. Balmoral, Aberdeenshire.

This single plot is of value on account of its age, now 44 years, and its slow growth. Quality Class IV. or thereby.

The plot is very fully stocked and the crop is good. It is still growing in height but exposure is beginning to tell and there are many broken tops. The elevation is almost 1000 ft.

The plot was found to be suffering from a very severe attack of Chermes Cooleyi in June 1926.

Figures for 1926:-

Age 43. No. of stems per acre, 391. Mean Height 72 feet. Mean Girth 37½ inches. Form Factor .363. Basal Area pre acre, 300.1 sq.ft. Volume per acre, 7833 cubic feet, after thinning.

In the thinning (B.grade) 42 trees per acre were removed with a volume per acre of 297 cubic feet.

The total volume was thus 8130 cubic feet and the periodic mean annual increment, 329 cubic feet. This is satisfactory.

Plot No.32. Douglas Fir. Kildrummy, Aberdeenshire.

A single plot established in June 1921 and treated on the C.grade standard, this has shown very satisfactory growth during the five year period which has just come to an end.

The crop is not of a very good form however, and in addition is generally coarse with a high proportion of heavy branching dominants.

The Quality Class is II - III.

A C.grade thinning is prescribed and has been applied in 1921 and 1926.

The figures for 1926 are:-

Age 26. No. of stems per acre 506. Mean Height 54½ feet. Mean Girth 26½ inches. Basal Area per acre after thinning 195.3 sq.ft

Volume per acre after thinning,3796 cubic feet.

In the thinning, 145 trees per acre were removed with a volume of 573 cubic feet.

The total volume was thus 4396 cubic feet and the mean annual increment for the period, 354 cubic feet.

Plot No.33.)
) Scots Pine. Novar, Ross-shire.
Plot No.34.)

These plots are unique among the Scottish Plots of this species in being of Quality Class I.

At the time of the first measurement, in 1921, they were almost free from squirrel damage but during the past five years this pest has become so active that now almost every tree in both plots has suffered. Indeed within a fortnight after thinning of the plots, no fewer than six trees had their tops, bitten almost through by squirrels, removed by a very moderate wind. It is much to be regretted that these animals are allowed to work what destruction they please and to multiply unchecked. As things are, it is not possible, in the north of Scotland to grow Scots Pine with any hope of obtaining more than five good stems out of every hundred in the final crop.

The figures for 1926 are as follows:-

Plot No.33. B.Grade.

Age 32. No. of stems per acre 1098. Mean Height, 43 feet. Mean Girth 17½ inches. Form Factor .379. Basal Area per acre after thinning, 186.6 sq.ft. Volume per acre, after thinning, 3003 cubic feet.

In the thinning, 313 stems per acre were removed with a volume of 169 cubic feet.

The total volume was thus 3172 cubic feet and the periodic mean annual increment, 150 cubic feet.

Plot No.34. C.Grade.

Age 32. No. of trees per acre, 947. Mean Height 44½ feet. Mean Girth 17½ inches. Form Factor .377. Basal Area per acre, 157.4 sq.ft. and Volume per acre, 2642 cubic feet after thinning

In the thinning, 284 stems per acre were taken out with a volume of 386 cubic feet.

The total volume was thus 3028 cubic feet and the mean annual increment over the period 1921-26 was 191 cubic feet.

This is very high.

Taymount Douglas Fir Plantation.

A measurement of this plantation was made by Dr.Anderson in March of 1926.

The figures are:-

Age (from ring counts) 65. No. of trees per acre, 130. Mean Height, 105½ feet. Mean Girth, 62 inches. Form Factor .326. Basal Area per acre, 277.8 sq.ft. Volume under bark per acre 9595 cubic feet.

The total volume of the wood which extends to 9.89 acres is estimated at 73,030 cubic feet under bark, or 82,989 cubic feet over bark.

"The Quality Class is III ... The growth is irregular over the area, falling off everywhere from the centre of the wood which lies in a slight depression. Up to 60 feet or more, the stems are fairly straight and symmetrical. Above that, con-

considerable deformity occurs, owing to crown breakage by snow or wind ... There are some signs of exposure on the tallest trees but the height growth is still vigorous and the curves show no signs of falling off in recent years. The average leading shoot has been 13 inches in the last 6 years."

OTHER WORK.

1. Painting of Plots.

(a) Dymock. Plots 29,30,31.

These three oak plots were repainted and put in order. The trees in each were girthed and classified. No thinning was possible but something should be done in five year's time.

(b) Dunster. Plots 40,41,42,44,45,46,47.

These plots were repainted by the women assistants in preparation for the winter.

2. Repair of Plots.

Plots Nos. 41 and 42. Douglas Fir. Murthly.

Considerable damage was done in these plots by a snowstorm in January 1926 and a week was spent in June in clearing up the damage. As a result both plots have several large gaps with groups of isolated and insecure trees and the general condition is very serious. Further damage from wind is almost inevitable.

3. Co-operation with other Branches.

(a) Forest Products Research.

Samples of Timber from the Plots are being sent regularly to Mr. L.Chalk at Oxford.

(b) Mycology.

As has been mentioned, treatment and observation of Plot No. 24, at Leighton Park, Welshpool, have been carried out in co-operation with Dr.Wilson.

The Douglas Fir had been damaged as a result of pruning with bill-hooks and a heavy attack of Phomopsis was the result. The branches were not taken cleanly from the stems but were cut off two to three inches from them. Unsightly snags were the result. It was decided to prune these off but in view of the possibility of further infection if this were done with the saw, it was agreed that one third of the trees should be pruned with the saw, one third with a secateur and the remaining third left untouched. This was done and by taking twenty trees at a time in consecutive numbers, the treatments were spread throughout the plot. In addition, a count was made of all cankers visible on the stems of standing trees.

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.									Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %		Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.														Basal area.	Volume.	Basal area.	Volume.
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.				Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.
Leighton Park Welshpool.																					
E.23		Japanese Larch.																			
8/20	13	1580	27	26½	.219	10	87	505	20		323	25	9½	17	80	111	585	-	-	-	-
1/26	18	915	38½	36½	.350	14½	103.2	1320	17		651	32	9½	32.5	234	135.8	1554	46.6	1049	9.8	210
E.24		Douglas Fir																			
8/20	12	1715	25½	22	.223	9½	88	434	15		-	-	-	-	-	88	434	-	-	-	-
1/26	17	1095	37	32½	.353	14	122.3	1402	14		618	27½	11	42.0	328	164.3	1730	76.3	1296	15.3	259
E.25		Corsican Pine																			
9/20	32	960	39½	37	.368	21	236	3212	21		291	30	12½	26	226	262	3438	-	-	-	-
1/26	37	811	47½	45	.385	23	241.7	4186	20		149	39½	18½	28.9	408	270.6	4594	34.6	1382	6.9	276
Lake Vyrnwy.																					
E.26		Douglas Fir																			
9/20	23	583	59	56	.350	23	172	3380	11		173	44½	16	24	392	196	3772	-	-	-	-
2/26	28	490	66½	63	.397	27	195.3	4878	11		93	56	21	22.9	504	218.2	5382	46.2	2002	9.2	400

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.									Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %		Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.														Basal area.	Volume.	Basal area.	Volume.
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.				Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.
Lake Vyrnwy (contd.)																					
E.27.		Douglas Fir																			
9/20	13	1331	29½	25½	.269	11	89	612	13		1142	23½	7½	35	92	124	704	-	-	-	-
2/26	18	745	43	40½	.361	16	110	1591	12		576	36½	13½	59	736	169	2326	80	1714	16	343
E.28		Douglas Fir.																			
9/20	13	1811	30	26½	.246	10	102	665	14		723	26½	9	32	173	134	838	-	-	-	-
2/26	18	1329	44	40½	.356	13½	137.1	1974	13		426	35½	12½	37.7	486	174.8	2460	72.8	1795	14.6	359
E.88		Japanese Larch and Douglas Fir.																			
	Japanese Larch																				
2/26	19	483	39	37	.367	16	68.2	926	17		397	36	14½	46.4	569	114.6	1495	-	-	-	-
	Douglas Fir (over bark)																				
2/26	-	1037	-	-	-	8	38.6	271	-		37	12	4½	0.4	2	39	-	-	-	-	-
	Total.																				
2/26	-	1520	-	-	-	-	106.8	-	-		434	-	-	46.8	571	153.6	-	-	-	-	-

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.								Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %	Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.													Basal area.	Volume.	Basal area.	Volume.
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.			Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.
32					Halden, Exeter				European Larch.											
Nov.1920	22	975	56	45½	.379	16	137	2360	16	365	42½	12½	32	400	169	2760				
Apr.1926	27	799	60	54½	.391	17½	135.7	2891	17	178	51	16	25.2	480	160.9	3371	23.9	1011	4.8	202
33																				
Nov.1920	27	680	55	50	.377	17	110	2085	17	405	46½	15	38	530	148	3615				
Apr.1926	32	488	60	56½	.409	19½	101.3	2340	17	194	53	16½	28.9	592	130.2	2932	20.2	847	4.0	169
34																				
Nov.1920	27	790	55	50	.374	17	126	2355	17	365	42½	11½	26	285	152	2640				
Apr.1926	32	748	58	55	.406	18½	141.2	3153	17	40	50	14	4.4	76	145.6	3229	19.6	875	3.9	17

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.								Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %	Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.													Basal area.	Volume.	Basal area.	Volume.
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.			Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.
Bagshot.																				
E.35		Scots	Pine.																	
6/21	35	1715	36½	30	.265	11	113	895	19	875	21	6½	20	10	133	905	-	-	-	-
3/26	40	1638	40	34	.307	12	130.9	1364	16	78	25½	8	2.9	8	133.8	1372	20.8	477	4.2	95
E.36		Scots	Pine																	
6/21	35	1370	36½	30½	.300	11½	104	950	18	1445	22½	7	32	35	136	985	-	-	-	-
3/26	40	1049	40½	36½	.343	13½	109.3	1369	17	322	28	9½	16.5	72	125.8	1441	21.8	491	4.4	98
E.37		Scots	Pine																	
5/21	34	985	39	36	.375	14½	117	1585	18	375	27½	9½	18	95	135	1680	-	-	-	-
3/26	39	845	45	39½	.360	15½	115.3	1640	18	140	38	17½	23.8	349	139.1	1989	22.1	404	4.4	81
E.38		Scots	Pine																	
5/21	35	1040	39	34	.358	13½	104	1260	16	625	27	8½	26	115	130	1375	-	-	-	-
3/26	40	650	43½	39½	.397	16½	95.7	1500	15	392	34	12	30.6	312	126.3	1812	22.3	552	4.5	110

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.									Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %		Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.														Basal area.	Volume.	Basal area.	Volume.
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.				Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.
	Bagshot (contd.)																				
5.39.		Scots Pine.																			
6/21	35	1000	40	36	.362	13½	101	1310	16		910	28½	9	40	220	141	1530	-	-	-	-
3/26	40	580	45½	42	.389	16½	89.9	1467	17		418	35	12	32.7	347	122.6	1814	21.6	504	4.3	101

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.								Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %	Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.													Basal area.	Volume.	Basal area.	Volume.
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.			Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.
									Sitka Spruce.											
No.73	23	872	50½	45½	.409	21½	221.3	4118	9	198	25	9½	9.9	51	231.2	4169.				
(9	21	570	-	42½	.379	25½	203	3271	12	10	39	15½	1	10	204	3281)	for comparison.			
									European Larch.											
No.74	16	1584	32	29	.208	11½	114	925	18	27	19	6½	0.7	1.3	114.7	926				
No.75	16	1369	33½	27½	.284	11½	99.6	777	19	414	23	9	18.4	74	118	851				

Record of periodical measurements per acre.

Sample Plot No.

Plot	Year of measurement.	Age of crop. Years.	Main Crop. Number of trees per acre after thinning.	Main Crop. Height. Average of largest trees. Ft.	Main Crop. Height. Average of crop. Ft.	Main Crop. Form Factor.	Main Crop. Girth at 4′ 3″. Inches.	Main Crop. Basal area per acre after thinning. Sq. ft.	Main Crop. Volume per acre (under bark). Cub. ft.	Main Crop. Bark %	Intermediate yield from Thinnings. Number of trees.	Intermediate yield from Thinnings. Average height. Feet.	Intermediate yield from Thinnings. Girth at 4′ 3″. Inches.	Intermediate yield from Thinnings. Basal area per acre. Sq. ft.	Intermediate yield from Thinnings. Volume per acre (under bark). Cub. ft.	Total Crop. Basal area. Sq. ft.	Total Crop. Volume (under bark). Cub. ft.	Increment of Main Crop. Periodic. Basal area. Sq. ft.	Increment of Main Crop. Periodic. Volume. Cub. ft.	Increment of Main Crop. Periodic mean annual. Basal area. Sq. ft.	Increment of Main Crop. Periodic mean annual. Volume. Cub. ft.
7	1920	43	945	-	46½	.478	21½	242	5375	8	100	40	14½	11	180	253	5555				
	1923	45	925	51	48½	.467	22½	254	5755	11	30	39½	16½	3	45	257	5800	15	425	5	142
	1926	48	925	52½	51	.448	23½	272.5	6227	11						272.5	6227	18.5	472	6.2	157
10	1920	17	816		37½	.371	17	128	1785	15						128	1785				
	1923	20	602	44½	43	.372	19	118	1903	16	215	41	16½	33	480	151	2383	23	598	7.7	199
	1926	23	500	52	49½	.383	21	119.3	2275	17	102	45½	19	19.8	345	139.1	2620	21.1	717	7.3	239
11	1920	22	1210		50	.400	19	239	4785	12	375	36½	11½	27	240	266	5025				
	1923	26	930	58	55	.386	21½	238	5056	14	280	45½	14½	33	505	271	5561	32	776	10.7	259
	1926	29	755	64	59	.392	23½	234.8	5438	13	175	54	17½	29.6	651	264.4	6089	26.4	1033	8.8	344
14	1920	45	570		64½	.419	28	249	6720	8	90	50	17	14	305	263	7025				
	1923	41	510	70	68	.425	30	253	7311	10	65	63½	21½	16	415	269	7726	20	1006	6.7	335
	1926	44	503	73	71	.414	30½	261.9	7696	10	6	65	25	2.1	54	264	7750	11	439	3.7	146

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop. Number of trees per acre after thinning.	Main Crop. Height. Average of largest trees.	Main Crop. Height. Average of crop.	Main Crop. Form Factor.	Main Crop. Girth at 4′ 3″.	Main Crop. Basal area per acre after thinning.	Main Crop. Volume per acre (under bark).	Main Crop. Bark %	Intermediate yield from Thinnings. Number of trees.	Intermediate yield from Thinnings. Average height.	Intermediate yield from Thinnings. Girth at 4′ 3″.	Intermediate yield from Thinnings. Basal area per acre.	Intermediate yield from Thinnings. Volume per acre (under bark).	Total Crop. Basal area.	Total Crop. Volume (under bark).	Increment of Main Crop. Periodic. Basal area.	Increment of Main Crop. Periodic. Volume.	Increment of Main Crop. Periodic mean annual. Basal area.	Increment of Main Crop. Periodic mean annual. Volume
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.			Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.
15									Scots Pine.											
1920	34	1390	-	36	.347	14½	159	1932	16	200	25.5	9	9	35	168	1967				
1925	39	1176	42	39½	.339	16½	175.8	2353	17	209	30	11	13.9	100	189.7	2453	30.7	521	6.1	104
16									Scots Pine.											
1920	34	1146	-	36	.349	15½	151	1888	16	300	28	10	17	105	168	2006				
1925	39	883	43½	41	.349	18	156.3	2238	17	255	33½	13	23.8	243	180.1	2481	29.1	593	5.8	119
17									Jap. Larch.											
1920	23	1345	-	32½	.318	13	126	1298	21	310	26	9	13	55	139	1353				
1925	28	992	42½	40½	.356	16	139.0	2003	17	352	35	11½	25.7	250	164.7	2253	38.7	955	7.7	191
18									Jap. Larch.											
1920	19	930	-	35	.362	16	130	1649	17	490	28	10½	30	255	160	1874				
1925	24	469	50	47	.384	20	105.2	1900	16	450	40	15½	60.1	897	165.3	2797	35.3	1148	7.0	230
19									Norway Spruce.											
1920	30	720	-	43	.435	21½	184	3433	9	125	28	10½	8	70	192	3503				
1925	35	552	49½	48½	.409	25	192.5	3817	9	167	46½	20	37.2	696	229.7	4513	45.7	1080	9.1	216

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop. Years.	Main Crop. Number of trees per acre after thinning.	Main Crop. Height. Average of largest trees. Ft.	Main Crop. Height. Average of crop. Ft.	Main Crop. Form Factor.	Main Crop. Girth at 4′ 3″. Inches.	Main Crop. Basal area per acre after thinning. Sq. ft.	Main Crop. Volume per acre (under bark). Cub. ft.	Main Crop. Bark %	Intermediate yield from Thinnings. Number of trees.	Intermediate yield from Thinnings. Average height. Feet.	Intermediate yield from Thinnings. Girth at 4′ 3″. Inches.	Intermediate yield from Thinnings. Basal area per acre. Sq. ft.	Intermediate yield from Thinnings. Volume per acre (under bark). Cub. ft.	Total Crop. Basal area. Sq. ft.	Total Crop. Volume (under bark). Cub. ft.	Increment of Main Crop. Periodic. Basal area. Sq. ft.	Increment of Main Crop. Periodic. Volume. Cub. ft.	Increment of Main Crop. Periodic mean annual. Basal area. Sq. ft.	Increment of Main Crop. Periodic mean annual. Volume. Cub. ft.
20										European Larch.										
1920	20	1450	-	30¼	.232	11	95	671	21	300	24	7¼	9	20	104	691				
1925	25	985	40½	38	.330	14	105.6	1326	20	423	27	8½	17.9	44	123.5	1370	28.5	679	5.7	136
21																				
1920	20	910	-	32	.281	12	74	662	21	705	25.5	8½	28	85	102	747				
1925	25	586	39½	38	.335	15¼	80	1019	19	308	32½	12	24.4	222	104.4	1241	30.4	579	6.1	116
22																				
1920	20	1240	-	30¼	.237	10½	77	556	21	275	30	11¼	21	175	98	731				
1925	25	605	41	37½	.321	14	84.4	1014	21	390	29	9¼	19.1	124	103.5	1138	26.5	582	5.3	116
23										Douglas Fir.										
1921	18	810	36½	35½	.336	14½	94.5	1076	13	1070	27	10	57.8	401	152.3	1477				
1926	23	647	49½	46½	.390	19¼	134.6	2443	11	163	42½	17	26.5	439	161.1	2882	66.6	1816	13.3	363

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.								Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %	Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.													Basal area.	Volume.	Basal area.	Volun
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.			Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub.
24										European Larch.										
1921	32	390	57	54½	.372	22½	109.0	2208	19	361	51	19	73.3	1347	132.3	3555				
1926	37	322	61½	59	.400	25½	116.2	2776	18	68	54	21½	17.2	391	133.4	3167	24.4	959	5	192
25																				
1921	32	675	57½	54	.368	22	178	3542	19	57	48	17½	9.9	168	187.9	3710				
1926	37	618	61½	60	.385	25½	188.2	4349	18	57	51	17½	9.5	170	197.7	4519	19.7	977	4	195
26										Thuja.										
1921	19	2655	28	25	.239	10½	164	980	15	740	15	5½	13	10	177	990				
1926	24	2163	37½	34	.322	14	227	2491	16	492	23½	7	13	16	240	2507	76	1527	15	305
27										Jap. Larch.										
1921	15	1235	34	31	.292	11½	87	785	17	1255	27	8	45	145	132	930				
1926	20	761	41	40	.382	14½	89	1345	16	475	37	12	38	436	127	1781	40	996	8	199
28																				
1921	15	1750	34½	31	.260	10½	105	845	17	795	22	6½	19	10	124	855				
1926	20	1299	39½	35	.331	13	126	1491	15	504	29	8½	17	57	143	1548	38	703	8	140

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.								Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %	Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.													Basal area.	Volume.	Basal area.	Volume
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.			Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft
29																				
1921	35	920	42½	38	.339	18½	171	2206	19	275	28	10½	17	130	188	2336				
1926	40	745	44½	41½	.349	21	185.8	2686	17	175	35	14½	20.6	204	206.4	2890	35.4	684	7.1	138
30																				
1921	35	750	43½	38½	.334	19	153	1989	19	490	31	13	47	445	200	2434				
1926	40	560	45½	41	.341	22½	157.8	2209	20	192	35½	16	27.5	330	185.3	2539	32.3	550	6.5	110
31										Douglas Fir.										
	38	435	69	64	.373	33½	271	6485	15	90	50	20	20	330	291	6815				
	43	391	77½	72	.363	37½	300.1	7833	14	42	60½	24	13.8	297	313.9	8130	32.9	1645	6.6	329
32										Douglas Fir.										
1921	21	655	47	45	.346	21½	167	2600	18	460	33	13½	44	560	211	3160				
1926	26	506	57½	54½	.357	26½	195.3	3796	15	145	46	20½	33	573	228.3	4369	61.3	1769	12.3	354

Record of periodical measurements per acre.

Sample Plot No.

Year of measurement.	Age of crop.	Main Crop.								Intermediate yield from Thinnings.					Total Crop.		Increment of Main Crop.			
		Number of trees per acre after thinning.	Height.		Form Factor.	Girth at 4′ 3″.	Basal area per acre after thinning.	Volume per acre (under bark).	Bark %	Number of trees.	Average height.	Girth at 4′ 3″.	Basal area per acre.	Volume per acre (under bark).	Basal area.	Volume (under bark).	Periodic.		Periodic mean annual.	
			Average of largest trees.	Average of crop.													Basal area.	Volume.	Basal area.	Volume
	Years.		Ft.	Ft.		Inches.	Sq. ft.	Cub. ft.			Feet.	Inches.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft.	Sq. ft.	Cub. ft
No. 33.																				
Sept. 21	27	1410	42½	39	.366	15	170	2424	16	570	29	9	24	125	194	2549				
									(Larch	45	39	14½	6	85)						
Sept. 26	32	1098	46½	43	.379	17½	186.6	3003	15	313	35	11	21.2	169	207.8	3172	37.8	748	7.6	150
No. 34.																				
Sept. 21	27	1230	41	39½	.367	14½	145	2073	16	1130	29	9	52	320	197	2293				
Sept. 26	32	947	46	44½	.377	17½	157.4	2642	13	284	38	14	31	386	188.4	3028	43.4	955	8.7	191
								Taymount Douglas Fir.												
Mar. '26.	65	130	-	105½	.326	62	277.8	9595	12	-	-	-	-	-	277.8	9595				
By ring counts						With Trees cut out			-	6	108½	62	12.8	442	290.6	10037				

MR E.V.LAING'S REPORT ON RESEARCH

1925 - 1926.

CONTENTS.

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1. Water Content of Nursery Seedlings and Transplants - completed April 1926.

This investigation was commenced in April 1925, and was partly reported on in the Report for 1925. In that Report the methods used were described. The results are as follows, the species dealt with being Norway Spruce, Sitka Spruce, and European Larch.

The data obtained bear out the general principle that there are seasonal differences in water content: that there is an extended period of low water content and a period of high water content. In addition, however, it is found that

(1) within the main variation there are smaller variations

(2) roots shoot and plant as a whole behave differently from each other in the spruces

(3) species differ from each other.

The fluctuations within the main variation are well marked in the spruces. The differences which occur in the amount of water in the root are great and these differences depend on differences in rainfall and soil moisture. In the Larch not only is there a correlation between root water content and rainfall but the correlation extends to the shoot. The first factor, and the one which is probably of most importance as influencing the amount of water in the plant is the rainfall or soil moisture. The higher the water content of the soil or the higher the rainfall, the higher is the water content of the root except from June to November.

The second factor influencing the amount of water in the plant is temperature. In the Spruces with increase of temperature in the Spring there is an increase of water in the plant. A point is reached however when at higher temperatures the water content falls i.e. there is probably an interaction between temperature and soil moisture. After the water content has reached its highest point there is no relation between temperature soil moisture and water content. It will be noted that the fall in the water content continues from June to

October or November despite an increase in the soil moisture.

As higher temperatures in the Spring lead to increased water contents cold on the other hand leads to less water content. Following a night of severe frost at the end of April, for example, both Norway and Sitka Spruce showed a marked fall on water content of shoot, the root not being evidently affected.

A third factor affecting the water content of plants is the age or type of plant. Seedlings have a higher minimum water content than transplants - except Larch. Further the older the seedling or transplant the less are the variations The older the seedling or the older the transplant the more stable it is; the less does it react to external variations.

As between species the following points may be noted.

1. The Larch presents a rather marked contrast to the Spruces

   (a) The water content begins to increase much earlier in the season than in the two Spruces.

   (b) A marked feature is the influence of moisture on the water content of all parts of the Larch.

   (c) The larch seedling plant and root shows the greatest range of values. The Larch root is closely followed by Sitka Spruce.

2. Generally as regards plant, root and shoot the Larch reaches the highest water contents. The Sitka Spruce is intermediate, the Norway Spruce least from March-October. In the other months the Larch falls to the lowest position.

3. The minimum and maximum periods of water contents vary as between species slightly but they vary more markedly as between different parts of the same plant. The periods of minimum contents are as follows :-

		Shoot	Root	Plant
2nd yr.	European Larch	Oct.-March	July-Dec.	Sept.-Jan
2nd "	Sitka Spruce	Nov.-May	July-Dec.	Aug. -Feb.
2nd "	Norway Spruce	Dec.-May	July-Dec.	Sept.-May
2/2	Sitka Spruce	Oct.-May	July-Feb.	Oct.- May
2/2	Norway Spruce	Oct.-May	July-Dec.	Oct.- May

Generally for all species the roots show small contents from July. - December. The shoots are variable but generally in the Spruces they show small contents from Oct. - May and in the Larch from Oct. - March. Although there may be slight variations the period Oct. -Dec. is naturally a period of low water content for all the species tested. The lowest points are reached in September and October. From then onwards there is a rise in the root culminating in June in the larch, in April in Sitka Spruce, in May in Norway Spruce.

The analysis of the data would appear to yield certain points of value.

1. There is the effect of soil moisture and rainfall on water content during the period December - May or June.

2. The water content in all species decreases from June to the end of the year irrespective of soil moisture or rainfall. This fall is particularly well marked in the roots. After October there is a rise in the water content of the root.

3. Since the influence of rainfall and soil moisture on the plant is so marked, the water content, if it was so desired, could be increased

(1) by artificial watering of the transplant lines or seed beds;

(2) by shading, since shading affects soil moisture and transpiration.

It was found that by shading the plants generally from November to May there was no significant difference in values. In the other period a decided increase was obtained.

4. The minimum amount of water in the plant is important. The minimum varies with different species of different ages and for shoot, root, and total plant of any one species of any given type. Never for instance in the Norway or Sitka Spruce transplant is the water percentage of the shoot found to fall below 100% of the dry weight of the plant, or for the root below 170-180%. If we take trees on peat it has been found that at the lowest the values for the shoots are about 102% - 105% for the Spruces. This minimum of 100% for transplants (shoots)

for instance would appear to yield a criterion of their condition at the time of planting. Probably if the water content is below 100% the plants are in a wilted condition - it may be permanently. The minimum which the seedlings could safely reach would be much higher, say in the neighbourhood of 140 - 150%. From the point of view a test of the speed with which Norway Spruce, Sitka Spruce and Larch lost water was made by exposing 2/2 yr. old shoots in the Laboratory at room temperature with the following results for three determinations :-

		Initial Water Content.	After 24 hrs.	48 hrs.	72 hrs.
Determination 1.	(Norway Spruce	122%	85		48
	(Sitka Spruce	147%	111		72
	(Larch	145%	135		75
2.	(N.S.	121	90	68	47
	(S.S.	120	108	83	69
	(E.L.	157	138.	123	85
3.	(N.S.	125	92	69	
	(.S.S.	141	106	95	
	(E.L.	155		122	

In every instance after 24 hrs. Sitka Spruce still had a value equal to or higher than the minimum found when the plants were functioning, Norway Spruce dried out rapidly whilst Larch, as might be expected, lost water slowly.

5. The water content variation for any species is so great as to have an important bearing on weight for any unit number of plants. Two things go to make up the weight of a package viz. plants and soil. As regards soil this probably constitues a very great part of the total weight - the proportion depending of course on the cleanliness of lifting of the particular plant and the degree to which the soil is shaken from the roots. Of the three species under review Larch lifts with the least soil attached. The Spruces tend to have a much larger weight of soil attached to the roots. From a large number of weighings it was found that taking dry weight half the total weight (40% - 60%) is soil in the Spruces about 1/3

(27 - 38%) in the Larch. In the wet state 18 - 22% of the total weight in the Larch is soil; in the Spruces 24 - 40% (generally about 37%). Fluctuations in weight of soil are small since the water variations show small variations (15 - 36%) whereas fluctuations in the water content may be very great. The number of plants per unit ofweight, therefore, is dependent more on fluctuations in plant water than in soil water, although the wetter the soil the more earth is there likely to be on the roots.

2. Periodicity of Root Growth.

Although the investigation was undertaken primarily to find when roots grow or to confirm previous work on periodicity of root growth short observations were also made on nursery plants.

The investigation was carried out with nursery seedlings although observations have also been made as regards root growth on trees growing under different growth conditions. The investigation so far has been more or less preliminary.

The nursery species used were Norway and Sitka Spruce and European Larch rising two years. Measurements consisted in weighing large numbers of seedlings at frequent intervals dried to a constant weight at 100° C. The investigation was commenced in April although data are available from the previous year for comparison.

The observations to date are briefly as follows :-

1. NORWAY SPRUCE: root growth as determined by weight begins to increase rapidly in the last fortnight of June, although the greatest increase takes place during July. Shoot increase becomes decided in the beginning of June with maximum in July.

2. SITKA SPRUCE: weight increase in root takes place later, namely during July and the greatest increases occur during August and again at the end of September. Shoot increase is decided in July becoming greatest in August.

3. <u>EUROPEAN LARCH</u>: results rather vitiated as beds from which plants were taken were badly frosted and latterly Meria larices did a great deal of damager. In this instance however main increase in roots took place in August and although there were increases in the shoot right through the main increase took place in August.

Root increases follow shoot increases.

All the outstanding increases in weight of the root were accompanied by observable increased root growth. There was a flush of new growth at time of each outstanding weight increase.

4. An attempt was made to find the relation between height growth and increase in weight. It was found that height growth commenced in Norway Spruce without increase in total plant weight. In Sitka Spruce with height growth the total weight of plant increased. In Larch had increase in height without increase in weight. The latter obviously uses up its reserves in the new growth as no starch occurs for instance in the root at the time of new growth. It was found to be different with the Spruces. The question is intimately bound up with the movement,nature and behavious of food reserves. In the Spruces no reduction in the amount of starch could be noted during the period of growth inception.

Notes made on other trees for instance on peat and under woodland conditions will require further verification before being reported on.

3. <u>Peat Research.</u>

Work was continued further as regards

(a) Age and type of plant for peat;

(b) Species for peat planting;

(c) Effect of shade;

(d) Effect of special treatment in the nursery.

<u>(a) Age and type of plant.</u>

During the season an experiment was laid out to test the importance of age differences on peat and to obtain material for root analysis. The species used were Norway and Sitka Spruce, and the ages were as follows :- Seed, one year old seedlings, two year old seedlings, three year old seedlings, 2 yr., 1 yr., 2 yr., 2yr. Planting was done by the Belgian method. Seeding has been found to be of no value. With the others it is too early yet to make an assessment but of the seedlings first year Norway Spruce appears very promising

(b) Species for peat planting.

Much better results have been obtained by the direct sowing of Scots Mountain Pine and Eurppean Larch than were obtained with Norway Spruce and Sitka Spruce.

Thuja plicata and Fraser River Douglas from the previous years' planting are showing good promise under conditions in which Sitka Spruce and Norway Spruce for instance have more or less failed. The former is capable of producing a healthy root system under conditions where Spruce fails to do so. Fraser River Douglas although it has shown small growth, is bushy, with well developed healthy side shoots, whilst the root system, although not vigorous, has produced numerous small rootlets.

Species planted this season (April 1926) include Mountain Pine, Beech, Tsuga albertiana, Tsuga canadensis, Pinus monticola, Abies sp.

(c) Effect of Shade.

The shading of Norway Spruce carried out in 1925 has been eminently successful. The shaded plants (2 yr. 1 yr.) are of a deep green colour and put in a height growth of 2 ins. (average) whereas the unshaded plants possess the characteristic yellow needles of Spruce on peat and have put on a growth of ½ in. or less on the average. By shading it is possible to bring about the translocation of starch.

Further, plants shaded during the present year (2 yr. 2yr.) of the same age as the former have not responded to the same degree, as regards height growth, although the needles are deeper green than in the unshaded plants. Both Norway Spruce and Sitka Spruce, however, planted during the present year and shaded immediately, have maintained a colour and height growth much better than the control.

If shading is to be successful it must be applied immediately after planting. It prevents the destruction of chlorophyll by intense light under conditions of poor feeding, and prevents the destruction of diastase in the leaves and so the conversion of starch to sugar. Hence the accumulation of starch noted in the report of 1925. It is of importance that yellowing of the leaves and diastase destruction results from absence of Potash (available) in the soil. The application of potash to yellowed spruce has so far given negative results on peat although positive results were obtained in the Nursery. (See Report 1925). On peat at Parkhill a restoration of normal functioning of the needles of Spruce has however been obtained with the application of Magnesium carbonate.

(d) Effect of Special treatment in the Nursery.

Plants which had been specially treated in the Nursery (Seaton) were planted in the peat at Parkhill in small plots of 50 in duplicate. The species were Norway Spruce and Sitka Spruce (2 yr. 2 yr.) lined out at Seaton Nursery as 2 yr. seedlings as follows - deeply planted, shallow planted, control, normal and lime, normal and potash, normal and manganese. In the nursery experiment the beneficial effect of potash in improving the vigour and colour of Norway Spruce was particularly well demonstrated. There was little to choose amongst the other plants. The deeply planted trees all gave the typical surface roots of plants so treated.

It is too early yet to estimate any difference in growth or appearance of the plants in the plantation stage.

4. Mycorhiza.

Work has been continued with regard to anatomy and physiology and the relation of fungal invasion to the food stores of the root studied. Results have been obtained which will give valuable information regarding the relation between tree and fungus.

5. Food Reserves of Trees.

Continued from previous year, and is still in progress, for the three species specified - Norway Spruce, Sitka Spruce, and European Larch.

6. Visit to Inchnacardoch Peat Area.

A visit was made to the Inchnacardoch Peat Experimental Area from 23rd November - 26th November, 1926. The promising results of experiments devised to preserve the nursery root system and to produce the new root/growth from the nursery system when placed in peat were seen. Arrangements have been made for a detailed examination of the root systems of the trees from the different experiments to determine the type of roots developed and their ultimate behaviour and fate, and to compare them with those root systems already examined in which the nusery root system dies or becomes unhealthy - observations of which the experiments at Inchnacardoch are the sequel.

The comparative success of seedlings, and the beneficial effect of Magnesium Salts on the growth and colour of the Spruces were features of the experimental work in view of the results got with these in research. A detailed examination is to be made and the development of these plants closely watched.

It is suggested that the Shelter experiment might be made more of the nature of a Shading experiment for the reasons given in the present report (Sect. 3. par. c.)

Proposed Research 1927.

The main subject of Research (as indicated at the meeting with Mr R.L.Robinson, Mr W.G.Guillebaud and Professor Borthwick - 22nd November, 1926) in the immediate future is to be

"Mycorrhiza: identification, distribution, habit and behaviour with special reference to peat soils".

It is proposed to determine the fungi forming Mycorrhiza on trees in nurseries and to identify those forming Mycorrhiza on different peat types. It is considered that the Mycorrhizal fungi in the nursery may be quite unsuited to live on a peat moor and that a complete change over may be necessary. Some peats may not possess the necessary fungi, which will entail a study of the fungi of peat and the conditions under which suitable fungi develop. Attention will also be paid to fungal distribution in other soils e.g. sand and in the soil profile. The fate of Mycorrhiza forming fungi requires to be worked out and their parasitic nature under certain conditions determined. Further work on the action of Mycorrhiza will be done to establish the relation of fungus to tree its beneficial nature or otherwise.

Ernest V. Laing,
30th November, 1926.

REPORT ON RESEARCH, 1926

G. K. FRASER.

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Mr G.K.Fraser's Report on Research. - 1926.

(1) Peat aeration by chemical means.

This has been investigated in the laboratory during the year by two methods (I) by measurement of the rate and degree of completeness of precipitation of peat suspensions by salts.

The results so far obtained indicate that :-

(a) previous results in earlier reports are confirmed as regards Hydrogen Ion concentration; rate of precipitation increases with increase in Hydrion concentration, but probably not within the ordinary practical limits of Hydrion concentration in the field.

(b) Ions of the metals and of ammonia have a specific action on peat depending to some extent at least on their own reaction to hydrogen Ion concentration e.g. Iron and Aluminium do not cover the same precipitating range of p H value.

(c) Mixtures of Ions have a different action from what would be expected as a result of the sums of their individual actions.

(d) Not only is the rate or degree of precipitation from solution important but the form of the precipitate varies and is apparently of considerable importance in relation to aeration. e.g. In acid media the precipitate obtained from a given quantity of suspension may be double in volume that obtained from the same quantity of peat in alkaline media; the same phenomenon is shown between different ions, e.g. Lime gives a smaller bulk of precipitate than Aluminium under similar conditions of Hydrion concentration, while mixtures again react in a different manner from the sum of their components.

This work is incomplete and is being investigated still with a view to obtaining light on the question of the action of Basic slag in the improvement of peat.

II. Pari passu with these precipitation experiments have been carried out percolation experiments, the technique of which however has not been put on a satisfactory basis; where reliable results can be got these bear out the conclusions stated in I (d) above.

In the field it has been found that Basic slag has a special action in this connection as shown in the complete change of peat to a "mouldy" consistancy when composted with slag, a result which was expected from observations on peats treated with slag for planting purposes. None of the other agricultural manures produced quite the same effect although Lime approximates this and nitrate of lime in very large quantities may produce a similar effect.

(2) Series of analyses have been carried out with typical peats on the available food material as opposed to the total food material. The lease-exchange hypothesis and methods of analysis have been used for available minerals and Sodium Chloride similarly for the determination of Ammonia.

Nitrogen as Ammonia and as Nitrate have been determined in some cases only and in fresh peat these (especially the latter) have been found to be lacking or present in very small quantities.

With regard to mineral food supply the results are somewhat variable; on the whole it may be said that all the usual minerals have been found to be present in the peats analysed but in some peats only in very small quantities. The smaller the total minerals, the less on the whole is available but exceptions have occurred. In the shallower types there is a rapid increase in some minerals with increase in depth. The better qualities of peat have at least more abundant lime in an available form. Indications of other interesting features occur, but the numbers of analyses required for generalization is greater than have been as yet carried out.

The best qualities of peat in some cases contain as much lime, and Potash, in a replaceable form as does the average agricultural soil.

(3) Apart from the completion of analyses along the usual lines nothing has been done in connection with the continuous cropping experiments. The crops are due to be removed this winter when crop samples will be taken for analytical purposes and the assessment of the crops will be made.

(4) A special report is included upon the present position as indicated by literature in regard to Soiling Crops. This is treated from the fundamental point of view, the silvicultural aspect , belonging to Dr Steven's province.

(5) Moss control in the nursery. (Not weed control).

Aim of experiment:- It was found that dilute solutions of metallic salts while having no effect on pot cultures of Sitka spruce were strong enough to destroy moss developing on these cultures. This fact might be made the basis of a method of dealing with moss-grown soils in the nursery. The original tests were carried out with plants in the dormant winter condition; the solutions were applied as far as possible without coming in contact or at least being left in contact with the green parts of the seedlings. Solutions of 1/1000 were used with these cultures.

At Seaton solutions of similar toxicity were applied to Spruce in the transplant lines on a section which had formerly shown growth of moss. This year, however, no moss development took place at all, so that from this point of view the trial was without result.

The plants showed no signs of being affected for the worse or for the better, therefore these concentrations can quite safely be applied to plants in the dormant condition.

Rates of Application :- 2 galons per sq.yard.

Corrosive Sublimate	-	1/1000
Copper Sulphate	-	1/750
Zinc Chloride	-	1/750
Ferrons Sulphate	-	1/500
Sulphuric Acid	-	1/500
Stannic Chloride	-	1/500

At Craibstone, on a 1 year old Spruce seed bed a further series of experiments was laid down at a later date, just before growth commenced. As the earlier experiments indicated that greater concentrations could be used without bad effects, the following conceentrations were used :- 4 gallons per sq.yard.

		(a)		(b)	(c)
A. Sulphuric Acid	-	1/250	&	1/100	
B. Copper Sulphate	-	1/500		1/250	1/100
C. Potassium Permanganate	-	1/500		1/250	1/100
D. Sodium Dichromate	-	1/500		1/250	1/100

The results were disastrous so far as the young plants were concerned; in all cases mortality was very great, with perhap s the exception of Sodium dichromate at the lowest concentration, D (c). Blanks were left between each of the series, A,B.C.D., and blanks left at each end.

If an average of the blanks at either side of each plot be used as an index then the estimated percentage of plants killed was :-

	A.	B.	C.	D.
(a)	55	65	90	15
(b)	10	50	70	5
(c)		5	0	0

The growth of the plants was also affected, to a marked degree in B (c), C (c), and throughout D., in A no marked effect could be seen. In D. the plants were apparently healthier and had a much better blue-green colour during the season, while longer growths occurred than in the untreated beds and blanks in the same area.

The cause of the heavier death list than was expected lay in the unexpected weather conditions. When the actual spraying was started rain had fallen frequently for a day or two and the weather forecast indicated a continuance of this weather. The work was carried out in the afternoon while the sun was shining and no rain fell and there was little wind during the next two days. Death took place through contact with the green leaves as the roots were in most cases fresh when the stem and needles were withered while in a few cases buds were afterwards sent out from the remains of the stem.

In any case it is concluded that without further experiment these concentrations are on the high side.

The effects upon moss :- Here again, possibly owing to the dry summer moss growth was very slight although the area was chosen as one of the most liable to that kind of trouble at Craibstone. In the neighbouring beds the remains of former years' moss were abundant. Only a little moss developed around and in the blanks small quantities of moss and of green algae were found. None occurred in any of the treated plots.

The effect of the treatment on weeds; a few notes were made in this connection and counts were made. Where the plants were badly affected weeds were badly affected in some cases even where the plants suffered little the numbers of weeds was considerably reduced, but the growth of those remaining was in almost every case more luxuriant than in the blanks, so that the net result is more or less negligible. A second weed growth at the end of the season is greater in the treated plots than in the blanks. (This is at variance with some American results, or at least this greater second growth is passed over).

The experiment as a whole has shown that as far as it goes the control of moss by chemical means is accompanied by considerable risk and that any beneficial results obtained might be negatived by a greater growth of weeds, against which might be set the possibility of greater growth of plants produced by a suitable weedkiller (e.g. Sodium Dichromate). At the same time the possibility of such control is not ruled out by the experiment.

(6) Peat planting with the addition of manures :-

This experiment has been continued along the lines indicated in the original plan. The crops of the first years' planting have been assessed but it is considered that another years' growth is necessary before conclusions of value can be drawn. Growth of last year has been very irregular. Soluble manures are dangerous, e.g. Kainit has killed out many plants where the vegetation is mainly Eriophorum augustifolium (supernatant water); so far as is shown they are not markedly beneficial on peat if applied along with the plants. Among the manures tried Basic Slag has produced the best results in individual plants.

(A point of note which has arisen during the last winter is the great amount of damage which may be done to plants (Sitka spruce, 2 yr 1) by mice. This may be due to our proximity to agricultural land but may be a point of general note in connection with the drier peats).

The application of solutions (dilute) of manure to plants already in the peat has not produced any marked result in either direction. This will be repeated with more concentrated solutions next season.

(7) Extension of the work on peat to other areas was not attempted this season. Work at Teindland was to have been carried out in conjunction with Dr Anderson. Arrangements were made for a survey in the south peat area but these apparently were abandoned.

(8) A special report is annexed on the investigation of literature and conclusions arrived at from those sources upon the effects of adding non-manurial "Chemicals" to the soil.

Scheme of work for 1927.

A. Laboratory work :-

(a) Investigation into the flocculation of peat will be continued as a laboratory research, with a view to obtaining a basis upon which the use of ameliorants in the field may be scientifically applied. The investigation as before will be oriented round the constituents of Basic Slag, which has been found to be specially useful in this respect. From the results it is hoped to be able to supply Slag to peat in a quantitative manner and possibly to substitute for Slag cheaper waste materials if such can be found having the same properties in this respect.

(b) Laboratory work in connection with field investigation Analyses of peats in regard to Aeration, Acidity, Food materials etc.

B. Field work :-

(a) The ecological investigations hitherto confined to Inverliever with few general observations throughout the western area of high rainfall will be extended to areas typical of peat ground throughout the country.

As far as possible correlation between peats, vegetational types, geology (including topography), and tree growth will be studied. Descriptions of peats will be made with a view to a classification of peats as a whole.

The edaphic conditions will be studied such as -

Water level, Aeration (including the effects of drainage), Acidity, Food-materials, and peat structure, together with such climatic factors as are of importance; all with a view to the practical characterization of these peat types, and the collection of information regarding failure or success of crops and likely means of achieving the satisfactory utilisation of these types as planting ground.

The investigation will be carried out as before with the idea of practical utility as a basis but at the same time in such a way as to admit of publication as a complete scientific study; for example though scientific summation of vegetational types is to be made, the possible translation of these descriptions into a simpler form of practical use will be continually aimed at.

The areas suggested as typical and suitable for this study are :-

Inverliever - South Western (High Rainfall).

Fort Augustus - Central.

Borgie - Northern.

New Castleton - Southern.

Aberdeen district - Eastern.

e.g. Drumtochty - (Sub Alpine).

(b) Experiments on hand at Parkhill on Peat-manuring and cultivation will be continued.

A. Line of manuring and type of manure.

Continued to completion and first assessment made.

B. The addition of peat ameliorants and manures to plants already on the ground - repetition with increased doses.

C. Small patches to be established in which very thorough cultivation of peat and mixing with manure is to be carried out, plants used to indicate results and samples of peat examined after a time to estimate the effects.

(Sgd) GEO.K.FRASER.

APPENDIX I.

Manuring in Nurseries with special reference to Green - manuring.

(A Resumé of the present position.)

Until about half a century ago the application of manures to the forest nursery was carried on in a somewhat haphazard way; and for some time later there existed a diversity of opinion regarding the question of whether plants in the nursery should be assisted in this respect in any way - the idea being that if plants were rendered "hardy" by a struggle with adverse conditions in the nursery they should be more likely to survive poor locality conditions in the forest. This idea still has its protagonists amongst foresters, a fact which may be traced to the unscientific use of various manures, especially notrogenous manures, and there can be no doubt that the question of the proper application of manures is even more important for nursery stock than for agricultural crops which are, on the whole, of the annual type and are adapted by cultivation to rich soil conditions.

Unfortunately systematic investigation into the effects of nutrient substances on plant metabolism and form of growth have been made almost entirely with the "agricultural" type of plant and may not be directly applicable to plants grown in the forest nursery over one or more periods of active growth.

It may be useful to recount in the first instance as far as is known the general facts underlying the manurial fertility of nursery soil; only those substances which it appears necessary to apply to the soil will be considered, e.g. though Iron, Soda, etc. are essential to plant life, yet they are sufficiently present in all soils, or might be expected to be in all soils chosen as nurseries, to render their application unnecessary.

The food materials required by forest plants, and likely to be deficient in the soil are Nitrogen, Phosphorus, Potash and Lime (and perhaps Magnesia); these are available or at least more readily available to the plant in the forms of Nitrate and Ammoniam salts, Phosphates

Potash salts, and Lime salts or preferably carbonate.

In natural soils the amounts of these substances apparently remain about the same over a long period, since the death of plants or of their organs returns the materials removed to the soil, while further disintegration of mineral matter and the fixation of Atmospheric Nitrogen may counter-balance on the whole losses due to leaching by rain etc. In cropped soils, on the other hand, the removal of the plant or of a large part of the plant means the removal of the food materials it contains, while cultivation itself, by intensifying bacterial activity, tends to increase losses, so that the soil may be depleted in a comparatively short time. In the forest nursery the same processes go on, to perhaps a less intense degree in some respects, but it has been stated that the annual losses in Phosphate, Potash etc. produced by the usual nursery practice are about equal to those resulting from the average crop of corn.

It follows therefore that soil depletion will certainly result from the continued removal of nursery crops from a soil of any description, the length of time required for the process to make itself noticeable depending on the original quality of the soil; and that therefore manuring of the forest nursery is quite necessary. Instances are quoted from continental experience where nurseries, turned infertile after long use have been renewed simply by one application of suitable manure. In this connection attention must be drawn to the fact that insufficiency of manure may not demonstrate itself in reduction of growth or poor development but in greater liability to diseases - damping off, etc.

Unfortunately soil analysis is only of comparative value in determining the question of what manures might be lacking in a soil, although present investigations throughout the world seem to be tending toward greater definitions in such lines.

Manures in general may be available to plants or unavailable, depending on their condition. For example Nitrogen for most plants requires to be in the form of nitrate (Nitrate of Lime etc.) or perhaps in the form of Ammoniam salts for a considerable number of plants; the large amount of Nitrogen contained in dead organic matter is immediately useless to plants, until such time as bacterial or fungal activity has liberated it in one or other of these forms, especially Nitrate, Potash, phosphate, and lime may be present in the soil in a mineral condition which renders them similarly useless for the immediate needs of the plant, owing to their insolubility, although they may be all-important as future reserves. Again, different plants have different capacities for making use of such food materials as are in the soil, and require different amounts of these for satisfactory growth and normal development and health. On this side of the problem data as regards forest plants are very meagre, and it is necessary to apply the general laws to these particular plants.

The part played by manures in the growth of plants.

Nitrogen:- The statement that all plants thrive better with Nitrate than with ammoniam salts is shown to be too sweeping by several workers. A number of plants are able to make use of ammonia, such plants as are found on the whole on soil types frequently suited to coniferous trees, and containing little or no nitrate, e.g. (From Russel - Soil conditions and Plant growth):-

Wheat grows best supplied with Nitrate and in a mild Soil.

Mangolds is similar to wheat.

Oats, Barley, Mustard grow equally well with Nitrate or Ammonia and are usually best grown on somewhat more acid or less mild soil. Potatoes and Maize grow best when supplied with Ammonia and grow best on a still more acid soil. (It must be noted in this connection that Nitrate reduces and Ammonia increases soil acidity - a probable explanation of the facts even although the Ammonia in all cases were actually taken from the soil as nitrate). Conifers will react similarly to the last of these three types mentioned since they occur naturally on the more acid than less acid soil types.

Other nitrogenous manures are for all practical purposes transformed into these two types before utilization by plants and are important simply as sources of these.

Nitrogen is an essential constituent of the protoplasm and is therefore of first importance in connection with all the vital activities of the plant. During germination the higher nitrogenous

compounds are rapidly produced from stored nitrogenous matter in order to produce the necessary organs of assimilation, imbibition etc., but after this initial store has been used, growth ceases in the absence of available nitrogen in the soil since further living tissue cannot be built up. Similarly nitrogenous reserves are brought into use in the initial stages of seasonal growth in perennial plants, but very soon require to be augmented by an extraneous supply of nitrogen.
Nitrogen Starvation:- When nitrogen is deficient in the soil growth is retarded and all the general activities of the plant are interrupted. The plants produced are small in size, have a weakly general appearance and the normal green colour of the younger parts is changed to a sickly greenish yellow; the needles are short and thin as if growth from the bud had prematurely stopped short and root growth is scanty and short. In older plants in transplant lines the wiry "starved" appearance occasionally seen in sandy nurseries is usually due to nitrogen starvation. Secondary effects are seen in the apparent scorching of the yellow needle tips and in liability to death in cold weather; while deaths (accompanied by a tendency to those symptoms), from other than well-defined causes may be mostly referred to this cause, lack of nitrogen. Extreme cases like the above are, however, perhaps not very common; usually, and especially with broad-leaved plants, deficiency in nitrogen makes itself felt in the greater liability of the plants to succumb to attacks of phyto-phagous animals e.g.g. slugs, wireworms, cockchafers etc. If this be so, the addition of small quantities of nitrate during the earlier growing season will give a marked indicative response, at least for a time. In some American nurseries the incidence of such pests as the above has been reduced to a remarkable degree, it is claimed, by greater attention to manuring.

On the whole, excess of available nitrogen is as dangerous in the forest nursery as is deficient - in fairly well managed nurseries it is more dangerous because less directly apparent. Even in older woodlands grown in strongly humose soils this has been described as a cause of the development of diseased woodlands in some cases on the continent

The effects of excess of Nitrogen supply are at first seen in the abnormally deep green colour of the leaves, with further excess these may become large and flabby and, to use the ordinary term applied, the plant as a whole becomes excessively "Sappy", a condition shown morphologically in the larger cells and thinner walls of these.

In close formation in the nursery-beds, the plants look healthy but are long drawn up, unable to bear their own weight of leaves, unevenness of growth is apparent and results in a much larger number of suppresssed plants. Starch formation is upset since there is apparently in some cases an increase in sugar production at the expense of starch. Correlated with these conditions there is a greater liability to disease, lack of resistance to fungi, sap-sucking insects etc., greater danger of "heating" during transport, liability to injury by rough handling and so on - all of these results being of a nature not usually ascribed to nutritional conditions at all. (And if any truth is to be found in the idea of "bringing up the plants hardy" by subjecting them to severe nursery conditions it lies in this fact that such plants although they "look well" are unhealthy and in general more liable to the dangers incident to transplanting into the forest, than slower growing but otherwise healthy plants from less heavily manured soil.).

In the forest nursery perhaps the most important effect produced by excess Nitrogenous food material is the prolongation of the period of active growth. In crop plants wheat for example, too much nitrate results in a very heavy production of straw which is still in a green condition when normally treated crops are yellow and ripe - the effect is often seen where manure-heap drainage runs into a corn field, patches of dung etc. With young trees the effect is similar, the plants continue to grow after the normal period of growth is past so that when early frost comes the plants have not hardened off or ripened; even when growth ceases these ripening processes may not take place, so that the plants are exposed to all the difficulties of winter in an unprepared condition.

It is therefore apparent that the addition of dressings of readily available nitrogenous manure is attended with considerable risk, especially if these are not exhausted both within and without the plant by the end of the season - the former because nitrates may be stored at least in many plants, and may be utilised at the end of the season with bad results.

It is therefore concluded that nitrogenous food material should be supplied to or made available to plants in proportion to their ability to assimilate it in a normal way, otherwise the effects produced by excess supply may produce results as harmful at least as an insufficiency.

Nitrogenous manures and their activities in the soil.

Nitrates:- These are soluble and immediately available to plants, they are not retained in the soil, the nitrate unabsorbed by plants being readily washed from the soil by drainage water and thus lost; thus with heavy applications direct financial loss may occur through wastage. The base (Lime, Soda etc.) with which the nitrate is combined in the manure is not so readily washed out, hence nitrates tend to reduce soil acidity; as compared with the lime salt, however, nitrate of soda tends to puddle heavy soils and render them less suitable for plant growth and more difficult of tillage, so that most probably nitrate of lime is the more suitable for nursery work where nitrate is required.

Ammonium Salts (Sulphate of Ammonia):- Ammonia is retained by the soil as such and is gradually changed by bacteria into Nitrate, thus forming a gradually more useful manure for plants. The retention of the acid (Sulphate) along with the conversion of the ammonia to nitrate tends to cause increase of soil acidity which has in agricultural practice been found to cause reduced yield, this is likely to be of somewhat less importance in forest-nursery practice.

Ammonium sulphate is probably the better of the two for application in ordinary manurial dressings; Nitrate of soda or of lime better applied in small quantity to make up for a marked deficiency in nitrate. All are harmful if allowed to rest in contact with plants even for a short time.

Other artificial nitrogenous manures are of less importance in forest-nursery practice, have not been tested in nursery work, or produce ammonium compounds when applied to the soil for some time (they must be applied when the crop is off the ground) and are similar to these.

Natural and organic manures usually contain more than nitrogenous food and will be considered as a group.

Phosphate:- Phosphorus is absorbed by plants in the form of phosphates and of course these must be in soluble form. The products of plant refuse decay in the soil to this form while insoluble mineral phosphates have to be weathered to soluble forms before becoming available plants.

Phosphorus is contained as far as is known in specialised parts of the living tissue of the plant where it seems to act as a regulator of vital activity rather than to be an active factor itself. That is to say that in the absence of phosphate correlation of action within the plant is interfered with, some processes may occur normally until hindered by the stoppage of others. For example the formation of starch, may proceed normally but its transference as food material throughout the plant is inhibited by the lack of phosphate. Hence the deficiency of phosphate may have no marked effect on the general appearance of a plant apart from the slowing down of the rate of growth. Certain effects however are notable, reduction in numbers of rootlets and a general effect similar to lack of water.

The effects of a good supply of phosphate are most noticeable in the early and late periods of annual growth. Seeds usually contain a store of phosphorus and phosphorus is usually stored in perennial plants in provision for spring growth. Young plants well supplied with phosphate rapidly develop a strong fibrous root-system so that deficiency of water-supply is not so markedly felt, and the start thus obtained early in the season is reflected in the better general growth of the plants through the summer.

The second and highly important effect of a good phosphate supply is the seasonal regulation of growth. Phosphate-starved plants (like nitrate-"poisoned" ones) tend to grow well into the autumn; a good supply of phosphate on the otherhand hastens the processes of of ripening so that plants well supplied with this manure are less liable to suffer from spring frost and the general rigours of winter. In short the effects of Phosphate in the plant are antithetical to those of nitrate; the plant is stiff strong and hardy, well-ripened off, with a good root system, and less liable to disease or climatic disturbance and to the disturbances incidental to transplanting. At the same time the effects of deficiency or abundance of phosphate are much less marked than of nitrate.

Phosphatic Manures :- A considerable number of these are in use; the two most satisfactory are Basic slag or Thomas phosphate, and Superphosphate; the former is a basic manure containing free lime or carbonate of lime which tends to reduce soil acidity, the latter contains sulphuric acid and Gypsum which tend to make the soil more acid. On the whole it would appear that practice favours the former as a nursery manure but at the same time there is little in the way of definite preference for either as far as nursery practice goes.

Ground mineral phosphates are much less immediately available to plants than these; Bone meal is similarly not so readily available; Bone Flour is available; but from the point of view of economy and reaction the two former are to be prepared in nursery practice. Phosphates are not readily removed from the soil by drainage. In practice bone meal is much favoured - its effects are due to a considerable degree to the readiness with which it sets free available Nitrogen.

Potassium :- The absorption of potash by plants is a simple one - potassium ions are absorbed, so that the effectiveness of all potassic manures depends (as far as this constituent is concerned) solely on the solubility of the salt used. The part played by potash in the protoplasm of the plant is perhaps meagrely known but its general effects on growth are quite readily demonstrated. Deficiency in this element results in weak general tone of the plant - slow growth and greater susceptibility to and inability to recover from disease. The apparent effects are not noticeable in any special way in the plants themselves although early shedding of needles, withering of needle-tips and such may occur. The processes of starch formation seem to be retarded by lack of potash (c.f. general agricultural expression "potash makes sugar and starch") but at the same time different workers have found different results in this respect - it may be the case that transport not formation of sugar is interfered with. The general effect of increasing potash supply seems to be shown in robust growth and colour and lower seedbed mortality.

Potassium Manures :- The efficiency of a potash manure is simply proportional to the percentage of potash it contains e.g. one unit of muriate of potash is the same as one unit of sulphate of potash; at the same time the Chloride or Sulphate contained in the salt has a specific action of itself and for this reason sulphate may be more useful than Chloride of potash. Potash is not readily washed out of the soil so that losses through over-manuring are not considerable. Other sources of potash such as wood ashes, leaf compost etc., are to be considered as mixed manures rather than potassic manures.

Lime :- Calcium is an essential plant food; but its principal importance and the principal necessity for it as a manure is connected with its function in the soil as a neutralizing agent for acidity and other toxic soil substances and conditions. In the plant it is required probably as a reaction-regulator, giving plants vigour and strength, and lack of lime in the soil (similarly to lack of potash) is seen mainly through secondary effects such as weakened resistance to disease and higher general mortality. Although it is now known that calcium is necessary as a counteracting agent to the effects of excess soluble alkali (like potash, soda, magnesia) in the cell, the cumulative effects of insufficiency of lime for nourishment in the soil apparently have not been solved, although the great diminution of root development which occurs on lime-deficient soils may be connected with this fact. Most conifers as well as the majority of broadleaved trees belong to the calcifuge type or are indifferent to the absence of free calcium carbonate in the soil.

Calcium in the soil :- Calcium (in the form of Quicklime or Spent lime) is necessary to the soil apart altogether from its value as a food material. It is not easily washed out, being required in larger amounts than other manures it requires to be applied in fairly large quantities to make up for losses. Its effect in the soil may be summarised as follows :-

It neutralises sourness, improves tilth especially in conjunction with leaf mould and in heavier soil types; renders other food material more available; improves beneficial bacterial activity such as the production of nitrate; and probably reduces the tendency to develop harmful organisms such as moulds; and in short produces those soil conditions which are grouped together by agriculturalists as mild or "sweet". Its effects in neutralizing the action of natural or artificial toxins in the soil are of secondary importance but still worthy of note in connection with nursery soils.

Magnesium is probably always present in nursery soils in sufficient quantity, or if not, is added along with other manures (e.g. Potash salts, lime,etc.,) in sufficient amounts. On some sands it might be lacking; if these are otherwise good, a yellow colour and tendency to slimness in the plants may be due to magnesia-deficiency which can be counteracted by the use of magnesian limestone or lower grade Potash salts containing magnesia.

Other necessary mineral constituents of the soil are usually present in sufficient amounts for normal plant growth sandier types being most liable to suffer from lack of any particular plant food.

In summing up the position it may be said that on the whole the question of nitrogenous manuring is the most important from the point of view of nursery practice, and completely dominates the question of the most suitable method of applying manure in the nursery. In addition to the plant food in the soil there is necessary a certain condition of the soil, obtained only by the presence of a greater or less amount of humus, which acts as an absorbent for food materials and water, as a buffer against violent change in soil reaction, as an agent promoting tilth, and as a medium for the bacterial and fungal activity of the soil, and such like, there being no fertile soil which does not contain this constituent in fair quantity. Therefore in the nursery soil where tillage causes more rapid decay of humus and the scanty production of litter does not supply sufficient material for its renewal the addition of humus or of humus-forming material becomes essential for the continuance of soil fertility.

This may be accomplished through the medium of farmyard manures, compost, or green (or soiling) crops, as well as by other plant or animal waste products of local origin, With regard to animal waste and substances like dried blood, fish-meal etc., they are so"rich" i.e. they are so easily decomposed and act so readily as a medium of growth for virulent fungal disease that, without further experience than has so far been gained, their use in the nursery for crops of tree seedlings or transplants is only in the experimental stage, so great are the dangers of damping off, through over rapid growth due to nitrate poisoning and soil heating.

Farmyard manure is undoubtedly the most satisfactory manure for agricultural and market gardening soil-amelioration both as regards humus and nitrogen; in the forest nursery, if applied in sufficient quantities to supply humus over a few years, it possessesto a considerable extent the disabilities noted in connection with animal manures - especially if not well rotted and probably fairly well leached of ammonia. In contact with seeds, seedlings or young plants it tends to hasten germination and spring growth, with the result of late frosting; owing to its heavy fungus flora, seeds sown after its application may be destroyed before, during, or after germination and growth have begun, a danger to which they are rendered liable also through the excessive nitrogen available to them from the decomposition of the manure. A similar disability occurs in transplant lines, though to a much less marked degree. If applied some considerable time before the utilization of the soil for coniferous plants these dangers are considerably minimised but where farmyard manure has been used regularly and with care it has been noted that deaths from damping-off and unexplained causes is higher than where compost has been the only source of manure.

If this manure is available and cheap then it should be used as a constituent of the compost heap or as a green-crop manure, when its greatest activity will have been expended before it has nursery plants brought into contact with it.

Compost is in very general use as a soil improver. If properly made it consists of a mixture of earth and mild humus, often however no lime is added to the heap, when it not only is less useful as a soil improver but is more liable to bring about disease in the crop through abundant development of fungi.

Compost may be fortified with artificials and farm-yard manure, animal waste and such like, and if obtainable in sufficient quantities would form a most satisfactory and complete manure for the retention of soil fertility in the nursery. Unfortunately it is not usually produced inlarge enough quantities. If the vegetable matter it is mainly composed of is not sufficiently well rotted and neutralised with lime it is as dangerous as farmyard manure in some respects, and not so useful. It should be turned over regularly for two years, under shelter before application.

The scarcity of compost and the risks attending the use of farmyard manure, together with the idea of the application of the agricultural Rotation to market-gardening and forest nursery practice has led to the development of the practice of soiling crops or green manuring. The theoretical basis on which this may be justified is discussed later.

The time of application of manures is of some importance. The general rule may be laid down that no active manure should be applied while seeds or plants are in the ground, since plants are able to deal with only very dilute concentrations of soluble matter and therefore, however well ground down and well spread a manure may be, at least local concentration of the soil solution will be caused resulting in plasmolyses and death (or "burning") of the cells of the seed or plant. An exception to this rule occurs when, for immediate improvement in growth small quantities of manure are added to the soil between the rows of plants in lines or drills, (for example nitrate starvation may be countered in this way). Any soluble manure must be applied in this way only in small amounts since otherwise they may be washed over or through the soil and thus injure the plants. Inactive manures such as bone meal and ground mineral phosphates could be applied either along with seeds without injury, or to plants in beds or lines with such trivial injury as may be caused by the temporary clogging of the leaf surfaces. Although soluble manures are apparently applied in small amounts to plants in wet weather (to prevent lodging on the leaves) even then there is always some danger of injury so that the practice had better be discontinued.

On the other hand there is no point in applying a manure which may be washed out by rain (e,g, nitrate) any considerable time before the crop is on the ground as this would entail considerable loss. Of the manures used in nursery practice Nitrates are most difficult to handle for this reason and in fact the special problem of nursery manuring is to be connected with the development of a suitable method of applying Nitrogenous manure to the soil. On the one hand the application of nitrate (or ammonia etc.) to the soil at the time of sowing or planting or while a crop is on the ground is attended by risks which are sufficiently serious to prohibit this method of application; on the other hand the application of such manures before the soil is cropped is exceedingly wasteful (e.g. it is shown that loss of nitrate is directly proportional to rainfall, and again loss may be extraordinarly rapid in lighter soils i.e. in good nursery soils).

Hesselman and others have shown by experiment that the essential condition for good growth of trees as regards nitrogenous manure is not so much an abundant supply of nitrate but rather a continuous supply throughout the growing season, in small amounts at any given time. As compared with agricultural plants, trees are unable to deal with temporary abundance of nitrate; they grow naturally on soils in which nitrate formation proceeds at the low rate regulated by the seasonal decomposition of decaying vegetable matter by seasonal activities of bacteria. Hence it is necessary that nitrogenous food material should be supplied in such a form as will liberate nitrate more or less in proportion to the normal seasonal rate of activity of the tree. This condition is supplied to some extent by farmyard manure, but here as already noted the rate of bacterial activity may be so much greater than the optimum, involving nitrate poisoning, heating of the soil, especially, and consequent greater frequency of damping off diseases. Compost again, is admirably suited for the manuring of nursery soil just for the reasons stated, and it appears to be the case that some of the larger commercial nurseries on the continent have been able to carry on for a considerable number of years, using only this form of manure, the material from which it is formed being collected from various sources, - nursery weeds, street, refuse, leaf litter, straw, etc., but all well rotted (for two years or more) under conditions which reduce waste of manurial constituents to a minimum, and with the addition of the amounts of lime necessary to reduce danger from fungal disease and conserve the tilth of the compost. Any deficiencies appearing are made up for by the addition to the compost of artificials - slag, kainit, woodashes etc.

The amount of compost available in the usual nursery, (from weeds and refuse) is quite inadequate to make up for the losses from the soil of Nitrogenous food material caused by the removal of crops and by leaching in the drainage water, Hence the usual method of nursery manuring advocated by most nurserymen both in this country and on the continent. In American scientific literature on the subject the tendency seems to be toward the trial of agricultural manures.

The method of retaining the fertility of nursery soil by means of green or soiling crops is now established as a recognised part of nursery organization. The practice has developed not so much on the scientific side but by trial as an approved practical method. The scientific basis of the practice is indicated above but no publication dealing specifically with the subject has been discovered.

In practice the operation bears two aspects, i.e. it may be ourely cultural, with a view to soil amelioration and similar desiderata, or it may be intended to combine profitable soil utilization with this cultural operation e.g. to grow a maketable crop. This latter aspect no doubt has had a considerable weight in commercial nursery practice, otherwise it does not form part of the actual operation of green-manuring, the central idea of which is the addition of a sufficient supply of humus containing nitrogenous and other food material which will improve the texture of the soil and afford available food materials as these are required by the plant during the several years over which its effects are expected to operate. At the same time advantage is taken of the opportunity of applying artificial or other concentrated manures which may get locked up in a temporarily unavailable form.

From the cultural point of view, therefore, the plants used should be such as will produce a good crop, fairly rich in nitrogenous matter, and not so fibrous as to prevent their ready humification in the soil. Nitrogenous manure may be applied to help the production of such a crop but the more economic method would be the use of nitrogen-fixing crops such as Legumes, like peas, beans, tares, Lupine, etc. Of these it is generally considered that the yellow lupine is the best for most nursery soils on the continent and in this country it seems to be favoured, at any rate on sandier and warmer soils.

Choice of species in any particular instance depends on several factors; (a) the plant must be suited to the soil conditions, e.g.g. Lupines on sandy soils, tares or vetches on heavier soils, Buckwheat on more sour soils and on colder areas. (b) Commercial considerations may decide the crops, marketing conditions in special localities, vegetables in urban areas, tares in small.holdings areas etc. (c) Secondary conditions of locality may prove important e.g. Mustard is useful in very weedy ground and produces a large quantity of good humus although not a nitrogen-fixer while it acts as an antidote to soil insect pests such as Chafer and wireworm; (d) the use of rich agricultural crops such as turnips, cabbage, potatoes on soil which is subject to fungal disease, is to be avoided. Potatoes are apparently specially dangerous in this respect.

No general rule can be laid down as to the most "suitable" plant for green manuring; the above may be considered as the lines generally indicated in such literature as is available. Again the relative frequency with which green cropping should be applied varies with a considerable number of conditions.

(a) Soil type - Green-crop more frequently on lighter and on the poorer qualities of sticky heavy soils; less frequently on good loams and on the richer heavier soils with good tilth but liable to disease.

(b) Mode of cropping - where the bulk of the crop is removed (e.g. with tares used as fodder) and only stubble or small waste is ploughed in, cropping must be repeated at shorter intervals than where a bulky complete crop is ploughed in e.g. Lupines or Buckwheat.

(c) If heavy agricultural dressings of manure are applied with the green crop then less frequent cropping is necessary.

(d) Forest crop - Broad-leaved trees require on the whole more frequent soil improvement than conifers.

(e) Bad disease attack of conifers may be followed by a "rotational" green crop to assist the disinfection of the soil.

etc.

Apart from such guides it appears that the general practice, developed through experience and correlated with continental tests as far as can be determined, is to allow of a green crop being introduced into the whole of the nursery area over a period of four to five years; that is to say normally in any given year ¼ to 1/5 of the whole nursery area is green-cropped.

The usual practice is apparently to follow up this green crop by seed beds and such crops as would be expected to make heavier demands on the soil; but if a heavy green crop is ploughed in at the end of the year then it may be advisable to use the ground for transplants in the following year to minimise the risks due to premature heating of the soil in spring. Frequently a good green crop may be introduced without the interruption of tree-cropping for a whole year, e.g. in the south winter crops may be grown between autumn lifting and spring lining out, or a catchcrop may follow late lifting of transplants; and one advantage of utilizing the ground in this way is the consequent reduction of weed carrying fallow land and reduction of general weeding costs; during the summer at least no ground which might be cropped should be left to grow weeds.

Any ideal system of green cropping can not be laid down as possible in detail as a practical measure. These details are a matter rather of pure nursery practice and are considered to belong more to Silviculture than to Soil science.

APPENDIX II.

Conclusions arrived at as the result of a search of Literature relating to the effects of non-manural salts, etc. upon the soil as a medium for plant growth.

A fairly exhautive search into and detailed comparison of the results of investigations into the effects of substances other than manures on plant life leads in the first instance to the conclusion that different workers have arrived at conclusions widely divergant and indeed diametrically opposed, with regard to almost any given substance or ion. This apparent conflict is readily explicable; the investigations involved fall into two distinct classes, (1) Culture experiments carried out on plants growing in pure water, dilute nutrient solutions or in solutions held in purified sand. (2) Experiments carried out in the field or in normal soils (in pots etc.) under control conditions.

(1) With regard to the first two media here mentioned it may be said at the outset that as far as rooting plants are concerned the effect of the medium itself is sufficiently great to emphasise beyond all practical considerations the harmful effects of any toxic substance - indeed in the case of pure water a possible explanation of the beneficial effect of very dilute solutions of toxic substances (e,g. Copper Sulphate, Iodine, etc.) lies in their exerting a neutralizing action on the toxicity which pure water possesses for living tissue. Regarding sand cultures, in the present connection they possess, owing to the small solid surface which they expose, so much of the nature of water cultures as to be considered identical with these in an investigation where the study of ionised substances is on foot; here they have been considered as such (see however page 6).

Any investigation into the behaviour of plants under the influence of salts in water culture, while having a value as a quantitative measure of their toxicity to the plant used under these conditions, is worthless as an estimate of the limit of safe application of these to the soil in which plants are growing or are to be grown.

An example of this may be quoted from an experiment carried out on a somewhat rough plan for another purpose some time ago. From this it would appear that although young beech plants are readily killed in culture solution by .2% Sodium Chloride, yet a young beech tree was grown (but not in a healthy condition) in soil containing 5% of its dry weight of salt and certainly affording on a basis of $\frac{\text{Salt Content}}{\text{Water Content}}$ a salt solution of more than 70 times that concentration.

Again most plants succumb to a Copper solution of 1/1,000,000 but the same plants have been grown in soils watered with solutions of 1,000 times that strength without harmful effects and often with increased growth as a result.

These examples definitely show that water culture and similar experiments have no direct bearing on the question of the toxicity of substances in the soil and have still less on the effects of the prolonged use of poisons on the fertility of the soil. Therefore they are not considered further in this connection.

Further, since the application of these takes place in the form of insecticides and fungicides (or perhaps as weedkillers when the crop is not on the ground) they are applied in forms and at dilutions calculated to be harmless to the crop in the immediate present. It may be said that very few investigations have been made directly into the question of their effects on the soil; most of the conclusions arrived at have been the result of observation or long continued application.

The substances under consideration may be separated into two classes - (1) Those in which the Molecule acts as a specific unit i.e. non-electrolytes or such Carbon disulphide, Benzene and with these the Carbolic derivatives phenols, Creosote, etc; (2) Those which in contact with water form solutions containing toxic ions or units as well as non-toxic or less toxic units which may have an effect on the soil, e.g. Copper sulphate in which the Copper ion is toxic; the sulphate practically non-toxic but more active in the economy of the soil itself. For this reason it is necessary to refer to these substances in two distinct connections e.g. the above as Copper and as Sulpahet.

(1) Group one may be separated into two classes (a) Volatile and (b) Non-Volatile.

(a) The former class including Carbon Bisulphide, Benzene, Toluene, etc. may be dismissed in a few words; as they are readily and completely volatile there are no direct permanent effects on the soil whatever, since within a few hours or a few days they are diluted or swept out of the soil by the processes of difusion and ventilation, the traces left being completely negligible. Their immediate effects on the soil are apparently beneficial as they act as partial-sterilizers and increase bacterial soil-activity. This effect also is probably limited in degree and transient

Chloroform, through formation of hydrochloric acid, and Carbon Bisulphide, through Sulphuric acid may increase leaching, but, in the quantities used, to a negligible degree.

Similar results may follow the application of any rapidly-acting and rapidly-destroyed plant toxin.

(b) Non-volatile substances like phenol, creosote, naphthalene, etc. all apparently disappear from the soil in a very short time. This in the case of phenol at least is ascribed to the action of Bacteria, but occurs in aseptic conditions apparently through the action of Manganese in the soil. The end prouots of the process are carbon dioxide and water, having no effect on soil conditions. The history of other coal-tar products in the soil has not been so throughly investigated but apparently follows a similar course.

Other organic plant poisons can be classed along with those indicated above: where salts are in question, the base has to be considered among those of the second group.

(2) Inorganic plant poisons. The units of these may be again considered under two groups (a) evanescent and (b) Permanent (relatively).

(a) The most important of these are the groups known as Cyanides, Sulphocyanides, Carbides, etc. in which the compound rapidly breaks down in normal soils forming manurial or relatively innocuous substances e.g.

Cyanide into Ammonium Carbonate.

Sulphocyanide into Ammonium Sulphate and Carbon dioxide and so on. These have no permanent effect on the soil in the strengths in which they are used.

(b) The main controversy has ranged round the salts of the heavy metals and metallic poisons like Copper, Iron, Lead, Mercury, Zinc etc., which are usually applied in the form of Salts or at least prepared from salts, the solution applied containing the Salt units.

It may at once be stated that these substances in solution and in direct contact with plant roots in anything but the lowest concentrations are toxic, and did they remain in solution in the soil should render it infertile. All of them however are to a greater or less degree, and, within the limits of the individual applications as Insecticides or Fungicides, totally rendered insoluble by absorption in the soil, so that only at very high concentrations do they come into contact with plant roots at all in soluble form. Hence solutions of metallic salts may be applied even to crops so long as they are not sufficiently strong to injure the leaves.

A good deal of the earlier work in this connection has to be neglected since the investigators in question were searching for a cause of infertility and having demonstrated the presence of metal (e.g. zinc, lead) in the soil considered they were justified in ascribing the observed effect to these substances as causes; subsequently other causes have been shown to be effective.

Exact work with most of these metals has shown that "the long-continued practice of spraying crops with metallic poisonshas in no case resulted in the reduced fertility of the soil through the action of these metals". This statement has however to be qualified by the proviso that should the soil become strongly acid (or very sour) then its harmful effect on crops is apparently intensifie and extended by the presence of appreciable quantities of soluble metal which may under these conditions become a soil toxin - e.g. Ferrous Iron is known to act as a toxic substance in very sour soils, and experimentally Copper-charged soils have reacted as poisonous when artificially acidified.

In the nursery soil however for general reasons the reaction of the soil will or ought never to be allowed to become so acid as to produce this effect.

In normal soils therefore metallic poisons have no effect as such, being completely removed from the soil solution by the absorptive properties of the soil itself. For example one of the most harmful copper compounds, Copper sulphate, may be added to the soil at the rate of about 2 cwts. per acre without bad effects on crop plants up to over 5 cwts. per acre have been added on good loamy or heavy soils with no bad effect after the first year of application; in the less soluble forms such as in Bordeau mixture much heavier applications have been made, so that taking average quantities and assuming that none of the copper is washed from the soil, Bordeaux mixture might be applied annually for over 25 years without harmful effect always provided the soil is otherwise kept in good condition with plenty of lime and humus.

There is on record statements that the application o copper salts has gone on continuously in this way in the French vineyards without injury to soil for over 100 years.

The general rules deduced from copper salts may be applied to all other metallic Ions. Arsenic which acts as a metal and as a non-metal, apparently is an exception. In the form of Arsenites its effects may be felt in the soil for some considerable time after application; in all probability arsenic will not be used in this form as a Forest spray.

(3) Acids; the second unit of the metallic salt, the acid ion is liberated as free acid hence it might be expected to have some influence on soil reaction and fertility. As far as observations appear to have been made the immediate effect of small quantities of most of the acid groups has been beneficial, perhaps due to the liberation of food bases from the colloid complex. The ultimate effect is no doubt to reduce the amount of base present in the soil and render it less fertile through the development of sourness. But since all non-basic manures - Kainit, Ammonium sulphate - except the Nitrates, produce similar effects from the same causes, and owing to their much more concentrated application, these effects, as may readily be understood, may be neglected and any soil acidity counteracted by the otherwise necessary addition of Lime to the soil.

x All harmful effects in very sandy soils are minimised by the addition of humus along with lime to counteract acidity.

The general conclusion to be gathered from literature on the subject of plant toxins is that although insecticides and fungicides are definitely harmful (as should be expected) to plant roots with which they come in contact, in the soil they do not make contact owing to their absorption and consequent insolubility in the soil solution; they are probably never added in such quantities even as weedkiller (arsenite an exception) to produce more than an evanescent effect and would require to be added regularly over many years before their effects should become noticeable in any crop, provided the soil is kept in a rich and (mild) "sweet" condition by an adequate supply of Lime and humus. The danger of applying these in large quantity to soils, the acidity of which might render them soluble, is well illustrated by culture solution results where death will occur with, say, Copper salts, at a concentration of 0.1 to 1.0 parts per million in ordinary water. In contradistinction to this it is emphasised that no soil has been "poisoned" by Insecticidal or Fungicidal sprays as far as well established record goes and that the general results of such have almost always been increased vitality in the plant and intensified biological activity of the soil.

GEO. K. FRASER.

Some of the principal literature analysed, and for further references seen :-

Brenchley :- Inorganic plant poisons and stimulants.

Collier :- Influence of copper compounds in soils upon vegetation.

Coupin :- Sur la toxicite des sels de cuiroe a C'egard des vegetaux superieurs.

Lipman and Burgess:- The effect of copper,zinc, iron and lead salts on the soil.

Lipman - Gerieke :- Smelter wastes and Barley growth.

Cyapek :- Biochemie der Pflazen.

Pfeffer :- Pflanzenphysiologie.

Various papers in Landwirtschaft Vers. Stet by Girard Jensen Sashser etc.

DR. J.W.MUNRO'S RESEARCH REPORTS

1925 - 26.

Megastigmus.

Pine Shoot Tortrix.

Chermes cooleyi.

Pine Weevil Work.

Chafer Work.

Megastigmus.

It was proposed to report on the status of Megastigmus as shown by the results of the examinations of Douglas fir seed collected since 1922. On going into the records it has been found that no seed collections have been received from the same localities in two successive years. The records of examinations are all contained in files at H.Q. and can readily be tabulated.

Meanwhile it may be stated that the highest percentage of sound seed found in any home consignment was 60% in a sample received through Mr Scott from Ardverikie in 1924 and that the percentage of infestation of home seed by Megastigmus ranged from 7% up to 35%. In considering these figures it should be observed that the analyses were as follows.

	a.	b.
Megastigmus	7%	35%
Sound seed	33%	2%
Empty seed	60%	63%

This suggests that in this country out of 100 seeds collected only from 40 to 50 per cent are developed and of these from 17% to 85% may be parasitised by Megastigmus.

Pine Shoot Tortrix.

An investigation into the Pine Shoot Tortrix was proposed by the Technical Commissioner and a programme of work was drawn up and approved. Unfortunately owing to the mining troubles and to the general strike the demarcation of experimental plots and arrangement of experimental hand-picking could not be made in the spring and has been postponed.

Inspections of the Wangford and Elvedon areas were made on April 7th and July 22nd - 23rd. The April inspection was confined to a general survey and by July 22nd one brood of moths had flown and the most useful work to be done was to ascertain the sites of egg-laying and behaviour of the first stage caterpillars.

Eggs were looked for at the base of the buds on the new growth. The first found was situated just below a side bud between two needles sheaths and subsequently others were found singly or in pairs either just at the base of a bud or on the shoot, at most quarter of an inch distant from the base of a bud or buds. In two instances eggs were found on the buds themselves.

The eggs[x] were of the usual Tortricid type, flat roundly elliptical scales sitting closely to the green bark of the shoot, They were of an iridescent pink colour and on being punctured with the point of a pen-knife burst and disclosed a brownish semi-liquid mass.

Some eggs showed signs of hatching in the form of minute elliptical gray spots near the margin. A considerable number of shoots bearing eggs were collected and the following further observations made in the laboratory.

On July 26th several eggs hatched and the emerging caterpillars crawled in between the needles and the needle sheaths. Here they fed on the sheath and needles throwing out minute

[x] Magnified photographs of the eggs accompany this report.

pellets of gray green excrement. On August 3rd some of the caterpillars had begun to form silken threads spun from the sides of the buds and were feeding on the bud scales and on August 23rd the silken web formed a complete covering between two or three beds into one of which the caterpillars had bored. At the date of writing (September 1st) all the caterpillars which have survived are concealed in the buds their entrance holes being blocked with resin. This is the condition in which the caterpillars pass the winter.

The species on which these observations have been made is not certainly known to me. Two very closely allied species have been collected by me at Thetford, Evetria (Tortrix) buoliana and Evetria turionana, while in 1917 I reared a third species, named by J.Hartley Durrant of the British Museum, as E.posticana, from pine shoots at Mildenhall. A fourth species E.duplana[x] is given by Meyrick (British Lepidoptera) as occurring on Scots pine.

The identification of the species is important as the following tables of the life-histories taken (a) from Meyrick and (b) from Judeich-Nitsche show :-

Species.	Mothflies.	Pupa.
buoliana	a. July - August	-
	b. June - August	June.
turionana	a. June	-
	b. May - June	April - May
duplana	a. May	-
	b. April - May	July - April

It will be seen that the two species buoliana and turionana overlap both in pupal period and flight time and have a similar life-cycle. Their modes of attack on the

x I am uncertain whether posticana and duplana are synonyms as recent work on the group is confined to purely entomological journals to which access can be had only in the British Museum. Lack of time has prevented my going into the matter.

plants are, however, different, buoliana tunnelling the growing shoots in early summer while turionana confines itself to the central buds. The resulting injuries are distinct when the moths occur singly, buoliana produces the deformed bayonet-like shoot, turionana produces a stunted top in which the leading bud never develops or in which none of the buds develop.

Both types of injury occur in the Wangford plantations and the question as to which species was found or whether both species have been found in the egg stage can be ascertained only by rearing the material now at hand.

With regard to E.duplana this species also seems to occur at Thetford as two pupae were found in buds on April 6th while all other buds examined contained caterpillars.

The position at Thetford with regard to these Pine Shoot Moths is much as it was when I reported on the area on May 26th 1924. In my report I suggested hand-picking on an experimental scale. Some hand-picking was done but was stopped by order of the Assistant Commissioner before enough had been done to yield any evident good result. Mr Guillebaud informed me that the cost was 1/- an acre and the measure was easily carried out.

In the absence of control measures the moths are steadily spreading and considerable damage is being done.

The question of parasites has been considered. An egg-parasite a species of Chalcid was obtained but no other parasites were obtained this year. In fact, before any trustworthy work on parasites can be done the identity and life-histories of the Evetria species must be cleared up. A beginning has been made and if next winter experimental plots can be established good progress might be made towards the control of these moths.

Chermes cooleyi.

Work relating to Chermes cooleyi has been confined to observations of its spread or increase made in the course of field work and to observations made in High Meadow and Lining Wood in the Forest of Dean.

Reports received from correspondents, either officers of the Commission or private individuals, show that C.cooleyi is more generally and widely distributed than was suspected. In part this appears to be the result of wider dispersal and to the insect's introduction in districts where it certainly did not previously occur. C.cooleyi is now recorded as far north as Laurencekirk on the Forfarshire-Kincardineshire border.

This question of dispersal is a serious one but it is doubtful whether it can now be completely checked. The chief means of dispersal is on young plants but this can be checked. The second means is by wind and this cannot be checked and there is now no doubt that it is only a matter of time until this Chermes will be found in most Douglas fir plantations throughout the country. This prospect may appear to render futile the control of the Chermes in the nursery but it cannot be too strongly urged that such a view is entirely wrong. Even although it were certain that all plantations established will ultimately become Chermes infested the longer the infestation is delayed the better and it would be very bad policy knowingly to distribute plants infested by Chermes cooleyi with the excuse that this insect is already wide spread and a few more infested plants will make little difference. Chermes cooleyi can be and, in many instances, is definitely injurious to young plants. When heavy infestation occurs it has a markedly injurious effect on the plant retarding growth and rendering the plant susceptible to attack by other injurious agencies. This has been amply seen in Dr Steven's experimental work. Every effort should be made to control Chermes in the nursery and prevent its dispersal on young plants.

Several control methods have been advocated against C.cooleyi both by spraying and by dipping and of these the most efficient is the Nicotine spray recommended in Bulletin No.4 p.30. The success of this spray depends however on repeated application. In summer there are produced on the Douglas fir needles a series of "Progrediens" generations and at least three sprayings at intervals of 10 days to a fortnight in the latter half of May and in June are necessary for proper control. That such control can be attained was shown by Mr Gray's sprayings in Dr Steven's experimental work this year.

In plantations the effect of C. cooleyi infestation varies greatly apart from variations due to seasonal or weather conditions. As I reported as a result of a visit to Lake Vyrnwy apparently different types of Douglas fir react differently to Chermes attack. Experiments to ascertain what types of Douglas best resist attack, or least suffer from it, are in progress in Bagley Wood but at present all that can be reported is that these plants have been infested this year and that different reactions to infestation will not be seen for a year or two. This experiment is under Mr Chrystal's charge and we are indebted to Dr Steven for the plants used.

Observations on plantations in High Meadow and at Lining Wood in the Forest of Dean have shown varied degrees of infestation. In 1925 in both plantations, one near Bunjups and in Lining Wood itself, there appeared to be an improvement. The numbers of Chermes per needle were less than in 1924 and the general infestation was less severe. This year in August the infestation was especially severe both on the low and the high ground. As in former years the degree of infestation varied from tree to tree. Some trees showed the needles shortened and curled lengthwise, shoot-growth short and adventitious buds numerous. Others adjoining such stunted trees were growing well with leaders three and four feet long. In such circumstances it is not possible to consider that soil conditions are responsible for these differences in growth and habit. Badly attacked or stunted trees showed no evidence of Armillaria or Fomes at the base or on the roots. Neither can it be considered that the Chermes is wholly responsible for these conditions. There must be some other less evident factor inherent in the individual trees themselves which produces so great a difference in the reaction to the Chermes. The discovery of that factor lies in the realm of physiological research and meanwhile the practical step toward solution of the problem is to determine by head mark, as the phrase goes, what types of tree are least affected by Chermes. It should not be assumed that Douglas fir is a forest tree reduced in value because of its being the host of C.cooleyi. C.cooleyi attacks are not entirely harmful. There is evidence on the timber testing side that Douglas fir may in this country grow too rapidly to produce the best timber and, while the introduction and spread of Chermes cooleyi into, and in, Britain is to be deplored, the insect may by slowing down growth and by calling attention to variation in type of the Douglas fir serve a purpose not wholly inimical to forestry.

The value of the lady-bird beetles as a check on C.cooleyi has received further consideration. The occurrence of the species, Adalia obliterata, was found at Bagley Wood and Lining Wood to be irregular but this species is still the only ladybird beetle occurring in any numbers in pure stands of Douglas fir.

One important aspect of ladybird beetles in their relation to Douglas fir should be mentioned; that these beetles, though normally carnivorous, may become phytophagous. Adalia bipunctata, a species closely allied to A.obliterata has been recorded as feeding on yew berries and Coccinella bipunctata our common red lady-bird has been found injurious to Silver fir needles.x

The C.cooleyi question is, as I have previously reported, closely bound up with silvicultural questions and further work on it should be carried out in conjunction with

xh in Larauer's Pflanzenkrankheiten - "Die herische Feinde" 1913.

the silvicultural and sample plot officers.

Pine Weevil Work.

This year's Pine Weevil work has been confined to the further study of the experiments at Hawkhill Inclosure in the New Forest.

The experiments are the outcome of a proposal to study the value of trapping Hylobius in standing woods one or two years before felling. Owing to uncertainty as to the times of felling and, when felling was decided on, to its being carried out irregularly as a market was found for the timber, the conditions of experiment are not those originally desired and intended.

The experiments are properly an endeavour to control Hylobius in standing woods during felling operations, experiments which must by their very nature give less efficient control than those carried out well in advance of felling.

The hypothesis on which the experiments are based is that in any given pine area Hylobius occurs in varying numbers and when felling takes place the intensity of Hylobius attack on replanting is directly proportionate to the number of weevils present before felling takes place. The effect of felling is to afford breeding ground for the weevil which increases rapidly in numbers within a year after felling and if unchecked will in two or three years attain such numbers as to menace replanting.

Assuming the weevil population in a standing wood in 1925 to be y and its rate of increase 140x, the population in 1926 would if everything favoured the weevil be (y x 70) as the porportion of sexes is known to be even. In the second year (1927) the population would be 70y x 70 and so on. Now the chief factor in standing woods which checks Hylobius increase is lack of breeding ground. For example, in Hawkhill itself the numbers of weevils present in 1919 after the 1916-1918 fellings has greatly fallen as last year's trapping clearly showed and this is due to two factors first, the scarcity of breeding ground and secondly, the consequent

[x] This figure of 140 is based on a statement by Rouche who examined the number of eggs laid in a season by single females.

dispersal of the weevil in search of breeding ground.

When felling takes place the chief check on Hylobius increase is removed and it is on this hypothesis that the Hawkhill experiments are based. The aim is to reduce y because obviously if the value of y is reduced the valye of 70y is also reduced and its sufficient reduction may mean the saving of much of the replanted crop.

The first fellings took place in Hawkhill in December 1924 and trapping was begun in May when the first weevils appeared from their winter quarters. I reported on the position then on June 20th 1925.

Since then felling has been carried out irregularly and trapping is now in force throughout the whole area. The numbers of weevils trapped are increasing but they do not show any such increase as would occur under normal conditions where no trapping had taken place.

On the occasion of my last visit on 12th - 15th July and inspection of each felling belt was made and the following points were noted :-

1. Damage to plants
2. Damage by insects other than Hylobius
3. Condition and efficiency of traps
4. Extent of infestation of stumps.

The damage to plants observed was slight except in strips Nos. 6 and 7 and in No. 6 this was ascribed to delay in trapping and too few traps. In No. 7 these factors were not present and except that in this strip two other weevil species were present no cause of the injury can be assigned.

In the earlier cut strips the almost entire absence (in some strips no injury at all had been inflicted) of injury by Hylobius is surprising even when it is considered that intensive trapping has been carried out and so far there is no doubt as to the success of the measure. Except in strips Nos. 6 and 7 there is good reason to hope that the planting done will be safe from destruction by the weevil.

In strip No. 7 and also here and there in other strips considerable injury has been caused by the two weevils Otiorrhynchus picipes (- O. singularis) and Strophosomus coryli. Corsican pine plants have most suffered from these. The type of injury resembles that caused by Hylobius, as it affects the stem, but Otiorrhynchus and especially Strophosomus nibble the needles and where severe nibbling of the needles occurs with stem injuries it seems reasonable to ascribe the whole to these weevils. Otiorrhynchus gnaws the buds much more than Hylobius does and this also strengthens the evidence for ascribing such injury to this weevil. Both these weevils occur in the traps but are not attracted to them as Hylobius is and probably use them for shelter only. Eckstein (Technik der Forst-schutz) recommends bundles of Rumex acetosella as traps for Otiorrhynchus but I have never tried these.

Both Otiorrhynchus and Strophosomus have in recent years become important in planting operations. Even in Mull their injuries have been reported as severe and at Margam they are proving as serious a pest as Hylobius. Both occur widely throughout Hawkhill. I observed their injuries to self sown pine in December 1924 and their attacks are not unexpected although the intensity of attack is much greater than was to be expected. Their presence is important for two reasons, first because of the injuries inflicted and second because these injuries may be ascribed to Hylobius and the results of the experimental work vitiated.

An examination of the traps at Hawkhill showed that while in the earlier cut belts these were sufficiently numerous and well placed, in the later cut belts and, in particular, in Nos. 6, 7 and 8 more and fresher traps were needed. The whole success of this control method depends on efficient, intensive trapping and the points needing attention most are the numbers and freshness of traps. No information was obtained as to the relative efficacy of bark and billet traps, both are in use, both if kept fresh are efficient, but bark traps rapidly dry up and billet traps must be closely in contact with the soil or soil vegetation.

Last year it was ascertained that trapping had not completely prevented egg-laying by the weevil in the stumps and this was further looked into on this visit. In many stumps only one or two grubs were found, in some none were found and in a few from twelve to twenty were found. These were full grown grubs or pupae. Their numbers per belt could not be ascertained in the time at my disposal but they are certainly many times less than normal. This again suggests that the experiments are at least in part successful.

Apart from the experimental results of the Hawkhill trapping results of direct value to the re-planting ought to be forthcoming. These will depend almost wholly on the intensity of trapping next spring and on the care with which trapping is carried out. During the next five or six years felling will take place in Hawkhill. Apart altogether from the principle it is desired to establish or refute, that trapping before or during felling is better than delay in planting, delay in re-planting in Hawkhill until the weevils cease to breed in the stumps is impracticable. If that method of avoiding weevil loss were adopted the soil conditions and the growth of weeds would involve much more expenditure in preparation for planting than intensive trapping would cost and meanwhile the weevils bred in the stumps would disperse to other areas, some of them not far distant, where felling and planting is also in progress.

Hylobius is endemic in the New Forest. As felling proceeds it may become epidemic and the reduction of its numbers throughout the forest ought to be taken seriously. On private estates where the forest area is limited, the forest staff small and labour costly in proportion to the area of woodlands, the control of Hylobius must probably be limited to control before or during felling. In the New

Forest where the pine woodland area is large and where the staff is organised an attempt should be made to reduce the weevil. When new plantations are being established _Hylobius_ is quite as important a pest as the rabbit and expenditure of money and labour on its suppression is no more unreasonable than expenditure on rabbit extermination. The increase of Hylobius ought to be regarded just as much as a mark of woodland neglect as the increase of the rabbit.

To begin with, that section of the New Forest which lies south east of Brockenhurst and east of the Lyndhurst Road-Brockenhurst railway line might well form a demonstration or experimental area for the suppression of _Hylobius_. In this work billet traps and stake traps will be most serviceable, billet traps where felling is shortly to take place or is in progress and stake traps where felling is not contemplated for a year or two.

Chafer Work.

The chafer work carried out this year has been directed towards clearing up the relative importance of the three species destructive in the Commissioners nurseries and determining the main facts of their life-histories as they may affect control work. A good foundation has been laid for further work and already the various problems to be faced have become clearer and more definite.

The three species of chafer concerned are the Cock-chafer *Melolontha vulgaris*, now known as *Melolontha melolontha*, the Summer chafer, *Rhizotrogus solstitialis*, and the Brown chafer *Serica brunnea*.

Two other chafers are referred to in British entomological literature as injurious to forest crops namely *Melolontha hippocastani* and *Phyllopertha horticola*. *M.hippocastani* is considered as the northern Melolontha replacing M.vulgaris but its occurrence even in Scotland is rare and it has no status as a forest nursery pest. *Phyllopertha horticola* the June or Garden chafer is an exceedingly common insect in England. It is seriously destructive in market gardens and allotments and in its adult or beetle state is commonly seen flying in the Dean Forest, New Forest and other woodland districts, but has so far never been found injurious in the Commissioners' nurseries. No explanation can be offered why this chafer should prove a pest in gardens and allotments, be common in woodlands, and yet be absent from the forest nursery. It may yet turn up but careful search for it made while examining chafer larvae from many localities failed to find it

Some attention has been given to other Lamellicorn beetles than the chafers. Not infrequently the larve of such Lamellicorns as *Aphodius* and *Geotropes* are confused with those of the true chafers and requests have been received for characters whereby to distinguish the groups. In *Aphodius* and *Geotropes* the anus is dorsally placed; in the chafer larva it lies ventrally. *Aphodius* larvae are frequently introduced into the nursery in cow and horse manure. They are entirely coprophagous and harmless. *Geotropes* larvae are most commonly found when pasture land is being broken up for nursery work. Several species occur but their larvae are much alike and are best recognised by their hump-backed appearance and blue-grey colour and on closer inspection by the much reduced third pair of legs which are mere stumps. The *Geotropes* grubs are also coprophagous and harmless. *Aphodius* grubs are also frequently found in pasture land. They occur in patches of cow or horse dung or below soil where dung has fallen.

The Common Cock-chafer.

Aims and progress of the work.

The main object of the work carried out this year has been to determine the normal duration of the chafers life-cycle from adult to adult and to ascertain whether flight or swarm years, in which larger numbers of chafers appear than in other years, occur in Britain as they do on the Continent.

Duration of the life-cycle.

There are two methods of ascertaining the duration of the life-cycle first by rearing from the eggs a series of grubs through to the adult stage. This method has been adopted but as it is slow and must await the development of the grubs over three or four years the second method of collecting and measuring grubs of all ages and so piecing the life-cycle together has also been used. The best period for determining the age or size of the grubs is late autumn or winter and the result of last winter's collections and examination from Surrey, Hampshire, Berkshire and Gloucestershire districts was as follows :-

Newly pupated beetles	emerging 1926
3rd year grubs	emerging 1927
2nd " "	" 1928
1st " "	" 1929

This summer's collections were as follows:-

Eggs	emerging 1930
Pupae	" 1927
3rd year	" 1928
2nd year	" 1929

In examining collections of larvae Perris'[x] characters for the recognition of the various chafer larvae were used and were found to apply to all stages of the three species found. These characters are afforded by the last abdominal segment and are best seen from the ventral aspect.

1. Anal orifice transverse, spinules on ventral surface in a double and longitudinal row.

2. Rows of spinules extending almost half way up the anal segment and beyond the apical bristles.

Melolontha Fig. 1 a.

2a. Rows of spinules extending only about 1/3rd of the way up the anal segment and not beyond the apical bristles.

Rhizotrogus Fig. 1 b.

1a. Anal orifice longitudinal, spinules in a single transverse row.

Serica Fig. 1c.

These characters have been confirmed by the rearing of larvae to the adult stage and from eggs. The size or age, for in the present investigation the terms are synonymous, has been determined by comparison of head measurements. Measurements of the bodies of chafer grubs afford no indication of age or stage of development because they vary with the amount of food taken and the extent to which the alimentary canal is laden or void of food or excrement.

From the examinations made it is apparent that the life-cycle of M.vulgaris in those localities is a four year one and confirmation of this will be obtained by observing individual larvae from hatching out until pupation.

x Larves de Coleoptères.

The habits of the adult Melolontha.

Pupae of Melolontha were first found in the middle of June and, from August onwards to May and June, perfect beetles were found in the soil. During the winter the beetles remain dormant but contrary to the accepted text book statements they become active in early spring and appear above ground in mild weather returning again in cold spells. Observations on this point were made in the experiment cages but outside under wild conditions chafer beetles were found just at and very little below the surface in mild weather in March. These observations tend to confirm the belief expressed in earlier reports that in Great Britain the sudden or concerted appearance of the chafers on or about a given date is rare and that our insular climatic conditions are the causes of this difference between the cock-chafer's swarming habits here and on the Continent. In Southern and Central Europe where spring comes with a rush and warm weather persists until summer, hibernating insects usually appear with uniform regularity and proceed to pairing and egg-laying without interruption from climatic disturbances. This difference in swarming period has already been suggested as unfavourable to the collection of chafers by beating from the trees a method much favoured and greatly practiced on the Continent.

Pairing of Cock-chafer.

Pairing in the laboratory cages which were kept at room temperature took place as early as February 26th but whether this pairing was effective has not yet been determined. In the field no pairing was observed until 3rd June and could not have been general before the middle of that month.

The beetles fly only at and after dusk and it was frequently 10 or 11 o'clock (Summer time) before they appeared in any numbers. During the day they were found on oak and chestnut foliage but only in two instances were couples found pairing.

Egg-Laying.

The act of egg-laying was not observed. In the cages female beetles were frequently found burrowing in the soil and egg-clusters were subsequently obtained. In the open, batches of eggs were found and one dead female was found among a group of sixteen newly emerged grubs.

In the cages none of the eggs laid produced larvae and this was apparently caused by the confined conditions. Fabre (Souvenirs Entomologiques, 10e Serie 9th Edn.) working with the Pine chafer, Polyphylla found that no successful pairing took place under cage conditions and it is probable that in future experiments female cock-chafers will have to be collected after swarming if fertile eggs are to be obtained.

First Stage Larvae.

First stage of newly hatched larvae were found at Perch Nursery in the Forest of Dean and in Bagley Nursery on 9th and 13th August. They showed the same chaetotaxy or bristle and spine arrangements on the anal segment as half and full grown larvae. These are the only observations made on them to date.

The bearing of this year's work on practice.

The first point in the chafer life-history bearing on practical control in the nursery is the prolonged and irregular swarming period under our climatic conditions. This reduces the efficiency of two important measures, the beating of chafers off the trees and the protection of nursery beds against egg-laying.

Beating of beetles off the trees would require to be done during June and July and furthermore even in main swarm years the numbers of chafers swarming never approach those arising on the Continent. Observations made during the past four years support this view and further evidence is to be found in old writer's like Mouffet and Gilbert White who make no mention of these beetles as defoliators.

Protection of nursery beds by quick-lime and naphthalene is impracticable because of the irregular appearance of beetles in swarming and because our climatic conditions during June and July rarely afford sufficiently long spells of dry weather to allow lime to remain quick or unslaked or to permit of naphthalene remaining effective. The naphthalene question is dealt with below but it may be here explained that although naphthalene flakes remain long in the soil unaltered the cresyl oil and other impurities which are the really potent insecticidal constituents of crude naphtha are washed out from the soil within quite short periods.

The second point of this year's work bearing on practice is the occurrence of flight years. The proportion of adult beetles found this spring was far in excess of 1st year and 3rd year larvae found. This confirms the results of last year's work and gives the flight years as follows :-

1926, 1930, 1934.

with minor flight years in 1927 and 1929.

Heaviest losses occur in the 2nd and 3rd years after flight years being caused by the 2nd and 3rd year grubs. Thus in 1928 and 1929 heavy losses caused by Melolontha grubs are to be expected and foresters in charge of nurseries should be instructed to pay special attention to collection of grubs in winter 1927 and spring 1928.

Next spring 1927 the grubs may also, and should also, be collected but they will be relatively small and unless carefully looked for will be neglected by the ordinary worker engaged on piece work digging.

The third point of interest in this year's work is that except during the 2nd and 3rd years following swarm years Melolontha can be controlled by Carbon bisulphide injection. In normal years Melolontha attacks are usually sporadic and strictly limited in area, features which afford conditions suitable to the use of C.S.2 injection.

All the observations made this year show that the best and most practicable means of eradicating cock-chafer in the nursery is by catch-cropping and rotation. This will entail increasing the nursery acreage by 25% but the adoption of catch-cropping and rotation will result in other benefits than the eradication of cock-chafer and the increased expenditure involved in acquiring, fencing and breaking up the additional land required will soon be repaid by better transplants, reduced weeding costs and freedom from chafer.

June chafer. *Rhizotrogus solstitialis.*

This chafer is frequently confused in the larval stages with *Melolontha.* It is, however, much more widely distributed and is in agriculture a more serious pest than *Melolontha*.

The Life-cycle of *Rhizotrogus*.

Three sizes of *Rhizatrogus* grubs have been collected during the past year's work and the life-cycle is presumably a three year one. Full grown larvae collected from Kennington nursery during the winter pupated in May but owing to rather rough handling in transferring them from Kennington to Bagley nursery in order to place all the experimental pots and cages together none emerged successfully. In the open *Rhizotrogus* beetles were seen during the last week of June.

Efforts should now be made to secure first stage *Rhizatrogus* grubs in order to resume the life-history work.

Serica brunnea.

Life-cycle.

Two stages of larvae were found last winter. Full grown larvae pupated in the end of May and emerged as adult beetles in July. Eggs were obtained in the experimental pots in the first week in August but were presumably infertile and failed to hatch.

The life-cycle is a two year one.

The relative importance of the three chafers.

While the Common Cock-chafer *Melolontha vulgaris* has always been looked on as the most important, if not the only important, species of chafer in the forest nursery and is the only chafer dealt with at any length in the text books, the work of the past three years has shown that that view is incorrect. The grubs of *Rhizotrogus* and of *Serica* cause in the aggregate greater loss than *Melolontha* and because of the shorter duration of their life-cycles are actually less easily dealt with in practice. The position given to *Melolontha* has been given it because no serious investigation of the chafers on an entomological basis has been made in Britain even in agricultural entomology and the whole of forest entomological teaching in the past has been derived from German or at least from Continental sources. Serica brunnea is nowhere mentioned in English economic entomological literature. A short article in the Tharandter Zoologische Miscellen for 1910 describing a severe attack by Serica in a Saxon nursery and a brief notice of a similar attack in Denmark contained in Boas' Dansk Forstzoologi (2nd Edition 1923) are the only references to it in the European literature.x

On the Continent Melolontha undoubtedly predominates over Rhizotrogus and Serica but in Britain these two species are much the more important. In Scotland Serica brunnea is the most important of the three species.

Relation of work done to the practical control of chafer in nurseries.

The following new information has an important bearing on control measures against chafers.

1. The recognition and confirmation of the occurrence of three species where formerly only one was considered.

2. The establishment of the period of duration of the life-cycle of the three species and of the periodicity of the cock-chafer Melolontha.

The recognition of the status of Rhizatrogus and Serica as forest nurseries pests is a considerable advance. Damage caused by the grubs of these beetles has in the past been attributed in many instances to such agents as drought, wind and bad transplanting. The type of injury inflicted by Rhizatrogus and Serica differs from that caused by Melolontha. These beetles girdle the seedlings and transplants and rarely gnaw the roots across. Melolontha gnaws the roots, under-cutting them, and plants more readily recover from Melolontha attack than plants girdled by Rhizatrogus and Serica.

x Reh in Larauer's Pflanzenkrankheiten 3rd Edn., cites Escherich & Baer's nate in the Tharandter Miscellen and Escherich Forst-insekten 1923 quotes it.

This has an important practical significance. Plants attacked by Serica and Rhizotrogus lose colour and wilt rapidly and if wilting plants are examined whenever the symptoms show, measures can be taken to prevent extension of the damage. With Melolontha wilting occurs as a rule only when a spell of dry weather follows an attack and not uncommonly Corsican and Scots pine transplants or 2 year seedlings may be almost completely deprived of roots before any evidence is visible above ground. At Rapley Nursery in 1924 Corsican pine transplants looked healthy although they could be brushed out of the beds by a sweep of the hand. Some of these plants formed new callus and would probably have survived but for a spell of dry weather which checked or prevented the formation of new roots or absorbing surfaces.

At present it appears that the methods of control to be adapted against the three chafers differs. Where Melolontha and Rhizotrogus are concerned the use of catch crops and a rotation system offers the best means of control. Where Serica is concerned early detection of damage followed by Carbon bisulphide injection is most likely to prove effective. It should be noted that Serica grubs are most injurious from midsummer to September and that their work should be expected and looked for from June onwards. Melolontha and Rhizotrogus are usually most injurious earlier in the year from April to July.

The bearing of knowledge of the duration of the life-cycle in the chafer species on practice is that swarm years can be anticipated and measures taken in advance. This applies less to Serica than to the others.

Where Melolontha and Rhizotrogus are concerned every effort should be made to collect their grubs during the coming winter and spring and in the following autumn. All beds where transplants can be moved out should be well dug over and where possible a Kainit dressing should be applied. Although the evidence that potash is either injurious or noxious to chafer larvae is still based only on scattered observations it is still trustworthy and experiments to confirm it are much to be desired. Such experiments were proposed to Mr Young in the Forest of Dean for trial in Perch Nursery.

The use of naphthalene for chafer control is still in the experimental stage. The results obtained from its use in the Commission experiments have been varied and similarly varying and opposite results have been obtained by the Ministry of Agriculture and at Rothamsted. There appear to be two main reasons for this, first that naphthalene of itself is only a little noxious to insects and that its toxicity depends on impurities contained in it of which the chief seem to be cresyl compounds. Thus crude, "unwhizzed" naphthalene varies in composition with the mode of its preparation and even in the same retorts from time to time. I understand that the Ministry of Agriculture, Plant Pathology Branch is investigating this matter in conjunction with the Rothampsted Research station.

The second reason for varying results from the use of naphthalene is that its efficacy as an insecticide or insect deterrent is dependent on soil conditions. The presence or absence of certain bacteria, the hydrogen ion concentration in the soil and the water content, all appear to affect the action of naphthalene.

For these reasons the use of naphthalene is not generally recommended but it should be experimented with in nursery experimental work.

The work of the Commissioners on the chafer problem has cleared the way for definite experimental work and this should be continued along the following lines :-

1. To ascertain the periods of activity of the three species with a view to early detection of damage.
2. To determine the value of rotation and catch cropping.

3. To improve $C.S._2$ injection methods.[x]

4. To devise other soil insecticide methods.

5. To test the value of Potash dressings.

[x] These methods are mentioned in previous reports and a generally applicable method is given in my report on a visit to the Forest of Dean on June 10th and 11th 1925.

(Sgd.) J.W.M.

REPORT ON RESEARCH, 1926

DR. MALCOLM WILSON

I N D E X.

Report of Consulting Mycologist for 1926.

Phomopsis Disease of Conifers.

During 1926 a large number of infection experiments were carried out with Phomopsis Pseudotsugae. The fungus obtained from Douglas fir gave a large percentage of positive results, when infections were carried out on Douglas fir and Japanese larch. The experiments have been carried out at Glentress, Peebles, on trees about 14 years old, and at the Royal Botanic Garden on pot plants. Cankers are produced on lateral branches in about two months. On the main trunk infection is slower. Leading shoots are killed back from 12-18 ins. within 6-8 weeks and small lateral branches are more quickly affected. Cankers have been produced on the main stem of the Japanese larch, but infections on young shoots have not been successful. The identity of the fungi on the Douglas and the Japanese larch which was presumed in the Bulletin has thus been proved.

Phomopsis Pseudotsugae has been found in Holland and Denmark, causing cankers and die back of the shoots of the Douglas fir. The fungi from these countries are now being grown in culture and they are identical with the form found in Britain.

A disease of the cedar (Cedrus atlantica) caused by Phomopsis Pseudotsugae, similar to that on the Douglas fir, has been received from near Salisbury, and also collected near Edinburgh. The fungus from the cedar is being grown in artificial culture, and infection experiments have been carried out. Although the fungus is identical in form with that found on the Douglas fir, infections made with it on the latter have all failed. It appears therefore that the fungus on the cedar is a special form, confined to that species.

Work has been carried out on the identity and relationships of Phoma pithya, Phoma abietina and Phomopsis Pseudotsugae and a paper on this subject is now nearly completed. For this work material of diseased plants has been obtained from Holland, Denmark, France (School of Forestry, Nancy), Norway and Germany (School of Forestry, the University, Munich), and the United States, and herbarium specimens of fungi from Kew, Hamburg, Copenhagen, also Padua and Washington (U.S.A.).Great assistance on this work has been given by Mr G.G.Hahn of the Bureau of Plant Industry, United States Department of Agriculture, who is working in the Mycological Department of the University.

Diseases on Scots pine, Douglas fir, European larch, Silver fir Abies grandis and Tsuga sp. caused by species of Sclerophoma have been investigated. These which have undoubtedly been confused with Phomopsis disease in the past, require much further investigation. The disease on European larch caused by this fungus appears to be serious.

Dutch Elm Disease.

Trees suffering from this disease were examined during August at Wageningen, Holland and a short description was given in the report on the visit to Holland and Denmark. A full report on the disease was sent to the Secretary of the Commission in December. (Copy attached).

Information regarding the disease in Norway has recently been received. (Copy attached).

The Ministry of Agriculture has now prohibited the importation of elms from the continent in consequence of the very virulent nature of the disease and its wide distribution in Holland, Belgium and France.

Damping Off of Seedlings.

A considerable number of specimens of seedlings apparently killed by Rhizoctonia Solani and Fusarium sp. have been received. Cultures of these fungi have been prepared for carrying out infection experiments in the coming season.

Various metallic salts have been used very successfully in United States of America during the past season, for the prevention of damping off. It is proposed to carry out experiments with these during the coming season.

Meria laricis.

A considerable number of specimens of larch, damaged by Meria have been examined and observations have been made at nurseries regarding the relation between this disease and frost. It is proposed to carry out experiments in spraying for this disease, at two or more nurseries, commencing in March, 1927.

Bacterial Canker of the Ash etc.

Work is being carried out on the canker of the ash which is said to be caused by bacteria. A bacterial disease of the poplar is also being examined, and infection experiments are being arranged to determine the relation of this disease to the bacterial disease of Willow, and the Dutch elm disease.

This work is being carried out by Miss M.J.F.Wilson.

Diseases of Douglas fir and Lawson's Cypress caused by Dermatea sp.

Disease of the Douglas fir caused by Dermatea sp. has been described by various authors in Scotland, Holland and Germany. Material of Douglas said to be damaged by Dermatea sp. has been collected at Beauly, Peebles, Aberdeen, and Montrose, and Lawson's Cypress apparently damaged by this fungus has been received from Devon.

A similar fungus has also been reported causing disease of Abies grandis at Novar. Specimens of the fungus have also been received from near Birkenhead.

Several cultures of the fungus have been made and infection experiments carried out on Douglas fir, and Lawson's Cypress. Sufficient time has not yet elapsed to obtain results. This work is being carried out by Miss M.J.F.Wilson.

Disease of Oak leaves caused by Sclerotinia Candolleana.

This was observed in several localities in Scotland in 1925 in an epidemic form and in 1926 was reported from many localities in Scotland and England. The life history of the fungus has been investigated and infection experiments have been carried out, which shew that the fungus is a strong parasite. Preliminary accounts of the disease have been published in the Gardener's Chronicle, and the Transactions of the Royal Scottish Arboricultural Society, and a full account is now in the press to be published shortly in the Journal of applied Biology.

Fomes annosus.

Pure cultures of the fungus from Beech, Hawthorn, Scots pine, Douglas fir and Silver fir are now being grown. Trees of a number of species have been planted out ready for infection experiments to be made in the spring.

The disease has been investigated in a number of localities and tests for soil acidity have been carried out.

A note on the host plants of Fomes annosus is now in the press.

Disease of Pines caused by Brunchorstia destruens.

The fungus obtained from the Austrian pine has been grown in culture and infection experiments have been carried out with positive results on Austrian, Corsican, and Mountain pines.

An account of the disease has been published in the Transactions of the Royal Scottish Arboricultural Society.

Sphaeropsis Pinea.

Specimens of Austrian pine attacked by this fungus have been sent in from Sussex and material on Scots pine from Devon. This species has been described as causing a serious disease of pines in this country and has attacked Pinus insignis in New Zealand. It is described as a disease of Douglas fir in Italy.

It is possible that this disease may cause some damage especially to pines in this country in future.

During the year 35 specimens have been reported on. The Bulletin on Phomopsis Disease of Conifers has been published and leaflets on Fomes annosus and Armillaria mellea revised. The following papers have also been published in the Transactions of the Royal Scottish Arboricultural Society :-

Rhizosphaera Kalkhoffii Bubak, as a cause of Defoliation of Conifers

By

Dr Malcolm Wilson and J.S.L.Waldie, B.Sc.,C.D.A.

Rhabdocline Pseudotsugae Syd.: A New Disease of the Douglas fir in Scotland.

By

Dr Malcolm Wilson and Mary J.F.Wilson, B.Sc.

A Die-back Disease of Pines.

By

John S.L.Waldie, B.Sc., C.D.A.